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KOWIEN–Projektbericht 7/2003

Towards Ontology-based Skills Management

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Das Projekt KOWIEN ("Kooperatives Wissensmanagement in Engineering-Netzwerken") wird mit Mitteln des Bundesministeriums für Bildung und Forschung (BMBF) gefördert (Förderkennzeichen Hauptband 02 PD1060) und vom Projektträger Produktion und Fertigungstechnologien (PFT), Forschungszentrum Karlsruhe GmbH, betreut.
Die Mitglieder des Projektteams danken für die großzügige Unterstützung ihrer Forschungs- und Transferarbeiten.

Dezember 2003
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ABSTRACT

During the last years more and more businesses have realized that knowing their employees competencies is an essential factor in order to stay competitive within the market. A knowledge management system based on ontologies can help a company to build up and manage skill profiles of its employees. For this reason a joint research project currently develops a suite consisting of a process model and a software application. This paper briefly lays out the midterm-results of the research project KOWIEN at the University of Duisburg-Essen.

Keywords

Skills Management System, Ontologies.

INTRODUCTION

During the last years more and more businesses have realized that knowing their employees skills is an essential factor in order to stay competitive within the market. Northwest Airlines Corp. had to cut 10.000 positions, in the days following Sept. 11, without assessing the loss in company based knowledge affiliated with the layoffs [1]. Another example is the change in demographics and baby boomers approaching retirement age, so employers are increasingly concerned about how they are going to replace these skilled employees [2, p.48].

A knowledge management system based on ontologies can help a company to build up and manage skill profiles of its employees. The use of inference rules within a knowledge based system allows the inquiry of implicit company knowledge. Explicit knowledge about the employees skills can help allocate these skills.

Based on that, ontologies can help curing the linguistic divergences that exist between identical information gathered from different parts of an organization by unifying semantics.

KOWIEN

KOWIEN (Kooperatives Wissensmanagement in Engineering-Netzwerken/ Cooperative Knowledge Management in Engineering Networks) is a joint research project in the field of knowledge-based systems development. The consortium consists of four business partners, a technology partner and a software development partner. The Comma Soft AG as the development partner will implement the conceptualized system. The technology partner is represented by the Institute for Production and Industrial Knowledge Management at the University of Duisburg-Essen in Germany. The overall aims of the project are to strengthen the competitiveness of small and medium sized companies, to raise the quality of development results and to close the technical gap between research and practice by using ontologies. The software prototype will support processes for developing new products and services in engineering networks.

Skills management means the management of knowledge about skills. KOWIEN will conceptualize, develop and evaluate an ontology-based management information system to allocate the skills of employees and even of the organisation itself. To achieve this

aim all the relevant information sources of an enterprise will be used to build the knowledge base about existing skills.

In this paper we will especially introduce the KOWIEN process model and the framework of the KOWIEN prototype at a glance.

Skills Management System

A skills management system can be seen as a part of an organizational memory information system, which gives it the ability to store dispersed and unstructured corporate knowledge, such as corporate competencies characteristics [3].

In general a skills management system (SMS) has to achieve three functions [4]:

- It has to support the complete and systematic acquisition of knowledge about skills of members of an enterprise.
- It has to provide the knowledge about skills and the skills owners.
- It has to apply the available knowledge to serve a purpose.

Normal (e.g. not ontology-based) SMS actually concentrate on the manual definition of skills by employees, a simple tree-hierarchy of relations between competencies and focus on the personnel department [5]. This can hardly satisfy basic business demands. For example because of focusing only on managing *existing* skills the strategic human resources *development* is not supported and often the SMS is not integrated in the existing IT infrastructure. As a result the organization does not benefit from sources of knowledge about its employees skills.

To get acceptance of a SMS, it is essential to gain a high actuality of the administrated knowledge about skills, so the users can rely on the statements the system gives. For this reason it is also necessary that the SMS can “look” continuously after its knowledge base and expand it.

Advantages of Ontologies

In the case of explicating gaps, e.g. the knowledge about skills of employees is only implicit contained in documents and not explicitly available for the SMS, an inference engine allows explicating the implicit knowledge. Using non-deductive inference rules can expand the knowledge base significantly. The user of an ontology-based SMS gets a more valuable answer than he would get with using a common database query. The in-

ference mechanism takes positive effect on quality, actuality, acceptance and trustworthiness of a SMS [6].

To the knowledge of the author, there are currently two other projects investigating the development of an ontology-based SMS [7, 8]. Both approaches do not use non-deductive inferences rules yet. Therefore it has not been taken advantage of the unique selling proposition of ontologies. Of course, research is done in not ontology-based SMS, for an example in a software consultancy company see [11].

