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Unlocking Efficiency, Security, and Interoperability in Drilling and Completion Operations with WITSML 2.1 and ETP 1.2

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Abstract Summary

As wells become increasingly complex, the data acquired during drilling, completion, and intervention operations is no longer just a byproduct—it is a critical asset for driving operational success and informed decision-making. However, efficiently sharing and leveraging this data across all relevant teams, both on-site and remotely, remains a significant challenge. Multiple vendors and fragmented data-server architectures imply the handling of large volumes and varieties of data, complicating real-time access and decision-making. Emerging cloud-based infrastructures offer the potential for more scalable storage and accessibility, yet their integration with existing systems introduces additional complexity.

In this context, operators require solutions that can securely and reliably capture all drilling, completion, and well intervention data; ensure timely access to accurate and trusted versions of that data; and enable its seamless use across workflows—from the rig to remote operations centers to office-based teams. These solutions must also be based on open, widely adopted standards to guarantee consistency, interoperability, and ease of deployment.

To address these needs, industry standards for wellsite data exchange have evolved significantly over the past two decades to meet growing demands for interoperability, scalability, and real-time performance. Building on this evolution, the Energistics Transfer Protocol (ETP) 1.2 and WITSML 2.1 were developed to provide a modern framework for fast, secure, and standardized data exchange.

Their adoption ensures compliance with corporate data security requirements (which was sadly not the case with earlier versions of WITSML), enables the handling of high-frequency data with low latency, enhances traceability, supports AI/ML integration, and drives improvements in operational efficiency and cross-system compatibility throughout the well lifecycle. This empowers drilling and completion engineers with better tools for faster, more informed decision-making, while contributing to reduced operational costs and greater efficiency in the field.

Introduction

Before the first version of WITSML was released, the oil and gas industry faced major challenges in data exchange. Although early standardization efforts began in the 1990s, true progress came with the development of WITSML under the Energistics® Consortium, now an affiliate of The Open Group®—providing a common protocol to capture, manage, and share wellsite data.

Over time, the volume and complexity of data from drilling, completion, and intervention operations has increased significantly. Common issues included minimal metadata, data quality problems, lack of time synchronization between vendors, mapping mismatches, data gaps, and the need to integrate data from multiple companies. By the release of WITSML 1.4.1.1 in 2011, many foundational issues had been resolved. However, the protocol still relied on SOAP, which became a bottleneck for real-time communication. SOAP was not designed to meet demands such as high-frequency data transmission (50 Hz), sub-100 ms latency, secure communication, and full audit trails. In performance tests, including those by Neri et al., 2019, SOAP-based services showed latencies of 10–15 seconds—insufficient for true real-time applications. To address this, the Energistics Transfer Protocol (ETP) was developed. Inspired by modern streaming models, ETP allows a client to request data and receive it through a continuous stream once validated.

WITSML 2.1, combined with ETP 1.2, retains the functionality of earlier versions but with greater speed, flexibility, and efficiency. It introduces better data object design, reduces preparation workload, and introduces high-speed streaming, endpoint-level authorization, and outage-recovery mechanisms that avoid full dataset re-streams. The global adoption of WITSML and ETP continues to grow as companies recognize their benefits. Key improvements in data quality include:

- Reliability – Accurate representation of rig-site conditions.
- Availability – On-demand data access.
- Integrity – Preservation of raw and derived values.
- Security – Complies with corporate cyber-security requirements.

Together, these factors enable data-driven decisions with confidence across the well lifecycle (Bardasz and Energistics, 2023).

WITSML 2.1 and ETP 1.2 Integration Framework

Before ETP's introduction—and in many deployments today—wellsite data was transmitted via SOAP-based web services over HTTP. This architecture relies on a request/response model, requiring constant polling to access updated information, which increases network load and introduces significant delays (De la Rosa et al., 2022). In typical multi-hop architectures (e.g., rig → shore base → operator → control room), this model can result in latencies of 7–15 seconds—even with modern satellite communication systems (Neri et al., 2019).

