WHITEPAPER

Five Ways the Industrial Internet is Changing the Oil and Gas Industry

Executive Summary

Unconventional resources challenge the oil industry. Exploration and development of oil and gas reservoirs require new sensors, analytics, and processes. Systems require better connectivity, monitoring and control, and process automation. Previously deployed technology limits the ability to quickly and reliably integrate and robustly operate field-to-cloud systems, especially across large field installations.

The Industrial Internet of Things represents the biggest opportunity in recent decades for the advancement of industrial technology. Major global companies are transforming their infrastructures to take advantage of the Industrial Internet's open, high-bandwidth protocols and low-cost, intelligent networks. Just this year, GE, Cisco, Intel, AT&T, IBM and 80 other companies acknowledged the importance of this transformation. They formed the Industrial Internet Consortium (IIC) to speed the adoption of the latest Internet technologies in industrial applications.

In this white paper, learn how innovative networking standards and protocols are enabling revolutionary system-building approaches that greatly ease field operations. Read how companies like GE, Siemens, Joy Mining, and Schneider Automation are using Industrial Internet technologies to re-vamp their product lines and field operations, and how oil and gas applications are already being fielded based on open standards and low-cost smart nodes.

Big Challenges and Bigger Opportunities

The current challenges relating to systems at the forefront of the Oil and Gas industry are extreme. Massive data flow from new sensor technology, new analysis techniques, complex drilling processes, changing requirements and regulations for well monitoring and reservoir management, and other industry trends call for innovative solutions.

Simultaneously, the numbers of field experts are plummeting, with as many as 60% of the current field experts expected to retire over the next six years.

To address all of these industry changes, companies need to embrace more intelligent systems and processes. The Industrial Internet, which facilitates building smart, distributed systems, offers a foundation for taking real-time data and using it to drive more intelligent, safer operations with more automated oversight.

Opportunities

Connectivity has always been at the heart of modern industry. The first factories emerged as innovators found ways to connect machines and develop efficient production flows. The next wave of the industrial revolution – the Internet revolution – heightened the role of connectivity, with distributed information networks accelerating the globalization of industry.

Today, the Industrial Internet has the potential to exceed the transformative results of the earlier phases of the industrial revolution. Evidence of the radical nature of the changes can be found in everyday life. The Internet and the worldwide web make it easy to find the price of the house across the street, chat live with a college roommate who now lives on another continent, and watch TV reruns on a tablet or smart phone.

For industry, the changes are similarly profound. With the ability to connect intelligent objects, the Industrial Internet of Things lets businesses converge devices and machines into intelligent systems and applications:

- Embedded sensors and software can be tapped in real-time to self-diagnose and self-correct.
- Reliability skyrockets as systems can proactively react to changes in the environment.
- More sophisticated machines, services, and systems can be rapidly provisioned and delivered.

To drive the advancement of Industrial Internet connectivity, RTI and other leading technology providers joined the Industrial Internet Consortium. The IIC establishes proof-of-concept test beds and recommends reference architectures with the goal of bringing standards clarity to the Industrial Internet.

Connext DDS

At the core of the Industrial Internet, there are several protocol standards including the Data Distribution System (DDS) published by Object Management Group (OMG). RTI Connext® DDS, the leading DDS implementation, directly addresses the development of intelligent distributed machines. RTI connectivity solutions deliver data at physics speeds to thousands of recipients with strict control of timing, reliability, failover, and language and OS translation.

Targeting device data use, Connext DDS provides fast, deterministic device-to-device communications:

- A logical DataBus connects thousands of destinations simultaneously, with the ability to scale to hundreds of applications and hundreds of thousands of data-generating and data-consuming devices. The DataBus scales much better than hub-and-spoke designs.
- Detailed Quality of Service (QoS) control, multicast, configurable reliability, and pervasive redundancy address industrial environments where even a few minutes of downtime can be disastrous.
- Powerful filtering enables precise control of what data goes where.
- The data-centric architecture provides future-proof scalability and extensibility while greatly simplifying distributed system development.

Connext DDS has already been widely adopted in Industrial Internet applications, with customers that include the world's largest companies in the oil & gas, automotive, underground mining, medical systems, military systems, air traffic control, and other industrial sectors.

The Industrial Internet – Five Ways it is Changing Oil and Gas

1. Automating Remote Operations

At a time when well drilling and completion complexities are increasing and field experts are becoming scarcer, automation offers many benefits. Besides capturing domain knowledge, automation increases safety and decreases personnel time on-site and therefore lowers cost. Automation has also been proven to improve well quality, and decrease downtime and equipment failures.

