Position Paper for W3C Workshop on Semantic Web in Energy Industries; Part 1: Oil & Gas

Submitted by: May Hsu, Mike C. Morgan and Fred VanHorne, BAE Systems

Background

At an energy conference in Feb 2008, Andrew Gould, CEO of Schlumberger, discussed the importance of working with companies from outside the oil industry to speed up the process of technology development. He emphasized that the upstream industry could use technologies and learn processes from, for example, the aerospace sector. "… Sometimes adaptation of technologies from other industries can be a much faster way of developing technology than an industry brining it along itself". Source: Society of Petroleum Engineers press release from the IE 2008 - Intelligent energy revolution reshaping E&P sector 3 Mar 2008

This position paper is an answer to that call for outside industries to bring their relevant technical expertise in other areas to explore new ways to address the challenges facing the oil and gas industry today.

Problem characteristics

Our previous work has focused on supporting the US Government Intelligence Community (IC). While a different problem domain, the IC has invested considerable time, money, and expertise in the areas of advanced **linked data systems** that integrate information across multiple, disparate data types and sources, **environmental assessment** to support planning and decision support systems, and stringent **information assurance** requirements where people's lives literally depend on our ability to protect sensitive information. This position paper focuses on these three critical areas.

Linked Data Systems

Recent activity developing linked data systems provides insight on information-based platforms to address many key issues in content aggregation and navigation. BAE Systems is exploring decision problems and linked data solutions within the Intelligence Community (IC). IC analyst's employ reasoned thinking strategies to decompose issues into sets of indicators and specific information needs. Capturing the organization and structure of these arguments with RDF-based vocabularies provides needed context to "situate" the issue within the larger, linked data graph.

Environmental Assessment

The overall life of our customer's problems consists of environmental assessment for planning and preparation followed by real time decision support. The planning and decision support processes drive the information requirements for environmental assessment. We have integrated ontology of plans, as common team process ontology, with the domain ontologies of subject matter experts in order to tie environmental constraints to alternative options for planning and action.

Information Assurance

Information Assurance plays a central role in all of our IC work. IC team members frequently cross different nationalities, agencies and locations. Even amongst team members, we must ensure protection of sensitive/classified data and data sources as well as civil liberties and data usage. The IC faces several security issues such as sensitive data, lack of international legal protections, need-to-know issues, etc. Ensuring information protection in a (partial) shared web of data was a challenging part of this application of semantic web technology.

We believe many of the same characteristics apply to the E&P segment of the Oil and Gas industry. For example both the IC and Oil and Gas Industries:

- Gather open source and intelligence information for environmental assessments and planning preparation for a real time decision support
    - Protect personnel located overseas in unstable areas
    - Protect personnel traveling to overseas locations
    - Perform scenario planning and prepare contingencies to world events
    - Gather intentions and warnings of potential future actions
    - Plan strategic moves and improve decision making
    - Keep abreast of weather issues affecting off-shore personnel and equipment
- Deal with different levels of perception and perspectives that users are expecting to conduct their tasks
- Require very strong information assurance practices to control data at key decision points rather than multiple downstream control techniques to simplify operations because most projects involve many professionals who are geographically dispersed over a country or even across different countries

Position

While the end missions are quite different, we believe the types and complexity of the organizational and professional relationships in E&P share many characteristics with the Intelligence Community (IC). Oil and Gas scenarios have much in common with IC scenarios. Structured content from data stores, sensor information from the field, unstructured content from reports and open sources all must be combined to give a clear picture. Teams are created to work specific issues, combining input and analysis from many disciplines. Many times, visualization techniques like maps and timelines provide needed clarity and direction for new questions. When we combine the analytic tradecraft captured in the analyst's decomposition of issues with all these sources we begin to see a path from volumes of data into actionable knowledge. Semantic web technologies will play a critical role in successful systems.

Like the IC, E&P projects bring together new teams of industrial and scientific partners that include business, government, scientific, and engineering experts. The challenge is often how to find the balance between extracting the right information needed to solve the problem while still protecting the individual group's data and methods. Similarly, in the IC, we frequently share information with foreign governments or with first responders where certain information can be shared but giving or receiving other information must be forbidden to protect source & methods and civil liberties. We believe some of the same techniques used to protect and audit the sharing of sensitive government data apply to proprietary E&P data.

