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New data transfer protocol improves drilling support and safety

Using a new protocol, a WITSML pilot project has shown significantly faster data transmission from an offshore wellsite to an onshore operations center. The updated standard has the potential to considerably improve operational support and reduce personnel trips to the rig.

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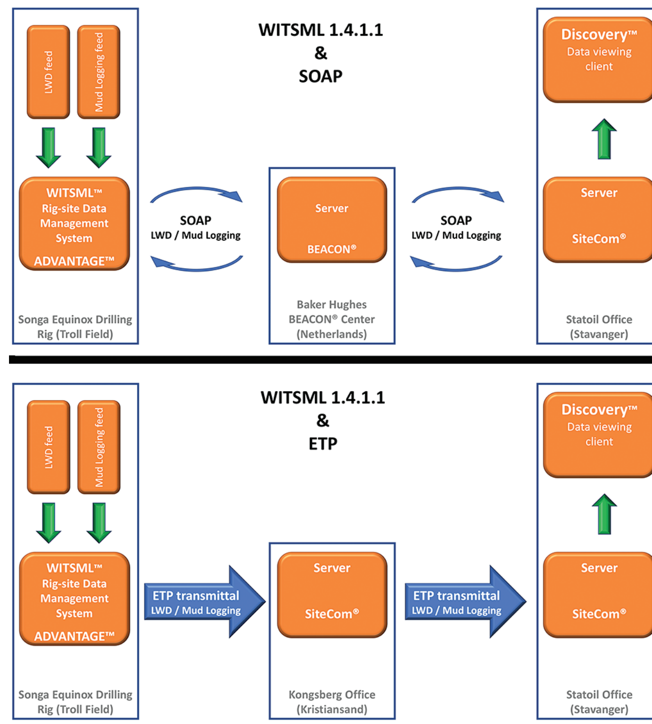
When drilling oil and gas wells, the goal is to complete the job safely, accurately, and cost-effectively. However, offshore operations present more challenges than onshore drilling, because they are more complex and the environment is inherently dangerous, which drives up risks and costs.

To solve these issues, operators are building remote onshore operations centers (ROC). At an ROC, digital data gathered from sensors and systems at the wellsite are transmitted to an onshore location equipped with state-of-the-art digital technology, to gather data for analysis and decision-support by domain experts. Those experts can efficiently share their expertise across multiple offshore sites. Crucial to successful ROC operations is fast, reliable data transmission, so that experts in the ROC can respond quickly—as close to real time as possible—and help drilling personnel make accurate, timely decisions.

However, data transmission and network performance from offshore drilling facilities (in some places characterized by temporary, satellite-based communications infrastructure) are also inherently less reliable than most commercial networks. To further complicate these performance issues, newer technologies, such as logging-while-drilling (LWD) tools, wired drill pipe, and downhole instrumentation, mean the volume of data generated and captured is growing exponentially. And as a result, it also means more data that must be transmitted to an ROC.

To capture this valuable resource, an Energistics Transfer Protocol (ETP) was designed specifically to improve data transfer between the technologies and systems used in upstream operations. An operator and two major service companies conducted a proof of concept (PoC) pilot project to show the performance and benefits of the ETP. In this offshore pilot implementation, the system latency (the time between when the data was transmitted and when it could be used) was reduced dramatically to an average of just 1.2 sec from data acquisition at the offshore wellsite to the arrival at the onshore operations center—an order of magnitude improvement from legacy rates that ranged between 10 to 15 sec.

Fig. 1. The limits of WITSML operating with SOAP-led Energistics members to develop the new ETP transport mechanism.



LEGACY APPROACH

In addition to the problem of data-transfer speed and reliability, another historical challenge for drilling operations has been difficulty in integrating data from the variety of disparate data sources and systems used at wellsites and ROCs. These systems typically are developed by different vendors, service companies and operators with different, often proprietary, data formats. The huge volume of disparate data must be aggregated to understand it and make informed decisions promptly.

To address this data-integration challenge, the industry developed WITSML, a data exchange standard that defines a common format for drilling and well-related data. WITSML was originally developed in 2000 by a group of two operators and three major service companies. WITSML was turned over to Energistics (then named POSC), an oil and gas industry consortium for developing data standards, where operators and service companies, through membership in the WITSML special interest group (SIG), have continued to evolve the standard.

Software that implements WITSML can read and write the common format (in addition to its native format), thereby eliminating the problem of data integration. WITSML defines data objects using Extensible Markup language (XML), a standard that defines a set of rules for encoding content in both human and machine-readable format.