KOWIEN Process Model

The KOWIEN process model is addressed to users within a practical environment. It intends to give advice to users who want to conceptualize, develop and evaluate an ontology-based skills management system. The model in detail [9] has been represented as an event-driven process chain [10]. Actually the KOWIEN process model will be extended with concrete tools that help the user to apply it successfully. For example a

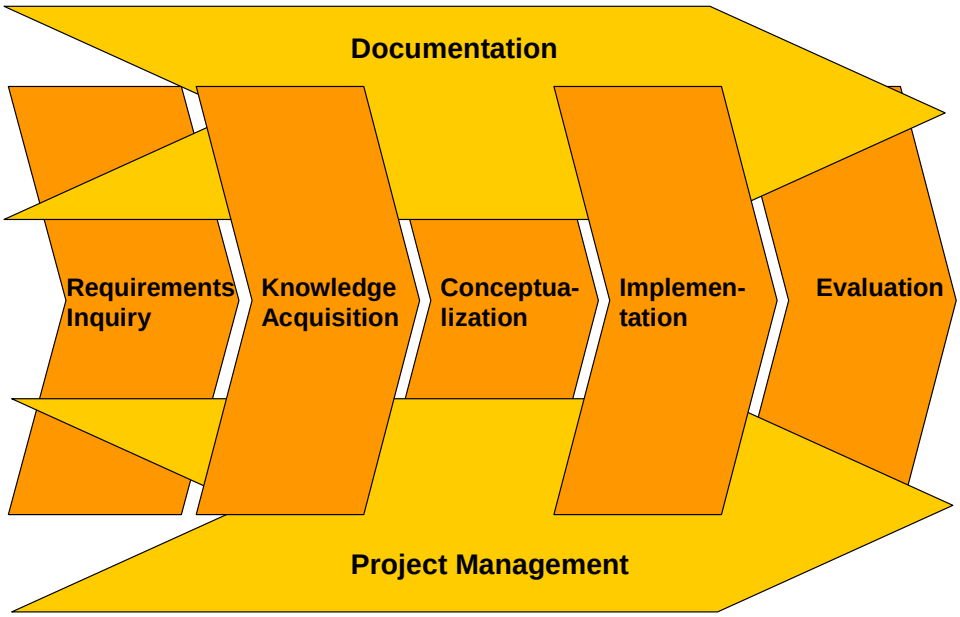

Figure 1: Top level of the KOWIEN process model.

questionnaire will be implemented that allows to evaluate the developed and implemented ontologies. Figure 1 shows the aggregated top level of the model composed of

the five phases: requirements inquiry, knowledge acquisition, conceptualization, representation, evaluation, documentation and project management.

The aim of the ontology development is specified in the first step of the KOWIEN process model. The *requirements inquiry* defines the area of application. By developing use cases and scenarios, different situations can be described where the application will be used. The identified requirements have systematically to be objected to support the phase of evaluation later on. If there has been identified a large and complex number of requirements, it can be reasonable to use a requirements engineering tool to support their management. The inquiry of the users and the analysis of the peripherals can be regarded as completed when the developers or users agree to it.

The phase *knowledge acquisition* denotes that the project team collects all the relevant information that is needed to conceptualize the ontology. Because the activities of acquisition and structuring of knowledge accompany each other, the phases of knowledge acquisition and conceptualization have to be done within an iterative loop. There are different sources that can be used to create a knowledge base. First of all the employees and their superiors of an organization can be interviewed about the employees´ skills. Another way could be to extract knowledge from electronic documents to ascertain skills. In all cases it is important to pay attention to the fact that knowledge about knowledge will be raised.

A model-like account of an ontology will be developed in the phase of *conceptualization*. On the one hand it contains a conceptual system of the domain (terminology) and on the other hand it contains rules for interpretation and the use of the concepts. Not only the members of the project team conceptualize, but also the users, who have been interviewed during the phase of knowledge acquisition. As far as possible the conceptualization should not be accompanied by a certain language or a technical requirement.

In the phase of *implementation* the formal account of the ontology will be developed. The implementation phase consists of the formal representation of the conceptualization and the integration of the ontology-based application in the system environment. The ontology engineers have to choose an appropriate language considering functionality and capability of the ontology and the constraints of the given information systems in the enterprise. After representing the ontology the result has to be implemented into an information system (e.g. with a graphical user interface) so that users can fetch knowledge about skills from it. Besides, it is intended that the skills management system ex-

plicates new knowledge about skills from documents or databases that are already used by an enterprise [6].

