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New Data Transmission Standard Facilitates Synchronous Remote Modeling and Surveillance via the Internet

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Abstract

The communication of data between various operator and service company data stores has long been problematic. Fragile, low bandwidth lines of communication coupled with a lack of standards have left serious efficiency gaps in the movement of data from the acquisition location to decision-making and interpretation centers. Various systems have been developed and deployed to minimize these difficulties; however, all have fallen short of industry requirements. Recent availability of more robust, higher bandwidth lines between locations has led to a new standard of communication called Wellsite Information Transfer Standard Markup Language (WITSML). Using this new technology, data can be acquired and transmitted synchronously or asynchronously among multiple stakeholders with limited effort. The ability to mix and match various data collection vendors and connect these data sources to interpreters and modelers with limited effort is creating new opportunities to improve the success and efficiency of remote operations. This paper reviews four cases that demonstrate the use of WITSML to synchronously transmit real-time data from domestic and international offshore locations to onshore sites. The cases clearly demonstrate that WITSML meets previously neglected industry requirements of durability, flexibility, economy and ease of use in omni-directional data transmission between rig and shore.

Introduction

The petroleum industry thrives on its ability to acquire, manipulate and share ever-improving types of data. Numerous industry standards have been developed to ease the transfer and manipulation of this data; however, each is limited by the knowledge and technology available at the time the standard was created. Furthermore, the value of using data synchronously with its acquisition is becoming increasingly more evident.

Technology advancements in offshore telecommunications have seen the radio replaced by the facsimile, the facsimile by email and now email by synchronous broadband connections over the Internet. Similarly, decision makers want to replace their static reports with secure, synchronous, dynamic information flowing from multiple vendors to multiple assets and stakeholders. Operators have been historically dissatisfied with proprietary data acquisition and transmission solutions that obligate them to a single vendor because a successful operation typically requires components from multiple data-acquisition companies.

These demands were the impetus for the American Petroleum Institute to create the wellsite information transfer specification (WITS) standard for moving drilling data between rig and office-based computer systems. The goal was to standardize rig-to-shore data transmission so that various acquisition companies could communicate with each other and the operator in a common language. Like the standards before it, WITS had numerous limitations that prevented it from becoming a perfectly acceptable solution to the aforementioned demands.

WITSML is a collaborative effort to update the widely used WITS. Internet standards-driven and hardware and software platform-independent, this new specification for secure, synchronous and asynchronous data transmission has recently emerged from the testing stage into commercial field deployment.

Basic WITSML Design

WITSML is a standard for sending wellsite information in a standard format between business partners using Internet-compliant rules (i.e. the familiar XML document format and HTTP/S-based delivery protocols). The content of an XML document is defined by XML schemas.

A WITSML data object is a logical organization and grouping of the data items associated with the major components and operations involved in drilling a well. For example, the group known as the rig “data object” contains the data item related to the rig such as its owner, type and manufacture.

WITSML data objects being exchanged between systems are always transmitted as XML documents, using a standard format known as an WITSML XML.

The WITSML standard consists of two specifications which will be versioned independently: the Data Schema and the Application Program Interface (API).

The WITSML data schema consists of a set of independent but relatable data object schemas. A data object schema is a set of data that can be transmitted within a single XML document and represents a cohesive subset (e.g.; well, wellbore, rig, etc.) of an overall logical schema related to a single domain (well). Data object schemas contain attributes, elements, and included component sub-schemas.

The Application Program Interface specification defines interfaces that will be implemented by a WITSML server for supporting client/server access. The specification defines two interfaces: Client/Server API (“Store”) and Subscriber/Publish API (“Publish”). The Store interface is the primary interface and it provides basic access information such as Get, Update, Add and Delete. The Publish interface is primarily intended to provide the WITS functionality of streaming data as it is being acquired.

WITSML Interfaces

Client/Server Application Program Interface (Store)
In Client/Server mode, WITSML data objects are “pulled”on-demand by a Client from a Server. The Client sends a request to the Server and the Server immediately responds with an acknowledgement or an error code. The Client can add, update, delete and retrieve WITSML data objects on the Server. WITSML uses an established, non-proprietary protocol to transport the requests/responses between Client and Server. **Figure 1** is a client/server use case illustrating a server located at a rig site acting as a central repository for data related to its well(s).