Up through version 1.4.1.1, WITSML also included a SOAP (Simple Object Access Protocol)-based application program interface (API), which defines behaviors for handling and transferring WITSML data, **Fig 1.** The SOAP API uses a client/server model that requires data consumers to continuously poll the servers for new data, which increases traffic on networks. With offshore communications characterized by limited bandwidth, speed and reliability, the SOAP API has relatively slow data updates and has become more time-consuming, especially as data volumes increase. It was these limitations that drove Energistics members to develop the new ETP transport mechanism.

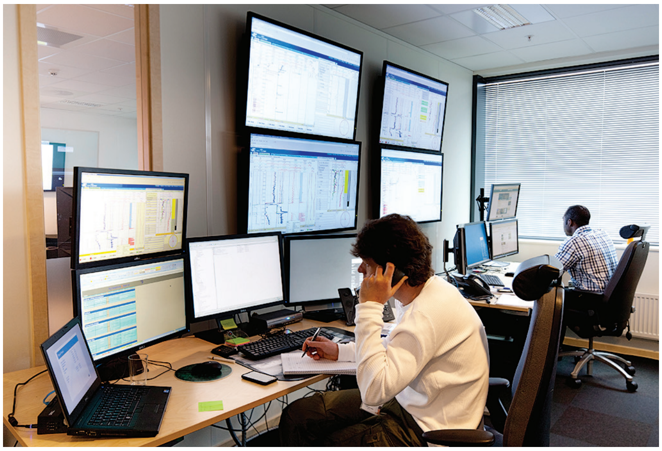
ETP OVERVIEW

Initially published in 2014, ETP is a data exchange specification that enables the efficient transfer of real-time data between applications. It has been designed specifically to meet the unique needs of the upstream oil and gas industry and, more specifically, to facilitate the exchange of data across the spectrum of Energistics' data standards. These standards include WITSML (drilling), PRODML (production operations), and RESQML (earth/reservoir modeling).

ETP defines a publish/subscribe mechanism so that data receivers do not have to continually poll for data and can receive new data as soon as they are available from a data provider. ETP version 1.1 (published in October 2016) has been expanded beyond real-time data transfer to include functionality for data discovery and historical data queries. Its flexible design means it can work with multiple data models. In addition, ETP has the ability to traverse firewalls in a secure manner that is acceptable to most corporate IT organizations.

Fig. 2. WITSML drilling-related data were provided from the *Songa Equinox* rig contracted by Statoil.

Fig. 3. The Beacon Center received data from the rig and relayed it to the Real-time Drilling Data Center (RTC).



PILOT PROJECT

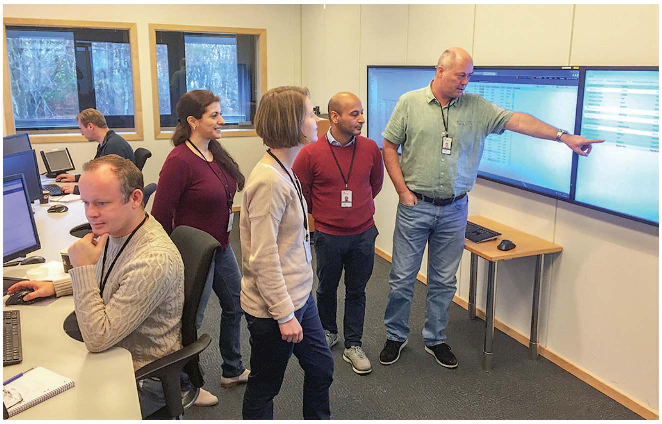
The pilot project was a joint initiative between Statoil, Baker Hughes and Kongsberg Digital. Because all companies are members of Energistics, and participate in the WITSML SIG and the ETP work group, the project team members have been working together for some time to define and develop these standards. The companies' membership in Energistics allowed them to start collectively seeking early implementation opportunities for ETP. Existing commercial relationships provided the framework to collaborate on this pilot project.

With the industry downturn, business priorities have been cost reduction, increased personnel productivity, and minimizing personnel required at the wellsite during drilling and completion operations. Pursuant to this business need, the project team defined key objectives that would meet the needs of drilling engineers: improving transmission speed, facilitating smooth handoff of data between systems and the ability to measure transmission performance.

The project's intent was to make a direct comparison of speed and performance between the original SOAP API from WITSML v.1.4.1.1 and the new ETP. Using the same WITSML v.1.4.1.1 data model and data set for both transfer protocols provided a control factor for an "apples-to-apples" comparison of the protocol performances (speed/latency), comparison of improvements in data assurance metrics, and the recovery of cached data updates following breaks in transmission.

The original WITSML-exchange workflow that was used as the benchmark included the following steps:

Fig. 4. The Real-time Drilling Data Center took data from the Beacon Center in the original process, but received a direct stream from the SiteCom test server in the ETP workflow.



