Design and Implementation of a Semantic Web Solution for Information and Knowledge Management in Real-time Reservoir Management

Ramakrishna Soma1, Amol Bakshi2, Will DaSie3, Kanwal Gupta4, Viktor Prasanna2

[1] Computer Science Department, University of Southern California, Los Angeles, CA 90089
[2] Ming Hsieh Department of Electrical Engineering, University of Southern California, Los Angeles, CA 90089
[3] Chevron Corp., San Ramon, CA
[4] Avanade Inc., CA
rsoma@usc.edu, amol@usc.edu, Will.DaSie@chevron.com, kanwalg@avanade.com, prasanna@usc.edu

In real-time reservoir management simulations of various aspects of the oil-field, e.g., reservoir models, geological models, well models etc. are used to make operational and strategic decisions on the oil-field. Three problems that are commonly encountered in such operations are: on-demand access to information, integrated view of information, and knowledge management. The first two problems of on-demand access and information integration arise because a number of different kinds of simulation models are created and used. Since most engineers are an expert in a particular simulation technology, accessing the information modeled in a model outside their area of expertise is not easy. Also since these models are created by different processes and people, the same information could be represented differently across models. A unified view of the models and their simulations is desirable for decision making, and thus the necessity for information integration. Knowledge management refers to a systematic way to capture the rationale (knowledge) behind the various analysis performed by an engineer and decisions taken based on the analysis. It is critical to capture this knowledge for auditing, archiving, and training purposes.

We describe a system that applies semantic web technologies (OWL and RDF) to address these problems. It is a result of a collaboration between researchers at CiSoft[5], reservoir engineers at Chevron and software engineers at Avanade[6] over the last two years. We summarize our thoughts and experiences on some important issues related to the development of such a system, with a particular emphasis on the two semantic web components- the ontology and the knowledge base. In particular we will highlight the following aspects:

1. **Ontology Design:** A bottom-up and modular approach has been used to develop our ontologies. We discuss some interesting aspects of our design including the advantages, disadvantages, a comparison and possible relationships to the POSC Caesar OGO ontology.
2. **Software Development Methodology:** We have used an agile methodology for software development in our project. An interesting problem observed in agile (it-

[5] http://cisoft.usc.edu
[6] http://www.avanade.com

erative) methodologies is that the ontology is constantly modified, which invalidates the rest of the artifacts in the system. We present a novel change management technique to address this problem.
3. **System Design:** We describe the software architecture and the main workflows describing the usage of our system.
4. **Performance:** Performance is a key risk in using semantic web for large scale applications. We present our approach to address this issue, an evaluation of the performance of our current system and some thoughts on its scalability.
5. **Lessons Learnt:** Finally we summarize some of the lessons learnt during the last two years of significant efforts in research, technology transfer and development of this solution.

A significant part of the above work has been presented in the following publications:

- **R. Soma**, Viktor Prasanna, Detecting dirty queries during iterative development of OWL based applications, (To Appear) Ontologies, DataBases, and Applications of Semantics (ODBASE), 2008.

- **R. Soma**, Amol Bakshi, Viktor Prasanna, W. DaSie and B. Bourgeois, Semantic-web technologies for Oil-field Management, SPE Intelligent Energy Conference and Exhibition, April 2008.

Acknowledgment

This research was funded by CiSoft (Center for Interactive Smart Oilfield Technologies), a Center of Research Excellence and Academic Training and a joint venture between the University of Southern California and Chevron. We are grateful to the management of CiSoft and Chevron for permission to present this work.