Before using the skills management system and the ontology in everyday life the ontology has to be *evaluated* towards requirements conformance and general applicability in the workflow. The process model determines verification (or falsification) and validation.

Project management and documentation are backing processes. They are essential to assure success, but not bound directly to the SMS development.

The *documentation phase* is very important for all phases (requirements inquiry, knowledge acquisition, conceptualization, implementation and evaluation) or the modification and reusing of the ontology later on [12, p. 34]. To avoid mistakes the project team has to document important milestones, decisions and results. Furthermore a good documentation is important for users to make the ontology understandable with its inherent definitions. For example the phase will create documents describing knowledge carriers, users and the knowledge acquisition techniques that have been applied. Ontology development tools do help by enabling natural or formal language or graphical account of an ontology or by allowing entering comments or descriptions into source code.

The phase *project management* contains mainly the coordination of the stakeholders, the tracking of the schedule and the budget control.

In the following section we will show in brief a possible *application* of the KOWIEN process model, which is actually in the development stage. The aim is to create a prototype of an ontology-based skills management system by considering the information systems and the using company as given.

KOWIEN Prototype

The software development partner will use his infonea®-Suite[1] as a basis to develop the KOWIEN prototype (figure 2).

Infonea® is a software-architecture for knowledge communication. It is a platform for intra- and internet applications. Different objects can be modeled for customers, e.g. employees, themes, expertises, projects, products or processes. Properties can be allo-

[1] For further information about infonea® and the Comma Soft AG visit their webpage: http://www.comma-soft.com.

cated to so called *knowledge objects*. These knowledge objects can be bound to one another and to different information sources like documents in a DMS or project data in Lotus Notes®. In the way of the specifically modeled objects, infonea® allows the connections to nearly any information sources. There are several additional features that are not important for our research topic in this paper and so they will not be explained here. The infonea® suite includes four Sub-Suites, two server applications and three supporting packages. We will briefly describe the constituents for our needs.

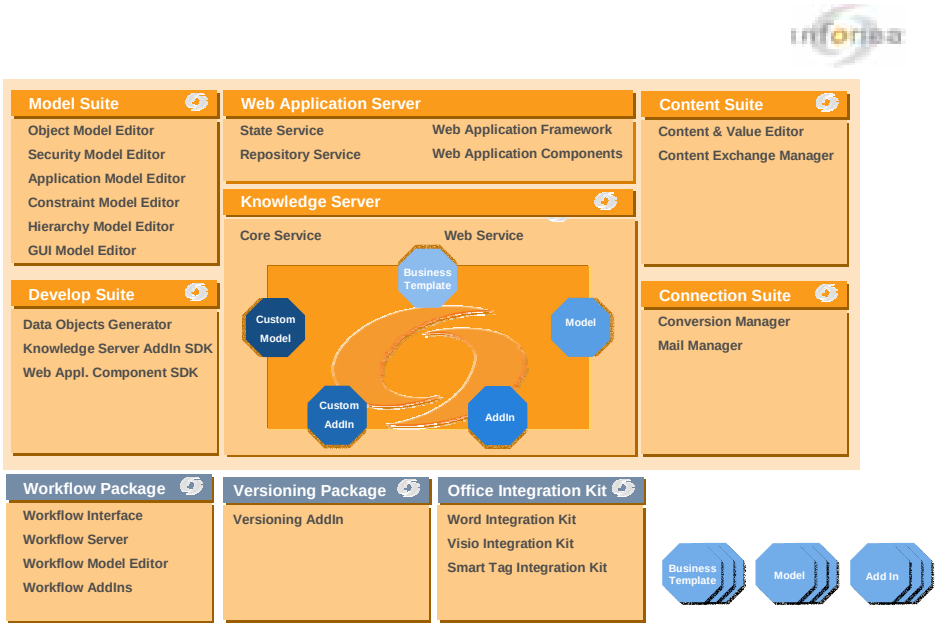

Figure 2: The system architecture of infonea®.

The model suite provides different editors to model objects, constraints and the graphical user interface.

The knowledge server harbors the knowledge base in the form of the custom model and the meta model.

The web application server provides with its web application framework the possibility that the users can actually access database knowledge just by using their web browsers.

Main Components of the ontology-based skills management system

The framework of the ontology-based skills management system is shown in figure 3. As we have already mentioned, the prototype will use the infonea® suite as a basis. Adding browser, web server, inference engine, ontology and knowledge base the ontology-based system is complete. The system architecture contains interfaces to security system, mail system, file converter and XML data. It is possible to build a distributed system.