Some of the data stored in such a repository would be collected by other front-end applications used on the rig, such as drilling management systems. These applications would act as Clients, using the rig server as a persistent store to either augment or replace their own internal proprietary databases. The applications could provide the user interface for initially defining the well, accepting manual input and for producing and distributing periodic reports.

Sensor aggregator applications would collect real-time data and transmit them to the proprietary databases on the rig server for future retrieval.

Backend applications located either at the rig or at the office could then act as Clients and retrieve data from the server on-request. A data analysis application, for example, could populate its own well definition based on the well object it retrieves from the server, and then retrieve the stored log curves for analysis.

Subscribe/Publish Application Program Interface (Publish)
Using the Subscribe/Publish API, WITSML data objects are periodically “pushed” from a Publisher to a Subscriber. The Subscriber defines what data objects it wishes to have sent to it by sending a subscription to the Publisher. The Subscriber then waits to receive the requested data objects. When new or changed data objects are available which match the subscription - either immediately or at some time in the future - the Publisher sends them to the Subscriber. Subscribe/Publish uses the standard Internet protocols to convey the subscription/acknowledgment between the Subscriber and Publisher, and to push the data objects from the Publisher to the Subscriber.

Figure 2 is a Subscribe/Publish use case illustrating how WITSML real-time data objects could be transferred using the Subscribe/Publish mode from a sensor aggregator application on a rig to an application in the operating company’s offices.

The sensor aggregator system is the Publisher and the office system is the Subscriber. The real-time data objects are “pushed” from the Publisher to the Subscriber. The first phase in the process involves “subscribing” to one or more of the Publisher’s available real-time data channels. To do this, the potential Subscriber sends a subscription request to the Publisher. The request will include the specification, a declaration that the Subscriber wishes to receive the WITSML real-time data object, and identification of the object’s channels.

Once the subscription has been accepted, the second phase of the process begins: *publishing* the data.

Whenever new or changed data for the specified channels become available – perhaps immediately after the subscription was received or at some time later – the sensor aggregator application will create a WITSML real-time data object and send it to all Subscribers who are subscribed to that object’s channel.

The sensor aggregator application is responsible for parsing the data coming in from the sensors, associating that data with the appropriate data items for the WITSML real-time data object, and supplying any missing data items and creating the WITSML real-time data objects.

The sensor aggregator application then sends the WITSML data objects to the Subscriber, as denoted by (*1*) in the diagram. On the Subscriber system, a process running under a Web server receives the WITSML data objects (*2*) extracts the data items from the data object and then persists them to its own internal data store (*3*).

It’s important to note that the Subscribe/Publish API can transport *any* of the WITSML data object types.

Field Application

Real-time wellbore stability modeling provides a fitting test bed in which to validate WITSML’s functionality under difficult operating conditions. The purpose of this application is to provide a continuous assessment of wellbore integrity and a "look ahead" prediction of formation pressures below the drill bit. Drillers use the information to maintain the drilling fluid pressure within the safe "window" provided by the modeler. Too high, and the well becomes unstable: the hole can balloon, formations can fracture and drilling fluids can leak into formation. Too low, and the well may collapse or flow uncontrollably—a serious and expensive hazard.

In deepwater applications the pore pressure "window" can become quite narrow, requiring frequent updates to the look-ahead estimate. Thus real-time pore pressure estimation is high-impact, high-stress, and very time-critical.

The estimation process requires instant access to multiple data streams from rig-site sources, notably a wide range of logging data, rig sensor data, well event reports and petrophysical data. These streams come from different data providers in different time frames—some are continuous, others intermittent. Additionally, the location of the personnel involved adds complexity—operators frequently prefer offsite interpretation of the data in direct support of their decision making processes.

Decision-making can suffer as decision boundaries are approached, especially in rapidly-changing drilling situations. Drillers cannot afford to wait for updated information, so the value of the wellbore stability assessments can degrade significantly with time. Decision quality is a function of both the accuracy of the information and its timeliness. In effect, technology has opened the door to controlling wellbore stability, but it is dependent on the reliability of data streaming in to the model.

In the following real-time applications WITSML successfully provided that reliability.

Application Examples

Case 1

An opportunity for field implementation of WITSML became available in March 2004. WITSML was used to communicate data from an LWD vendor acquiring data offshore Trinidad to a commercial wellbore stability application from a different vendor in Houston Texas (**Figure 3**). There was a requirement to use existing equipment and infrastructure, with no special considerations for transmitting or receiving the data.