To overcome these limitations, the Energistics Transfer Protocol (ETP) was developed using the WebSocket standard (RFC 6455), enabling low-latency, bidirectional communication. This approach supports near-real-time streaming and multiple concurrent data channels with far greater efficiency (Neri et al., 2019). WITSML 2.1 complements this by introducing an optimized object model—including channel-based logs and growing objects—designed to fully leverage ETP's publish/subscribe capabilities. Together, they streamline data exchange, reduce latency, and improve scalability across systems. The architecture in Figure 1 shows how a centralized Data Aggregator collects payloads from diverse services and distributes them to multiple consumers using standardized WITSML structures. This supports time-synchronized, multi-vendor interoperability with far greater efficiency.

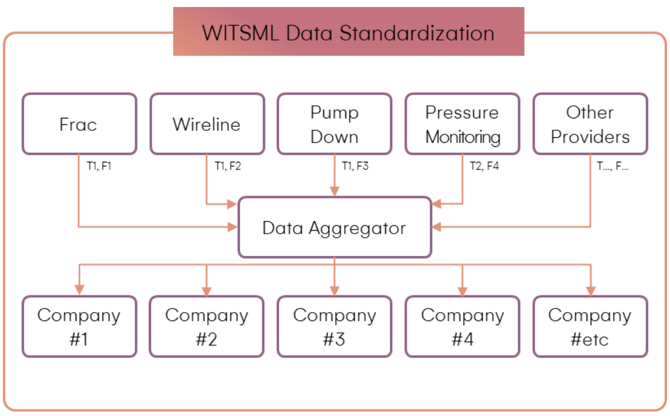

Figure 1: Standardized data aggregation architecture enabled by ETP.

Additionally, WITSML 2.1 was designed to align with other Energistics standards—PRODML and RESQML—to support integrated data flows across drilling, production, and reservoir domains for the first time. This enables seamless cross-domain workflows and real-time collaboration from rig site to reservoir modeling (Bardasz and Energistics, 2023).

Data ingestion from external sources (e.g., REST APIs) into WITSML 1.4 or 2.1 servers can be achieved using configurable tools that support real-time loading rules executed in parallel (see Fig.2). This enables flexible, vendor-agnostic integration of sensor data and accelerates the standardization of heterogeneous data streams across drilling and completion operations.

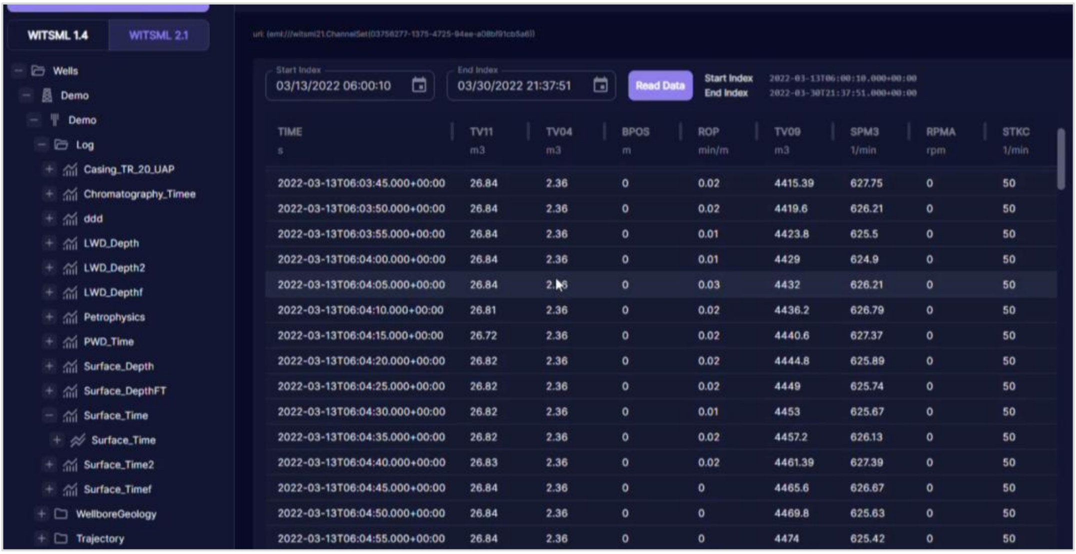

Figure 2: Web-based WITSML 2.1 platform for managing real-time data.