The most important component of the KOWIEN prototype is the *ontology* (figure 3). The project KOWIEN plans the configuration of an ontology for every business partner in the project accounting the scenarios of product engineering and service engineering.

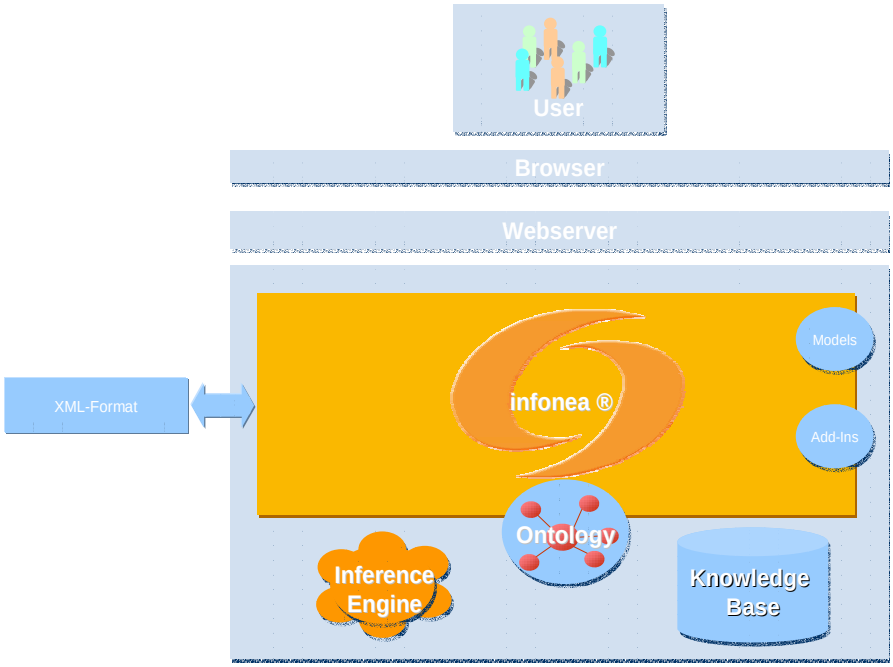

Figure 3: Framework of the ontology-based skills management system.

Additionally to the representation of concepts, relationships and properties, the ontology will represent rules of integrity and inference. The inference rules allow explicating implicit factual knowledge about the skills of the employees. In the *knowledge base* the knowledge about the skills of the organization and the employees will be hosted. The *inference engine* will serve to explicate the implicit knowledge. For this purpose the inference engine will access the ontology and the knowledge base. Deduced knowledge

will be saved in the knowledge base. The *web server* adopts the communication between the browser and the infonea® application. Using XML the data between external applications and the knowledge management system can be exchanged.

Possibilities of Queries

On the one hand the knowledge base can be queried directly. On the other hand the possibility to work with the inference engine exists to get results of better quality in actuality and reliability.

Querying the knowledge base directly without using the inference engine means a fast result of high performance. It is planned that the possibility to work with the inference engine can be chosen by the user. That means normally the user queries directly. Only in the case of not getting a satisfying answer with a direct query he uses the inference engine to get better quality.

Future Research

The KOWIEN process model has been revised by the project partners. After this it is planned to expand it to take reference models into consideration. A reference model already disposes about knowledge in a certain domain. So the users get information that make it much easier to develop the needed ontologies. Currently a top level ontology exists as a prototype that represents the domain of skills in an enterprise in general. A more specific one has been build recently that represents the domain of skills of one business partner. After surveying, the consortium decided to use the language f-logic developed by Kifer, Lausen and Wu [13] for the stand alone representation of the ontology, because of the nearness to first-order predicate calculus.

In the case of the KOWIEN prototype the representation of the ontology will be split: The concepts, relationships, properties and parts of the rules will be represented in the infonea® data model. The remaining rules will be represented in f-logic (especially the non deductive ones). The part of the ontology that is represented in infonea® can be exported as a XML-document.

It is planned that in spring 2004 the KOWIEN prototype will be implemented. After this it undergoes an evaluation phase. Additionally, a web based training module that allows learners to develop their own ontologies without knowing before what the concept “Ontologies” means will be developed. In the year 2004 the project will be finished.

ACKNOWLEDGMENTS

The joint research project KOWIEN (Kooperatives Wissensmanagement in Engineering-Netzwerken) is sponsored by the BMBF in the framework „Research for the Production of tomorrow“ (Government Aid 02 PD 1060). For further information in German visit the website: http://www.kowien.uni-essen.de.

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