The LWD provider in Trinidad and the wellbore stability application vendor both deployed pc-based WITSML v1.2 applications. The wellbore stability application with WITSML was deployed on a standard pc laptop while the LWD vendor chose to use a server to host the data. The wellbore stability specialist was located on the rig, allowing direct access to the data acquired on at the rigsite if the communications system proved unreliable.

This server collected real-time data from the offshore installation and made it available inside the client network through WITSML. Surveys, resistivity, gamma ray, penetration rate and numerous other data were made available via WITSML and the wellbore stability application was configured to acquire the desired data.

With the configuration complete, the existing static data was preloaded into the application. Next an auto-load configuration was created to scan for new data every 10 seconds and upload new information to the geomechanics application.

The performance was almost perfectly synchronous with only the 10-second pause separating the application performance from data acquisition on location. The effort to create the WITSML store and retrieve the data was minimal with no specialized personnel or equipment required. Using the WITSML data, the models created information that was used to maintain the appropriate wellbore pressures, avoiding potential problems such as fluid influx, fluid loss and wellbore instability.

Case 2

A second opportunity to use this newly-proven technology arose in February of 2005. The operator wanted to remove specialist personnel from the rig and deploy those analytical assets in the office where they could be much closer to the decision-making process (**Figure 4**). The local connection offshore was being made with WITS, which lacked the desired functionality and security to move the required data from rig to shore. A WITSML server was requested of the LWD and surface-logging provider, and a WITSML client was attached such that the geoscience modeling could take place synchronously in the operator office. The transition from WITS to WITSML required minimal effort and was not noticeable to the operator.

Case 3

The operator chose the replace the LWD vendor in Case 2 (**Figure 5**). This change is typically traumatic to the data transfer operations and requires significant work on both the sending and receiving sides to re-establish the existing functionality. In this case, because of WITSML, the vendor change did not affect the data transfer and remote modeling operations.

Case 4

The fourth case involves the construction of a well on the Gulf of Mexico shelf (**Figure 6**). The available personnel space offshore was very limited, and the project economics favored a solution with costs lower than those associated with the field deployment of an expert analyst. Using WITSML technology, a remote surveillance system was put into place so the modeling technology could securely receive the required data from any Internet portal. This included the analyst's office and residence. The omission of the physical presence requirement allowed the service company to dramatically reduce the cost of the service, while delivering synchronous support on demand to improve the efficiency of the operation.

Conclusions

Historically, the movement of data has been problematic in the petroleum industry. In drilling applications, this has inhibited well engineering efforts and effectively forced all decision support to be located at the rigsite. Recent advances in telecommunications and Internet technology have led to the development of improved systems for communicating petroleum industry data. By leveraging these advances, WITSML provides a system that allows for omni-directional synchronous and asynchronous communication amongst multiple vendor and operator stakeholders. The benefits over previously available technologies include:

- Short connect and configure time (typically under 30 minutes)
- No special hardware or IT involvement requirements
- Low installation and operation costs
- Secure synchronous and asynchronous data exchange
- Omni-directional, multi-user data movement
- Portability
- Rapid access to data
- Broad base of qualified system technicians and programming expertise

The technology has broad implications for E&P field operations. WITSML facilitates cross-discipline collaboration, which delivers the right information to the right people at the right time. It provides improved utilization of available bandwidth, data and expertise—commodities which cannot be diminished in realizing efficient field operations. Further, WITSML provides operators with the flexibility to change vendors without disrupting the data links which are critical to effective decision-making.