Use Case: Automated Well Drilling and Completion

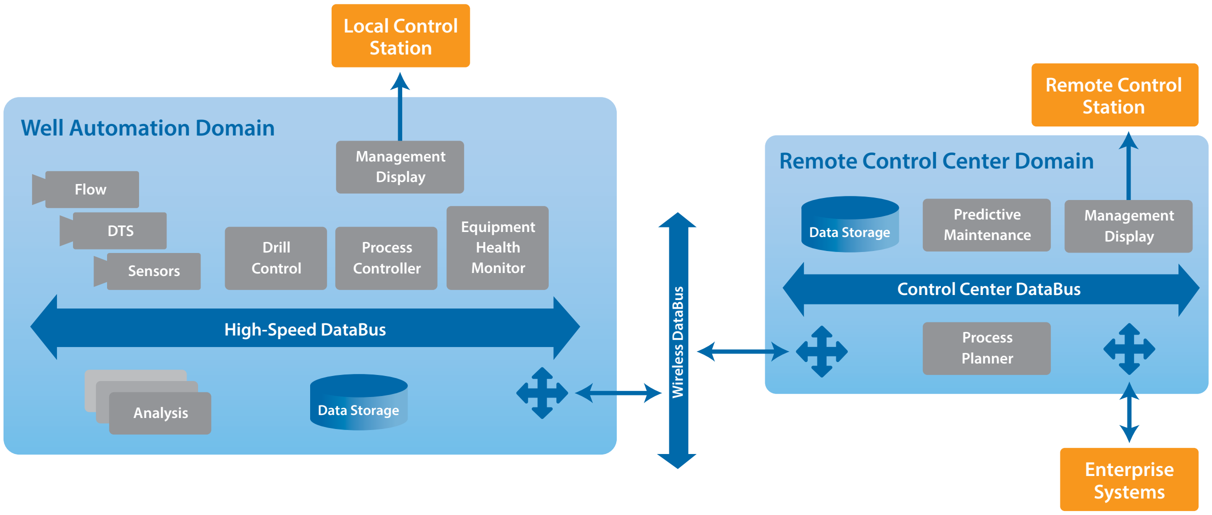

Figure 1. At the well site, a high-speed DDS DataBus connects all the sensors (e.g., temperature sensors, flow monitoring) and actuators (e.g., top drive, key drive, flow controllers) along with a process controller to automate the process of drilling and completion. The high-speed connections can also be used to monitor the health of the equipment, analyze activity, log status readings, and more.

High-speed connectivity also enables integration of the well domain and a remote control center. A wireless link or fiber network enables well information to be automatically sampled, with readings downloaded and stored in the control center. The data can then drive predictive maintenance and provide process planners with the ability to intelligently analyze well operations and send corrective feedback to the well systems. Experts in the control center can help debug and restart remote processes that have encountered errors the local automation cannot handle.

2. Enabling Massive Data Collection

The data generated from a single well can be sizeable; a large field of wells can produce massive amounts of valuable information. Industrial Internet technology can tackle the large-scale collection across an entire site. The proven results include better asset utilization across all wells, reduced effluents, and accelerated production. Broad oversight also accommodates hydrocarbon recovery, and offers insights that can lead to better decision making about well locations.

Use Case: Intelligent Well Monitoring

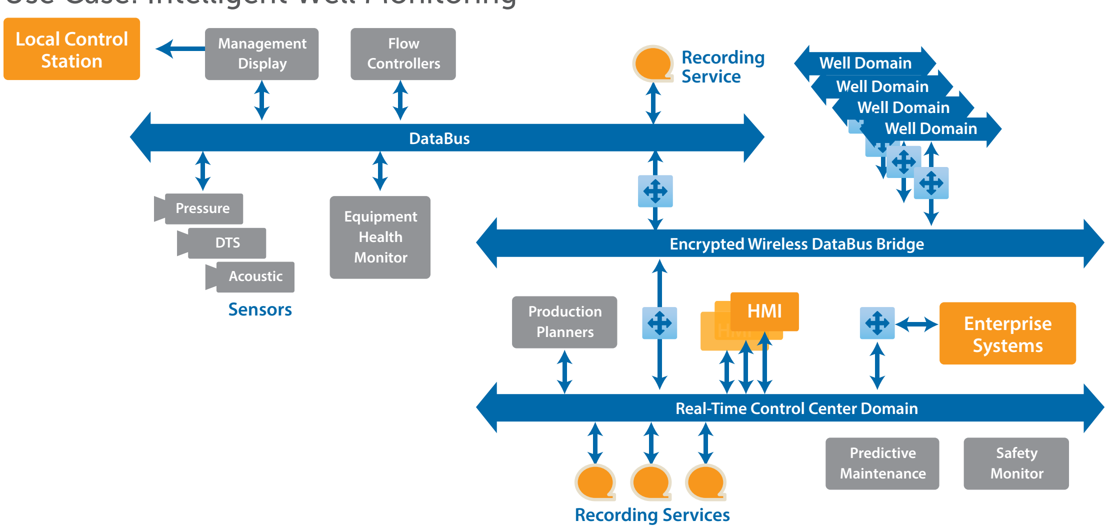

Figure 2. An entire field can be integrated by combining local DataBus instances. The system can aggregate hundreds of thousands of sensors, providing data to a control center for easy analysis, health monitoring, and data storage.

