AKSIO- An application of Semantic Web technology for knowledge management in the petroleum industry

KW Partner: Computas

1. Overview

Challenge

The management of offshore oil & gas fields, in the North Sea and elsewhere, is moving towards integrated operations, the challenge is to provide support in a situation with decreasing personnel levels and higher reliance on individual expert resources.

Solution

AKSIO supports collaborative work in teams with members from the offshore platform, onshore operations centre, individual specialists, and suppliers. It will link databases, applications, specialist knowledge networks, and real-time data from the field to a visual representation of the work process.

Why a Semantic solution

Core functionality of the AKSIO system is provided by careful application of Semantic Web technology, including ontology-based annotation and smart retrieval of content.

Key Business Benefits

Real-time knowledge and process management of the drilling operations

Business Partners

UniK and @semantics.

Keys components

Existing Software
OWL, RDF/S, SPARQL
Microsoft Sharepoint technology
Oracle Database

Research and development
Automated Data and process integration
Automated monitoring of drilling operation
Centralized Ontology maintenance
Social networks
Contextual and focused search

Technology locks
Semantic Web Services
Semi-Automated annotation of resources
Integration of legacy systems

The AKSIO project is developing an integrated system to support operations of offshore oilfields. The system will provide timely and contextual knowledge for work processes. AKSIO supports collaborative work in teams with members from the offshore platform, onshore operations centre, individual specialists, and suppliers. It will link databases, applications, specialist knowledge networks, and real-time data from the field to a visual representation of the work process. Core functionality of the AKSIO system is provided by careful application of Semantic Web technology, including ontology-based annotation and smart retrieval of content.

The management of offshore oil & gas fields, in the North Sea and elsewhere, is moving towards *integrated operations*, i.e. integrated work processes (including planning, drilling & well operations, production, and maintenance), real-time data from the field, on-shore operation centres, and massive use of IT for on-line monitoring, analysis, and decision tasks. For integrated operations to succeed, it is critically important to provide appropriate and timely knowledge to decision-making personnel involved in drilling operations. The challenge is to provide support in a situation with decreasing personnel levels and higher reliance on individual expert resources.

AKSIO focuses on knowledge and IT-enabled knowledge management (KM) for successful implementation of the integrated operations concept. Knowledge is recognized as a critical resource for achieving business results in the oil & gas industry, but KM is often not well connected to core work processes. KM research focuses on issues like communities-of-practice, narratives, innovation, organizational issues, as well as purely IT-oriented aspects. In the AKSIO project, Semantic Web technology is being used as a foundation for building more intelligent knowledge support to operations.

2. Work processes

Planning and executing a drilling operation is a highly complex undertaking, and is governed by an overall work process, as indicated in Fig. 1.
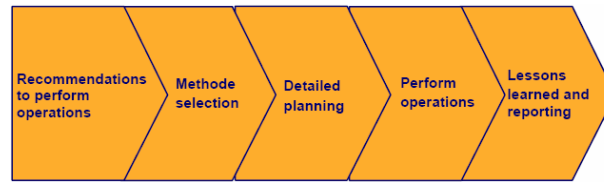

Figure 1. The overall work process for a drilling project.

The three first stages of the process are all concerned with *planning*, starting with a business proposal to drill for oil in a certain geological area, and ending with a detailed plan for the operation. Several types of expertise need to cooperate to make a high-quality drilling plan, such as geologists, geophysicists, petrophysicists, drilling engineers, reservoir geologists, etc.

The operation phase uses the detailed plan to carry out the actual drilling work. Depending on experience gained during drilling, the detailed plan may be revised "on-the-fly". Such experience is documented in an experience data base and can be used as a basis for the reporting phase as well.

The definition of the drilling work process seems to indicate a sequence of steps. However, many of the stages are overlapping, often in order to save time for the subsequent stages. The potential for better integration of planning and operation activities are considerable. In particular, studies have shown that there is a need for improved feedback of knowledge from the operations phase to planning of subsequent drilling projects, as well between the operations phases of different projects.

3. Design concepts

The major aspects of the AKSIO concept are illustrated in Fig. 2. Engineers and other decision-making staff at an onshore operations centre perform work tasks as part of certain work processes. To make the best decisions, they access data sources (historical and real-time data), use specific IT tools, and interrogate colleagues in knowledge networks for specific pieces of knowledge. Knowledge must be timely and contextual relative to the decision task and work process at hand.
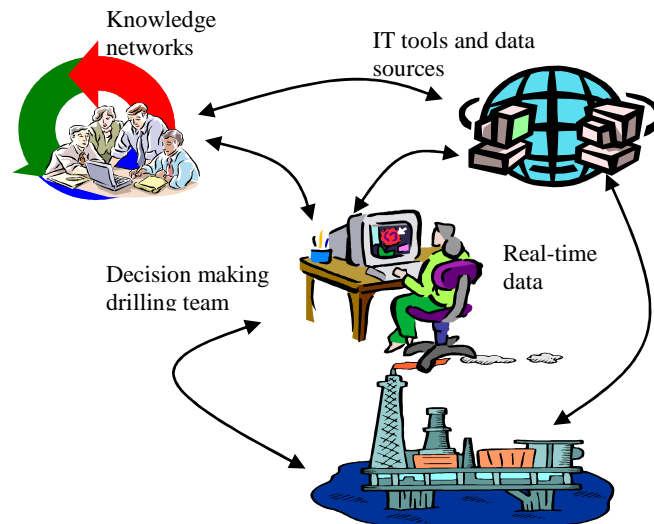