1. A fully WITSML v1.4.1.1-compliant rig site data management system (Advantage, from Baker Hughes) provided WITSML drilling-related data (LWD and mudlogging) from Statoil's *Songa Equinox* rig (**Fig. 2**), located in Troll field, offshore Norway, to Baker Hughes' BEACON center (**Fig. 3**) in the Netherlands.
2. The data were then transferred from BEACON, in real time, to Statoil's Realtime Drilling Data Center (RTC, **Fig. 4**) in Stavanger, using SiteCom and viewed through Discovery Web viewer, both from Kongsberg Digital.

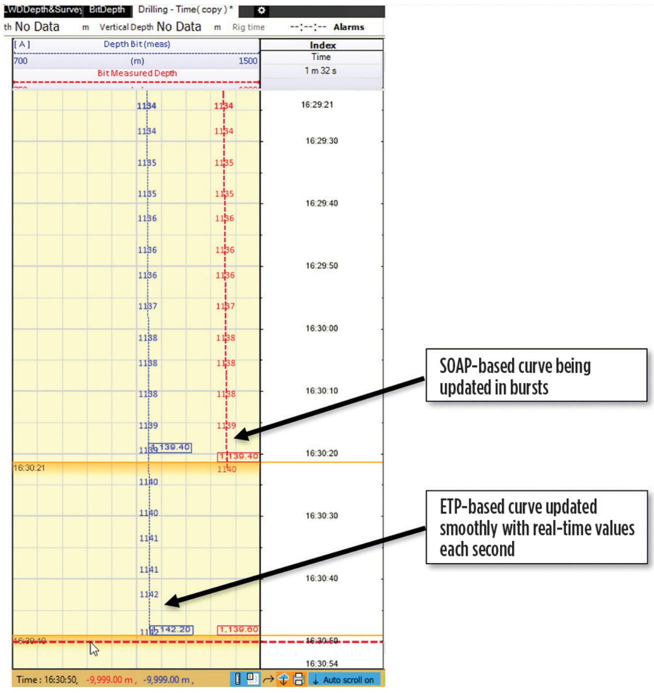
The new ETP-enabled workflow, using the same data set as the original workflow, included the following steps:

1. Baker Hughes' Advantage system was enhanced to transmit WITSML v1.4.1.1 data on ETP and streamed data to a Kongsberg Digital test server running ETP compliant SiteCom, which was located in Kristiansand, Norway.
2. The data were then streamed, using ETP to a SiteCom server hosted in Statoil's RTC in Stavanger, for viewing in an ETP-compatible Discovery client.

These setups were not identical, but they were regarded as comparable for this project, because the underlying network protocols have approximately the same latency. In both workflows, the data acquisition rate implemented by the rig site data management system, and subsequently processed to the end viewer, was set to 1-Hz (The design objective of ETP is to support at least 50 Hz. For this study, 1-Hz data were sufficient, as the objective was to measure latency and not capacity.).

The viewing portal displayed the ETP real-time and legacy data streams, side-by-side, which allowed for easy correlation and the ability to compare the update rate, **Fig. 5.** While the two data sets obviously matched each other, the 1Hz data feed using legacy protocols updated discontinuously, with discrete blocks containing some 6 to 10 sec of data being displayed, the most recent data point being 10–15 sec old on arrival. In contrast, the ETP data display streamed smoothly and continuously on-screen at the original 1 Hz, and was essentially real-time.

Fig. 5. A screenshot of the continuous real-time ETP data stream on the left, and the legacy data stream on the right, shows a 10-15 sec gap at the end of the curve while awaiting display of the next discrete data "block."



The legacy data transfer protocol aggregates all the data and transmits the entire block of accumulated data. On the other hand, ETP's design ensures low latency, because the source system transfers data only when it is changing. As a result, consuming systems that subscribe to ETP data channels get immediate updates, with latency of approximately 100 milliseconds above the speed provided by the underlying network infrastructure.

In this pilot, the ETP system latencies averaged 1.2 sec from data acquisition to an application in the operations center onshore—a ten-fold improvement from legacy rates that ranged between 10 and 15 sec—and required one-tenth the bandwidth.

THE RESULTS

The goals of the project were to meet the needs of drilling engineers, namely, improving transmission speed; facilitating smooth hand-off of data from system to system; and the ability to compare performance. During the trial, ETP functioned, as expected. However, conscious of the operational advantages of ETP, the team planned to accelerate the field deployment of a real-world, functional ETP system, as well as to demonstrate the operation of the ETP data exchange across their proprietary systems and platforms. This necessitated development work within each team member's own application, and also cooperation and collaboration to ensure cross-platform interoperability.