Introducing an efficient communication and application architecture across an entire field builds on the well-management model previously described in the automated well-drilling use case. To tie together an entire site calls for a wireless DataBus bridge between the well domains and the control center domain.

In this scenario, Industrial Internet connectivity gives the control center staff high-level site-wide visibility and analytic capabilities and also provides the links for viewing individual well sites and monitoring subsystems during operation. DDS DataBus technology supports this real-time operations visibility and simultaneous coordinated collection of massive data. Deployments have been proven to scale to encompass hundreds of thousands of devices.

3. Integrating Analytics

To fully exploit analytics, all of the components of the system under study must be integrated such that information can be reliably gathered. This is especially critical for real-time analytics that directly drive process improvements and production optimizations.

The data collection topology behind large-scale analytics can be complex, however. Every smart machine within every system must be connected and data driven up to site busses and eventually into the cloud or control centers for consolidation at the application level.

Using DDS across the system allows designers to build a single logical DataBus that connects the various subsystems. A single logical sensor-to-cloud DDS DataBus can hide the underlying complexities of the physical connections between machines, systems, and sites.

Use Case: Intelligent Real-Time Reservoir Management

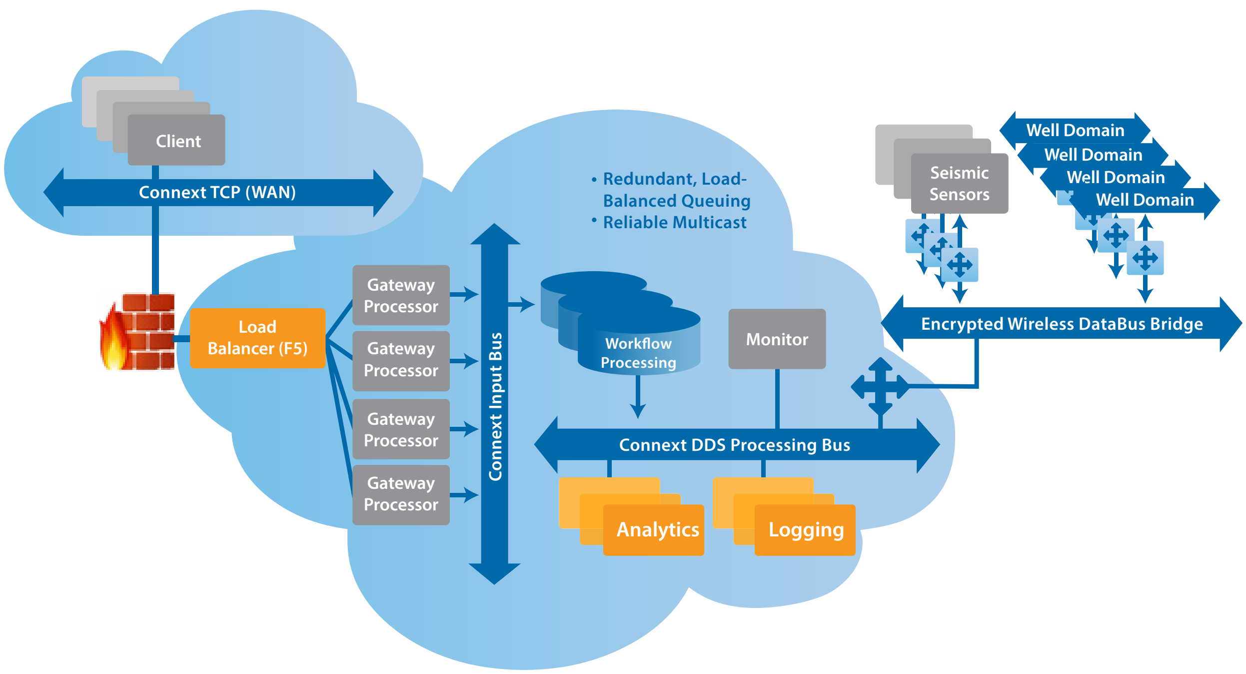

Figure 3. This example of a deployment model for a cloud-based analytics application connects well domains to a private datacenter cloud. The DDS processing bus facilitates the real-time collection and logging of well data, creating a repository for analytics applications. For high performance, a load balancer takes information and queues it up for processing. A single intelligent system can get data, process it, and drive appropriate actions and feedback back out to the active wells for optimized operations.