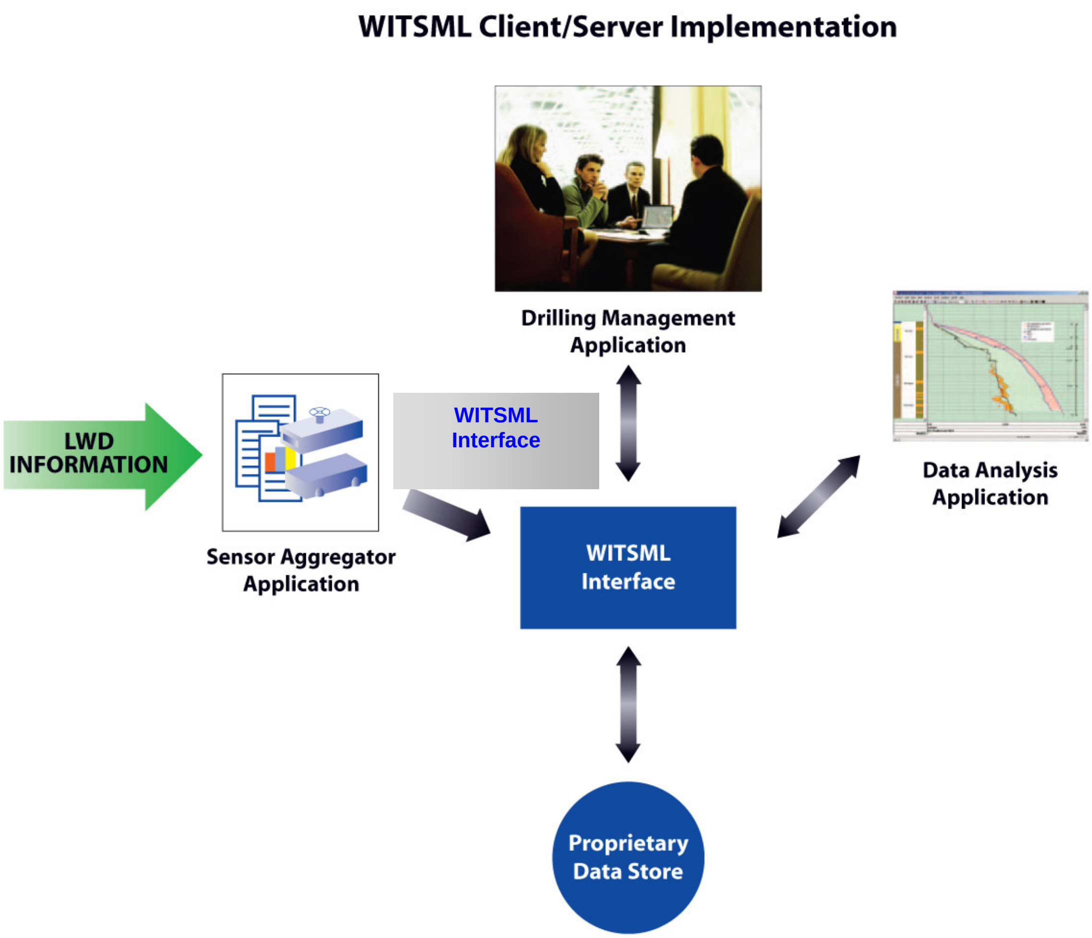

Figure 1. Client/Server interface

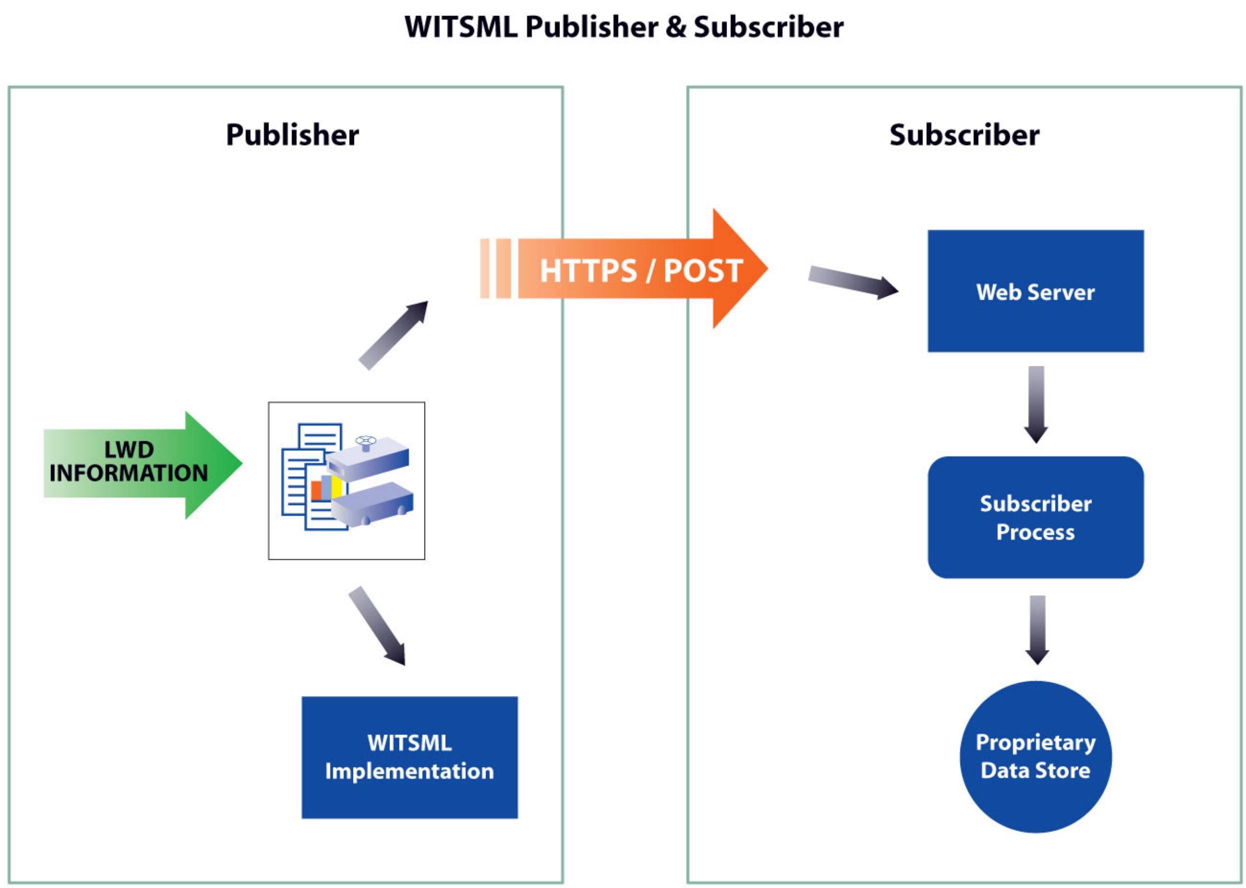

Figure 2. Subscribe/Publish interface

