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A Multivendor Data-Exchange Format To Support Digital Oilfields

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Abstract

Over the past decade the rapid evolution of Information Technology has enabled oil companies to much more effectively exploit hydrocarbon reserves than was possible up to now. These technologies all rely on an extensive set of instrumentation and controls.

The expected benefits of this novel approach to oilfield management are very high, but can only be harvested by means of an appropriate IT infrastructure and data exchange protocols.

PRODML (PRODuction xML) is a proposed data exchange mechanism which will facilitate the integration between software tools that are used in combination to turn raw production data into control actions.

PRODML intends to be an industry standard XML-based exchange format for production data. The scope of the first version of PRODML will be determined by what can reliably be delivered in a one year period.

This first version will support data exchange between applications in the office domain with emphasis on near-real time optimisation. In this context, near-real time optimisation is defined as optimisation that can be achieved by making changes in the existing production configuration that can be effectuated within one day.

The overall approach follows the successful example of the WITSML project, which established a similar set of specifications for the drilling domain.

PRODML was initiated jointly by BP, Chevron, ExxonMobil, Shell and Statoil in early 2005.

The initiative has since been joined by Halliburton, Invensys, OSIsoft, Petex, Schlumberger, Sense-Intellifield, Tietoenator and Weatherford, and is now in the process of developing the standard. POSC has agreed to take over stewardship of the effort once work on the first version has been completed and to foster further developments.

The paper represents the work of the entire team.

Introduction

Many oil companies have begun to exploit the benefits of highly instrumented fields for optimal operation of their assets. This approach relies on much-increased use of data streaming from field to office.

Improvements in infrastructure for data handling and a common data exchange format as a 'lingua franca' between applications are prerequisites to robust and efficient dataflows.

Many of the software tools used to process and monitor the data flowing from the field are provided by a number of independent software companies and service providers. The current commercial landscape is characterised by a relatively large number of companies, each providing a piece of the solution. The majority of these tools do not stand on their own, but require information from other tools. An efficient means of interoperability between these tools is essential.

In this commercial setting it is in the interest of both users and providers of tools that a viable open industry standard for a data exchange format be established. Such a standard levels the playing field by assuring some level of compatibility between vendor products, allowing them to focus on delivering innovative, distinguishing functionality. From an operator's perspective the standard will accelerate the delivery of integrated solutions to end-users and decrease the costs of connecting and supporting the various parts.

The evolution of the Internet has had a profound impact on the manner in which data is being processed. The technologies, although still developing, have matured over the past years to the extent that they can now be used reliably for routine operations. Internet-based IT architectures are being adopted by most companies and will be incorporated in the PRODML design.

PRODML will help oil companies reap the benefits of highly instrumented fields.

Potential benefits

The PRODML team envisions a number of benefits for both operating companies and vendors who adopt the standard. Some of these benefits include:

a) *Improved operations performance*
Production optimisation systems will be more reliable, more accurate and have a lower total cost of ownership. Easier implementation and support will

help operators increase production, minimise costs and maximise flexibility in managing assets and deploying personnel who support them.

b) *Improved collaboration and data sharing*
Data can be transferred without need for extensive negotiation of format or meaning. This reduces the effort of implementing new tools and technologies and provides a clearer understanding of the information relating to an asset.

c) *Integration with Partners*
Data transfer between operating companies or between an operating company and its vendors is greatly simplified. Current processes often require significant manipulation of data. The standard would make it easier to supply data to external vendors to offer new services, for example data analysis.

d) *Inter-organisation Communication and Analysis*
Collaboration within an organisation becomes simpler as technical professionals from different regions adopt a single data 'language'. Additionally, common data structures (e.g. 'Total Production') can quickly be aggregated across production units.

e) *Reduced cycle time required to capture benefits associated with highly instrumented fields*
Tools which are upgraded to be PRODML compliant will be easier to connect into a data-stream to support more flexible work processes than the sequential Discover-Analyse-Develop approach that is currently commonly used throughout the industry.

f) *Rapid deployment of internal tools.*
Oil companies can more quickly deploy internally developed tools or workflows. These may be the result of proprietary R&D efforts and would normally require extensive customisation to be used in different production areas. Standardising on a single common data model reduces the time to deploy innovative technology across an organisation.

g) *Increased capabilities of applications available in the marketplace*
Vendors who develop PRODML compliant tools will be able to deliver their products to organisations that adopt the standard with minimal modifications. The barriers to entry, which are commonly around the understanding of specific operating company environments, are reduced if a common data access model is available.

Although it is difficult to quantify the value of each of these benefits, there is clearly potential to realise both an increase in recovery efficiency and reduction in costs by developing an industry-wide data exchange standard for production data.

High level architecture

Figure 1 is a simplified, high level architecture picture showing how applications interact with data from the field.

Data is generated by sensors in the Process Control Domain and may be used directly by systems in the field for real-time control. Some of these data are stored locally in historians for a limited period.
A subset of data is transferred from the Process Control Domain to the Office Domain where it is stored in historian databases.
The historian data is accessed by a applications for a variety of purposes including monitoring, reporting, optimisation and history matching. Some applications use the data as-is; others process the data along with other derivative or proprietary information.
After generation of results applications might send control data to the Process Control Domain to complete a feedback loop.
Some applications not only need the raw data from the field, but also data which has been processed and stored for other applications.

Key characteristics of this architecture are:

- Data is typically stored at various places, and in various formats within the system, and must flow between multiple applications
- Different architectural solutions can be put in place to enable interoperability between applications. Such solutions include:

a) Point-to-point data transfer utilities between applications.
b) A common database with a single data model and access procedures which are adopted by all participating applications.
c) A common Integration Platform upon which all participating applications are constructed.
d) A common data exchange protocol which is implemented by all participating applications.
e) A service-oriented architecture which is implemented by all participating applications.