Figure 2. AKSIO combines knowledge management, decision support, and real-time data tracking

The services to be offered by the AKSIO system include:

- Sustained knowledge creation and sharing (between different fields and work process phases)

- Manual and autonomous monitoring of the drilling process – situation assessment

- Solicited as well as unsolicited ("active") guidance during performance of work process operations

- Assistance in identification of needed information sources (human, databases, documents)

Services are to be embedded in the tools already used by oil company personnel to carry out their daily duties.

Semantic Web technology

Semantic Technology plays an important role in realizing the AKSIO design concept: The first version of the system focuses on experience transfer from ongoing drilling operations to planning of subsequent operations. The scenario involves the following Semantic Web technologies:

- A *drilling ontology* has been established to serve as a common vocabulary for planning and operations (OWL)

- Experts *annotate* operational experience reports with semantic markers to increase its reuse potential (RDF, annotation client). The annotation is a collaborative process involving "first-line" operators and "second-line" expertise networks. Later versions of AKSIO will investigate automated/assisted annotation

- *Semantic queries* are used to retrieve experience material with high precision and recall (SPARQL). Retrieval modes includes both pull by end-users and push by active invocation of knowledge based on e.g. semantic profiles of domain objects, such as wells.

- A centrally maintained *knowledge base* holds the ontology and metadata required (triple store, Semantic Web Services)

Annotation and query functions are embedded in the *work processes* and IT tools normally used by the personnel in question. The IT tools (based on Microsoft Sharepoint technology) are augmented to communicate with the AKSIO knowledge base.

Conclusions

Key innovative elements of AKSIO are real-time knowledge and process management. The underlying tools borrow from Semantic Web technology. AKSIO will enable drilling engineers to make the best informed and optimal decisions, and will bring state-of-the-art semantic technology to a new arena.

Acknowledgements

Technical information

The AKSIO KM pilot aims to lay the groundwork for an improved way of sharing experiences between the operational phases of a drilling project and planning of new wells.

In this demo we will simulate the registration of new experiences and show the basic functionality for annotation of experience material. The result is a context aware knowledge resource coupled to social resources that could be used in context specific retrieval. We will also explain the technical architecture of the solution.

Registration of experiences

Currently in Statoil the drilling project manager registers new experiences in a legacy reporting system for drilling operations. These experiences are then stored in an Oracle database. As in most enterprises you rarely have the luxury to replace existing operational business applications, hence the registration of experiences will not be replaced in AKSIO but we will interface to existing systems.

Screening

The incoming new experience records are fetched from the Oracle database, converted to RDF and the result is merged with sub-graphs from other sources, including contact information for the users involved and cross references.

The original data model is extracted and preserved in the RDF using simplified SPARQL–SQL rewriting.

Common semantics are then extracted in upper level ontologies and experiences are coupled to oil sector ontologies to allow better discovery.

The experience is then presented in the Subsurface Support Center's portal (Microsoft Share Point) for initial screening where experiences that are not applicable for reuse, or only locally applicable are thrown away, whereas experiences found valuable are delegated to discipline advisors for classification and annotation.

Classification and annotation

The discipline advisors will be assigned new experiences through a Share Point task visible in Outlook Today.

In AKSIO classification and annotation serves different objectives. Classification, either being established for the oil industry or Statoil specific ontologies will in next pilots aid in context specific search and retrieval of the experiences and covers various dimensions including geography and disciplines, equipment in use, and activities.

The objective of annotation is to aid the well-planning projects in the interpretation of the experience and to connect experiences to social networks. Hence the discipline advisors try to generalize the specific experiences and evaluate its applicability in future projects.

All annotations, links and ontologies are stored and managed in RDF/S and OWL. SPARQL queries are federated over the sources, and full descriptions are sent to the clients where the application decides what and how it is to present the information.

Next step: Context specific retrieval

AKSIO aims in next phase to leverage on the various ontologies to retrieve the most relevant qualified experiences. The flexible model of RDF will in addition provide the instance-level flexibility and accuracy to let the user dynamically navigates through descriptions in various visual models and connects hard information resources to soft social resources.

In next pilot we aid the planners of new wells in retrieving the most appropriate experiences given the in the planning process and activities they execute, and the characteristics of the well they are planning. This will give the ability to conduct context specific retrieval.