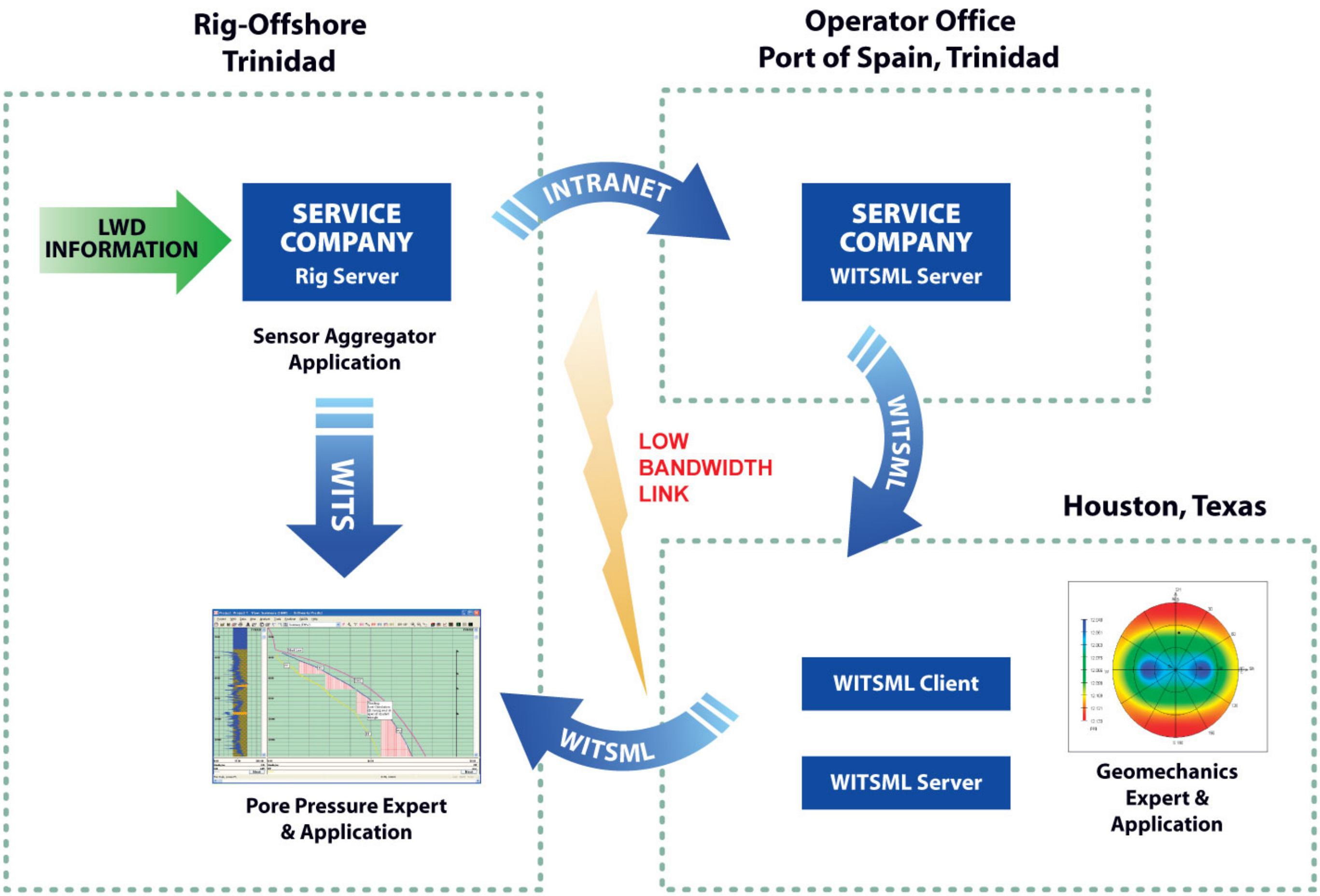

Figure 3. WITSML used to transmit information to a modeling application at the rigsite, supplemented with WITSML-enabled support from remote locations.