We believe explicitly capturing (using semantic web technologies) the relationships between environmental knowledge used to effectively plan courses of action and support real time spatial information requirements is as important for planning and execution in E&P projects. For instance, effective emergency/disaster planning for oil spillage or unstable offshore structures requires detailed actual and predictive environmental knowledge to be able to assess the consequence or alternatives and ensure resources needed to react are already in the vicinity before contingencies develop.

In addition to the environmental knowledge, semantic web technologies also play an important role in helping improve communication between different organizations, professions, and countries since effective exchange of knowledge often lies at the heart of many problems.

USE CASE 1 – Environmental Assessment and Information Assurance.

For a mission critical project, an established E&P team takes on geoscientists from a new university with key local expertise. The tools and datasets used by these geoscientists have important differences from the established members of the team. Also, the collaboration is only

for this project, so accidental exposure to data from other projects or businesses should be avoided and monitored.

Key technologies

a) SOA Integration of data labeling, auditing and role based access controls on semantic web data, and associated datasets of seismic, vector, post and surface data. Techniques which avoid unnecessary replication of very large data are preferred since the relationship is temporary.
b) Ontology based mapping of local vocabularies – the new university uses slightly different terminology, including applying standard ISO 15926 terms in a slightly different way (even as ISO standards mature, business practices to carry them out consistently will always lag).
c) GML and XML (including RDF) layering on top of JPEG 2000 adds positioning and geospatial information along with web-based W3C, structured and semantic information and Open Geospatial Consortium (OGC) standards compatibility
d) Streaming GML JPEG 2000 imagery allows derived products such as elevation matrices, vector features, or distributions of physical properties (e.g. pressure, temperature and chemistry) to be delivered with imagery and semantic annotations over one connection, simplifying and reducing interfaces

USE CASE 2. Planning and Real-Time Decision Support with OSINT linked data

An integrated E&P team wants to get more value out of expensive exploration activities. They already invest heavily in real-time graphic visualization of environmental and drilling operational data. They decide to get more out of planning and preparation and integrate these efforts more tightly with real-time decision support infused with open source intelligence (OSINT) combined with operational information to provide a good view for the decision makers. Non-real-time preparation will improve real-time decision support.

Key technologies

a) Reuse maturing oil & gas process industries domain ontologies – but integrate with a higher level ontology of plans. This helps integrate environmental information with alternatives for action. Explicitly represent alternative plans and courses of action and the environment conditions they require/respond to.
b) Integration with multiple, linked data sources are needed for analysis. The work has focused on both geo-spatial and temporal characteristics.
c) From planning results – use business rules and inferencing to generate information requirements/display configuration for common operational picture used for real-time decision support. Provide environmental and planning inputs to simulation of alternative courses of action to build a decision support template for the exploration project.

Workshop Objectives

1. Provide example/discussion of ontology of plans integrated with environment assessment domain ontologies. Provide example of how plans relate to decision support templates and requirements for common operational pictures.
2. Participate in use case development to better understand what types of role based access controls are appropriate for different E&P projects.
3. Discuss ideas related to automated processes to construct linked data documents. Our initial work with geospatial and temporal rules to constructing GEOINT (Geospatial Intelligence) could be a starting point. Development of topical knowledge bases (i.e. UMBEL) for issue-based specifics and how that could support knowledge level integration would also be of interest.
4. Demonstrate and discuss one approach to designing issue-based systems and how they might be integrated into the global linked graph. Our emphasis is on open standards and available web sources. The idea is to capture metadata about the specific issue and then provide recommendations from available feeds for further analysis and aggregation. We

are also very interested in techniques to expose specialized content sources (i.e. relational DB's and excel spreadsheets) into the current picture.

5. Participate in use case development to better understand opportunities to relate planning and decision support in E&P. The best planning is really preparing to re-plan.
   a. What are key environmental opportunities for planners?
   b. How can early and comparatively inexpensive geo-science stimulate new planning ideas?
   c. What information serves as leading indicators?
   d. How do we rapidly re-plan to take advantage of surprises uncovered in exploration?
6. Provide examples of GMLJP2 streaming with access control and semantic annotation.

Conclusion

The Intelligence Community (IC) faces many challenges that parallel E&P within the Oil and Gas industry. Like E&P, the IC uses broadly distributed, virtual teams that bring a wide range of expertise together to address a specific problem. This mode of operation requires a strong focus on information assurance, collaboration, and communication across the teams and complex data and information needs that lend themselves to semantic web technologies. We are here to share our knowledge from the IC and to gain a better understanding of where and how these techniques and our expertise from another industry might best help Oil and Gas rapidly move into new and exciting areas.