In drilling operations, where minutes make a difference, the new solution improves the reception of valid data—using faster alerts of data outliers and dropouts—and allows faster resolution of data anomalies. The major benefit of using ETP is the dramatic improvement in data transmission speed and data volumes from the wellsite. Initial implementations indicate an order-of-magnitude speed improvement, from data acquisition at the rig, to the delivery of that data to applications needed for decision-making. Although dependent on bandwidth, the new protocol can easily handle over 100,000 data points per second, and it is able to handle a wide variety of device and application implementations programmed in C#, Java, C, C++, JavaScript and Python. The capability of ETP, to provide data in close to real time, will allow for improvements in online collaboration between the rig and the onshore teams, because both groups will be seeing the same thing at exactly the same time.

This project demonstrated that the combination of WITSML and ETP is a critical technology for Statoil's streaming of real-time data to the company's large number of onshore support centers, which are located within its offices, as well as to some external centers located within the offices of its service companies and sub-contractors. To enable integrated and optimized work processes between its drilling rigs and onshore centers, the company needs high-quality, low-latency, high-frequency, real-time drilling data available at all locations.

Previously, many different drilling-related work processes required service companies and contractors to fly personnel to rig sites to perform drilling-related operations. By empowering these contractors with onshore centers and high-quality, streaming real-time data, this is one (of many) contributions to Statoil being able to reduce the number of personnel needed at rig sites. The cost-savings, as well as the hazard avoidance by reducing people onboard (POB), are substantial. Other major benefits include more robust work processes, better use of resources, and more efficient operations.

NEXT STEPS

Statoil, Baker Hughes and Kongsberg are using this solution for drilling operations, where the three companies are working together. In addition, they are collaborating through the Energistics WITSML SIG to enhance ETP with improved security, additional data protocols, and investigation of compression algorithms to further improve data-streaming performance.

Statoil has been adding the solution to its internal data management platform during 2017. The company has, in 2017, used ETP for transmitting data from a drilling operation, using wired drill pipe, where satellite bandwidth is 1⁄10 of the theoretical capacity because of the satellite's extremely low angle above the horizon. Wired drill pipe allows for 1-Hz downhole data to be transmitted to the rig, and, by using ETP, Statoil can realize the benefits of high-resolution downhole data in the office.

Kongsberg is offering ETP v1.1 in its current release of SiteCom. Baker Hughes is continuing to work closely with industry operators to provide and enhance an ETP v1.1 data-streaming service to complement its current WITSML services. WO

THOMAS HALLAND holds an MS degree in information systems from the University of Stavanger. He works in Statoil's Real Time Centre (RTC) as a specialist within subsurface applications and real-time drilling information systems. Statoil's RTC is responsible for technology development and projects related to real-time drilling data streaming from all of Statoil's drilling operations worldwide, into onshore monitoring and decision-support systems. RTC is operated as a 24/7 service and has a corporate responsibility for streaming drilling data from Statoil's drilling service contractors.

KJELL INGE MEISAL holds an MS degree in naval architecture and marine construction from the Norwegian Institute of Technology in Trondheim. He also works in Statoil's Real Time Centre (RTC) as an advisor within subsurface applications, real time drilling information systems and IT infrastructure. Kjell Inge is responsible for Statoil's corporate WITSML data hub, SiteCom, and Discovery Web (the integrated analytical system for drilling and formation evaluation data in SiteCom). He provides advice to improvement projects involving usage of real-time drilling data, enabling third parties to use available data to improve their work processes, etc. He is also involved in tender processes for integrated drilling service contracts, drilling rig contracts, and procurement processes within real-time drilling data.

TED ABRAMSEN of Kongsberg Digital holds an MS degree in computer science from the University of Trondheim, Norway. He is the development manager in Kongsberg Digital's Drilling and Wells unit. His team develops SiteCom and Discovery, a software product suite for real-time and historical analysis of drilling data. SiteCom is a high-capacity WITSML store and data aggregator. The Discovery product line is a set of state-of-the-art end-user tools for data viewing and analysis.

PETER MORRISON of Baker Hughes holds a BSc honors degree in geology from the University of Durham, UK. He is the UK software development manager for Baker Hughes Drilling Services. Mr. Morrison has more than 37 years of oilfield experience, both offshore and onshore, with extensive domain knowledge in all aspects of the industry. His focus is on developing real-time software solutions for the wellsite,and remote operation services using industry-adopted standards. He has been actively involved in Energistics' WITSML and ETP community since its start, and strongly promotes their adoption within Baker Hughes and other software vendors and oilfield operators.

FOR MORE INFORMATION:

Readers may consult SPE paper SPE-181088-MS, "A new communications protocol for real-time decision-making," presented at the SPE Intelligent Energy International Conference and Exhibition in Aberdeen, Scotland, Sept. 6–8, 2016. Authors include W. McKenzie, R. Schave, M. Farnan, L. Deny, P. Morrison, and J. Hollingsworth.