The architecture best suited to solving the problem depends on a variety of factors, including the diversity of players in the field, and the choice of enabling technology.
To enable a variety of vendors to rapidly and efficiently implement this architecture and to deploy the use of state-of-the-art, proven web technologies, the group has selected options d) and e), using XML and web-services as the most appropriate broad solution for the industry.

Scope

The proposed production data standards in its entirety will include the data required for making production optimisation decisions and for regulatory or internal corporate reporting purposes Recognising that this is ambitious, and taking heed of lessons learned from other initiatives, the team has defined a reduced initial scope for developing cross-company standards that can be quickly deployed.
The first version of PRODML, will focus on the software, data flows and workflows that are required for development and usage of computer models with the objective of operating an asset fully optimised, all the time. A continuous, closed-loop comparison of predicted behaviour and observed reality to assess the validity of the models is part of the scope.

This scope will include data flowing from the Process Control Domain through historians to applications, and data associated with the modelling process.

Applications include modelling tools for reservoirs, wells and surface facilities for the purpose of predicting short-term asset performance, optimisation tools, data validation tools, advisory tools and collaboration environments, and tools that enable smart reconciliation of precise measurements at custody transfer points back to individual components of the production system.

Way of working

To focus the development of the data transfer standard, the team has developed a realistic use case. This usecase is described briefly in the Appendix.

The use case was subsequently divided into three workflows each of which will be documented in terms of required web services and xml-based data exchange between the tools to support the workflow.

To promote rapid progress, the PRODML team was kept small. However, since industry-wide acceptance is a key success factor for an open exchange format, the project has provided a means to gather feedback during the process. Interim results will be published on a public website for comment.

For further information…

More information on the PRODML project can be found on our website: www.prodml.org

On that page you can join our extended team and discussion group.

Alternatively you can contact one of our representatives:

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Appendix

This appendix describes a usecase that is based on a real-world problem and is used by the PRODML team to develop interoperability standards.

1. Setting

The example case consists of an offshore field with a series of wells producing oil and gas. Some of the wells produce primarily oil, with associated gas, others produce primarily gas, with condensate as by-product. The gas is contaminated with CO_2, but the percentage varies widely across the field. The oil production is limited by the amount of gas that can be sold to customers; flaring is contractually penalised. The gas is delivered to two facilities: a power plant and a LNG plant. Both customers have a fluctuating demand. The power plant's daily demand varies by about 50%. There are frequent opportunities to sell additional LNG cargoes; the penalty for missed contract-cargoes is high.

Some of the oil wells are free flowing, but the majority rely on artificial lift, mostly gaslift. The liftgas is obtained from the gas system, sometimes requiring additional compression.

The gas power plant contract specifies the maximum acceptable contamination as a percentage, the LNG plant as a tonnage. A comprehensive blending system is available to mix the production from different gas sources to meet contractual requirements regarding contamination.

2. Constraints

- The focus is day-to-day optimisation and must be accomplished by manipulating the existing operational facilities. Planned changes to this infrastructure, however, must be able to be taken into account.
- Not all wells and facilities can be utilised all the time, because of scheduled maintenance, and the inaccessibility of certain assets that can not be remotely operated during parts of the year.
- All elements of the production system must be operating within their limits. (e.g. maximum draw down, minimum and maximum flow rates etc)

3. Business Objective

The company wishes to operate the field in an optimal manner, meeting the gas contracts with maximum permissible contamination, and maximizing oil production within these constrains.

In addition the company wishes to closely monitor facilities to detect all variations from expected behaviour in a timely fashion.

4. The methodology

The basic methodology that underpins the operation of the field is based on simulating its performance in different configurations and selecting the configuration that optimally meets the demands.

The tools required to do this are:

- Modelling tools for reservoir, wells and surface facilities that produce models with adequate accuracy to predict short and medium term performance.
- Simulation and optimisation tools that can advise an optimum configuration of the production facility. These tools are used for planning purposes (maximum 2 year planning horizon), but also in response to events (cargo opportunity, equipment outage, etc).
- Tools to gather actual performance information. Where direct measurements are made they can be retrieved from a data historian). Where direct measurements are not available the data needs to be retrieved from reconciliation programs or other data processing tools.
- Monitoring tools to compare the actual with modelled behaviour and advise on corrective action as needed.
- Execution tools to implement the selected configuration.

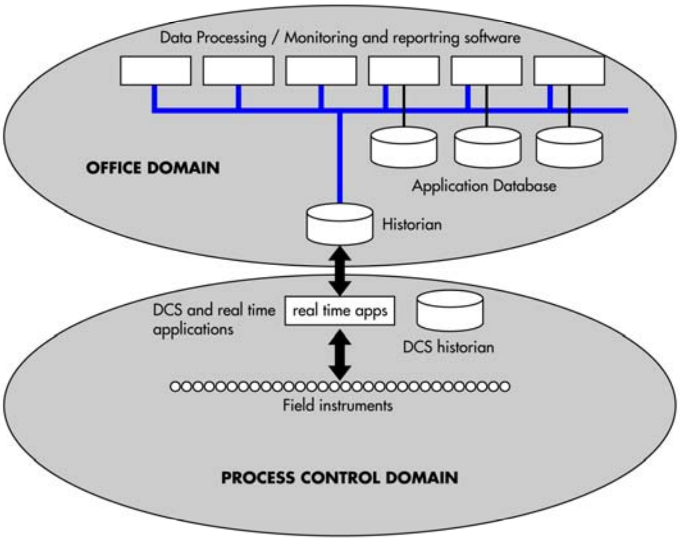

Figure 1