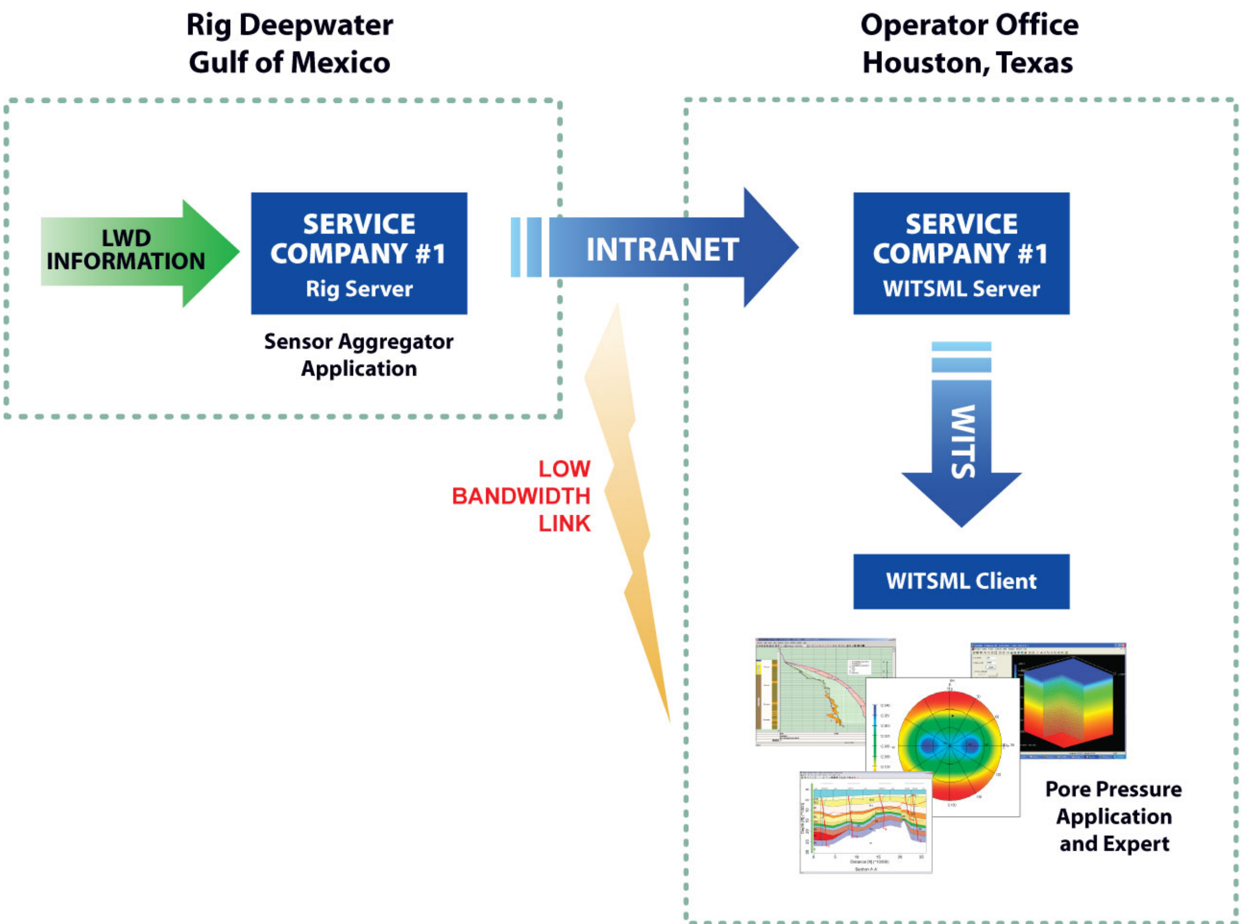

Figure 4. WITSML used to transmit information to a modeling application based at the at the operator's office, with no alternative access to rig-based data stores.