Results

The benefits of WITSML 2.1 and ETP 1.2 adoption are evident in both performance and operational continuity. In a live offshore trial conducted by Equinor, in collaboration with two other companies participating in the Energistics community, the legacy SOAP-based protocol delivered 6–10 second blocks of delayed data with overall latencies of 10–15 seconds. The ETP-based stream, by contrast, delivered continuous 1 Hz updates with an average latency of 1.2 seconds, even in offshore conditions (Halland et al., 2018).

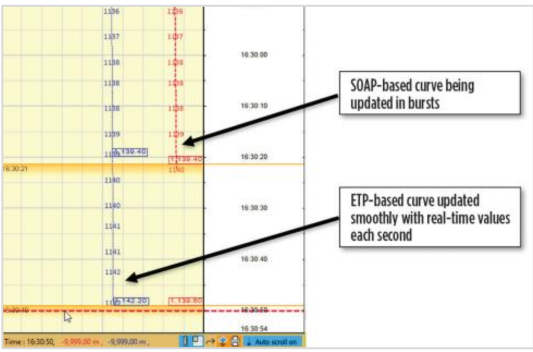

Figure 3: Comparison of ETP vs. SOAP data streaming latency. Source: Halland et al., 2018.

Figure 3 clearly contrasts the fragmented, delayed SOAP delivery with the near-real-time, smoothly streaming ETP feed. These improvements allowed engineers to detect anomalies and tool misalignments more quickly, improving safety and enabling remote collaboration between rig and onshore teams.

Further performance testing revealed that ETP 1.2 can support over 100,000 data points per second, using only ~10% of the bandwidth consumed by SOAP (Neri et al., 2019). This increased throughput and efficiency unlocks true real-time analytics—even under limited or high-latency connectivity.

These dramatic data transfer improvements will now allow for real-time analytics on torque and drag, friction factor, and other critical drilling parameters. In parallel, KPI metrics—once calculated manually using spreadsheets and post-job reports—can now be generated and visualized in real time, enabling faster operational assessments and proactive decision-making. (De la Rosa et al., 2022). With the addition of ML/AI, operators can now build predictive alerts on top of this high-quality data stream.

Conclusions

The adoption of WITSML 2.1 and ETP 1.2 represents a key step toward building high-performance, standardized, and secure digital infrastructures in upstream operations. These technologies resolve legacy bottlenecks—cutting latency by an order of magnitude, reducing bandwidth usage, and enabling streaming in real time. Beyond technical benefits, the standards facilitate workflows from the wellsite to reservoir simulation. They also preserve all functionality from earlier versions like WITSML 1.4.1.1, while improving efficiency through enhanced data object design and reduced validation overhead. New features in these versions include high-speed data streaming, endpoint-level authorization, and mechanisms for recovering from unplanned outages.

Despite these advancements, challenges persist in fully harnessing real-time data. Sensor fragmentation, data modeling gaps, and limited bandwidth in some regions still hinder adoption. Yet, the move to WITSML 2.1 and ETP 1.2 is not only a technical milestone—it signals a cultural shift toward standardized, actionable, and trusted data as a foundation for digital transformation in drilling and completion operations. Ultimately, WITSML and ETP provide the foundation for improved data quality, complete data management across the well lifecycle, fast and reliable streaming, and increased safety by enabling more robust remote operations with fewer personnel on site.

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