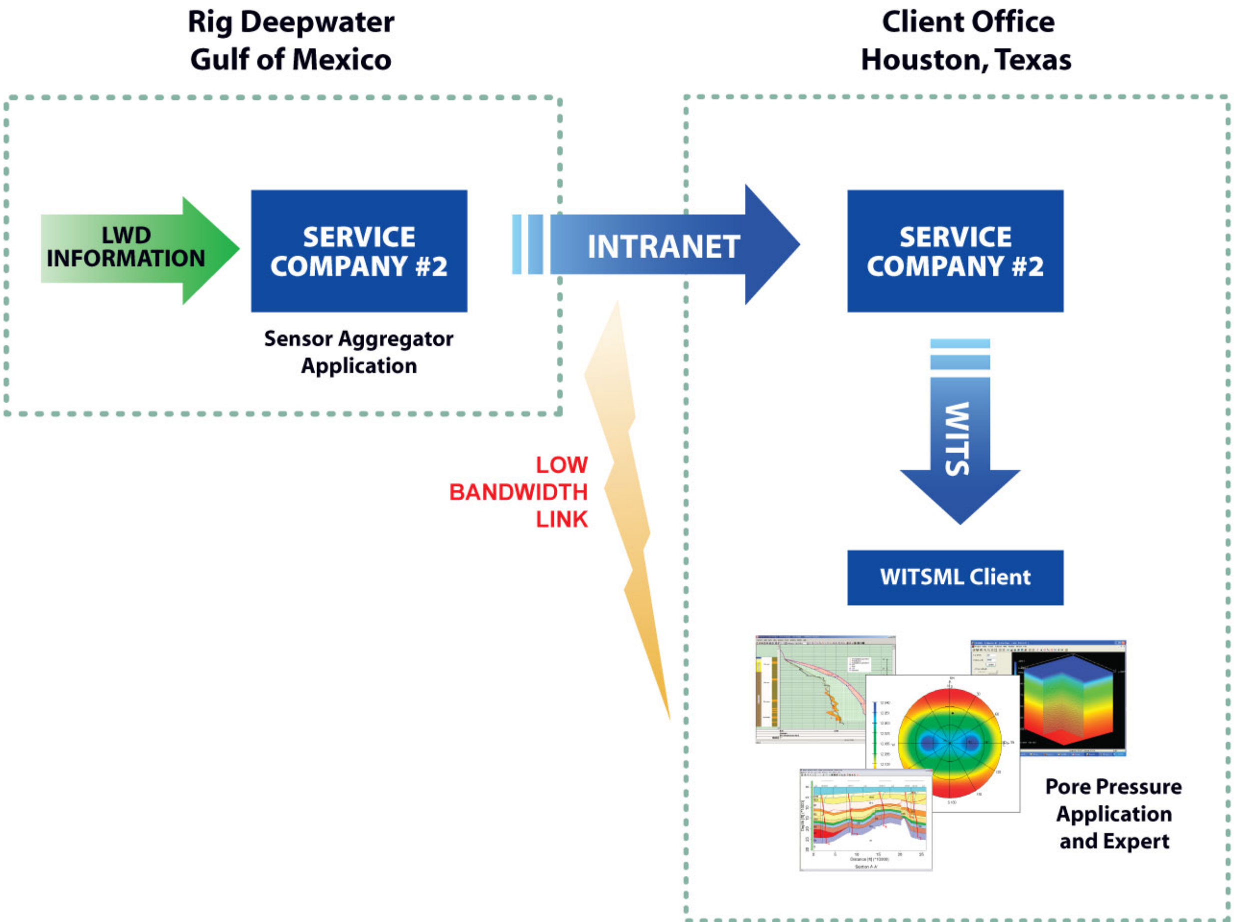

Figure 5. WITSML used to transmit information to a modeling application based at the at the operator's office, involving a mid-project change in data providers and management of the communications system.

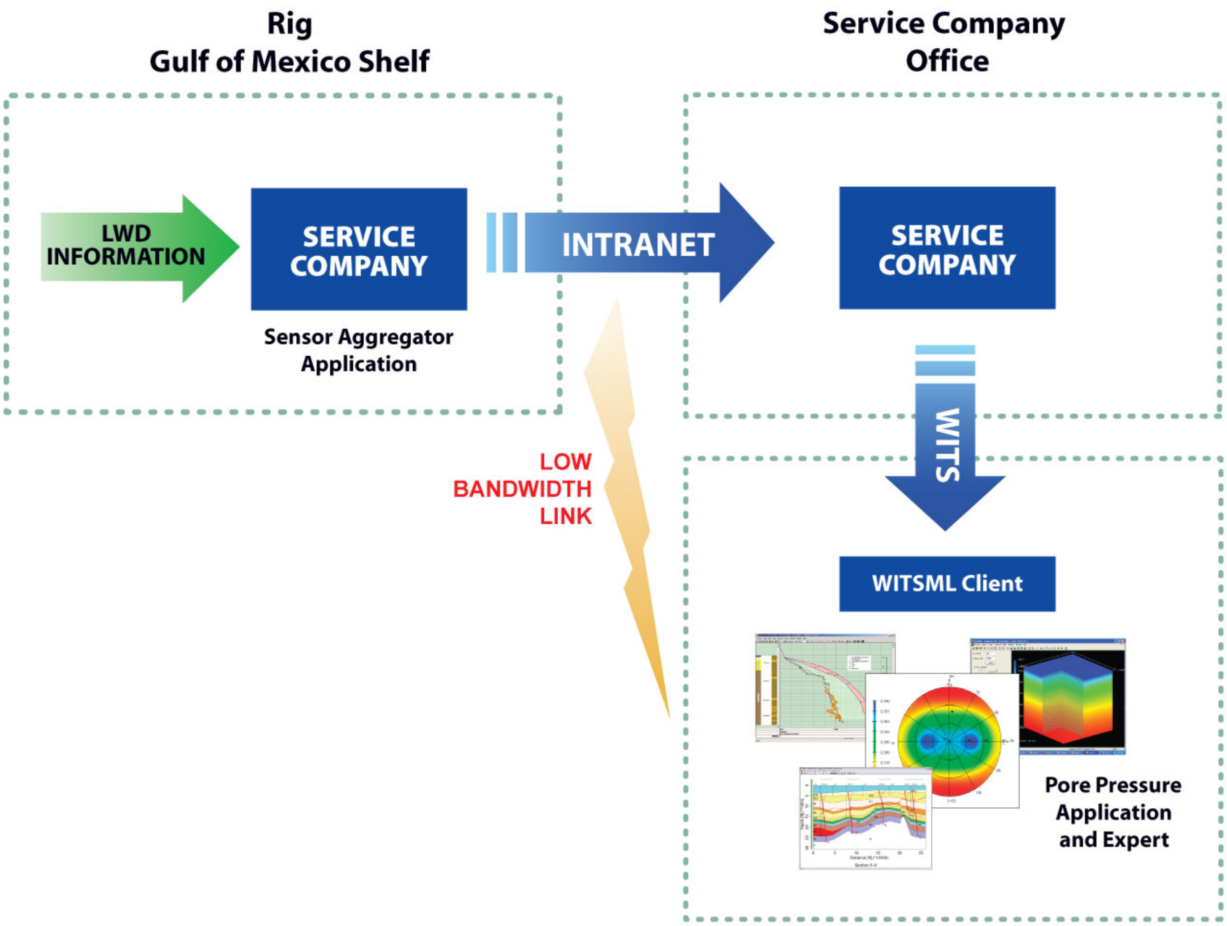

Figure 6. WITSML used to transmit information to a modeling application based at any site accessible to the Internet.