4. Securing Operations

The recently adopted DDS security standard offers complete security protection for data flows. Data flows can be secure, independent of protocols, roles, and nodes. The DDS security model allows protection of every dataflow. This "per-topic" security is logically simple: the DataBus connects information sources to information sinks. The security model simply enforces the connections by authenticating endpoints and allowing only the configured communications. The protocol supports discovery authentication, data-centric access control, plug-in cryptography, tagging/logging, and secure multicast – in a 100%-standards-compliant manner.

Because it leverages the existing data-centric design, adding security to an existing DDS system does not require any additional coding; security is implemented only by configuration.

Truly robust security requires both protection (stopping unwanted activities) and detection (finding and reporting when the protection has been compromised). This is why, for instance, a typical laptop has both a firewall (protection) and a virus scanner (detection).

The DDS DataBus also makes it easy to combine both protection and detection. Because it is a multi-channel bus, DDS supports facile data tapping. Because that bus has extensive information about the connection information and access to the data formats, it enables tapping programs to detect anomalies.

Use Case: Security Breach Detection

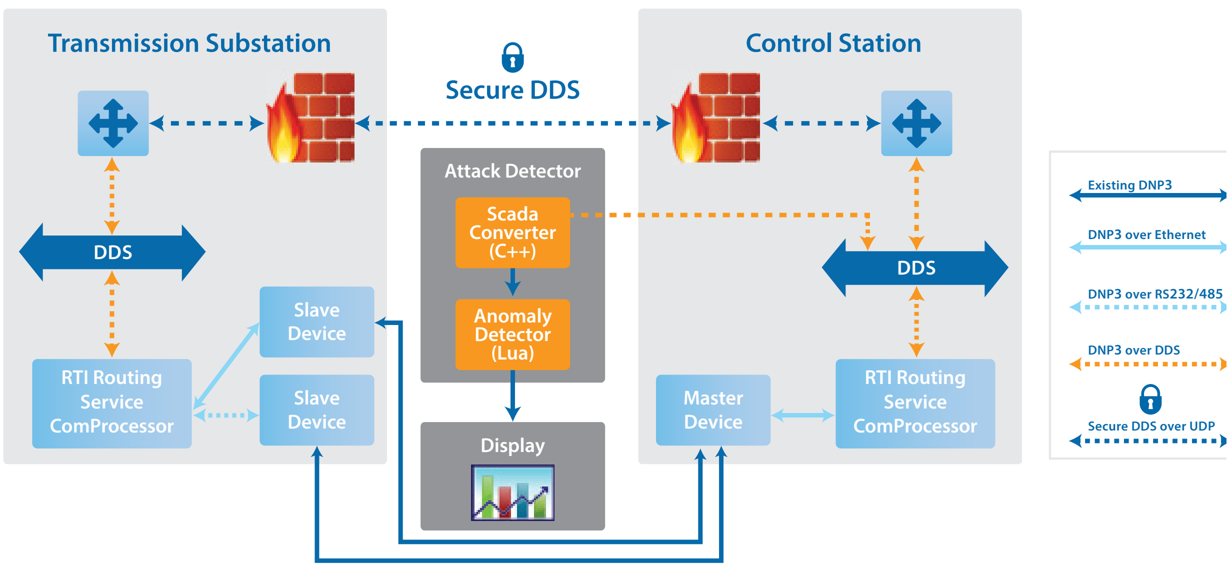

Figure 4. This system demonstrated both protection of a previously-insecure link and detection of many attack vectors through simple scripted analytics.

An example from the power industry is instructive. At Pacific Northwest National Laboratory (PNNL), an RTI DDS solution was introduced to both protect data flows and detect anomalies between a transmission substation and a control station. For protection, a legacy, insecure protocol connection was replaced with a Secure DDS connection. Messages in the legacy protocol were wrapped as Secure DDS messages and sent from substation to control station, thus implementing a secure, protected link.

However, even a secure link may be subject to virus insertion, man-in-the-middle attacks, and more. For detection, a data tap was installed in the secure control center. By monitoring both the "meta data" (who is connected, speed of connection, etc.) and the actual data flow, simple security scripts were able to detect various types of attacks.

5. Replacing Special Software with Industrial Internet Platforms

Developing distributed systems applications traditionally required a significant amount of networking and error handling logic. DDS middleware makes it possible to replace previously low-level communications programming with high-level data-centric publish/subscribe interfaces. Topics guide communications, rather than strict physical addressing schemes (sockets, host names, IP addresses, and ports).

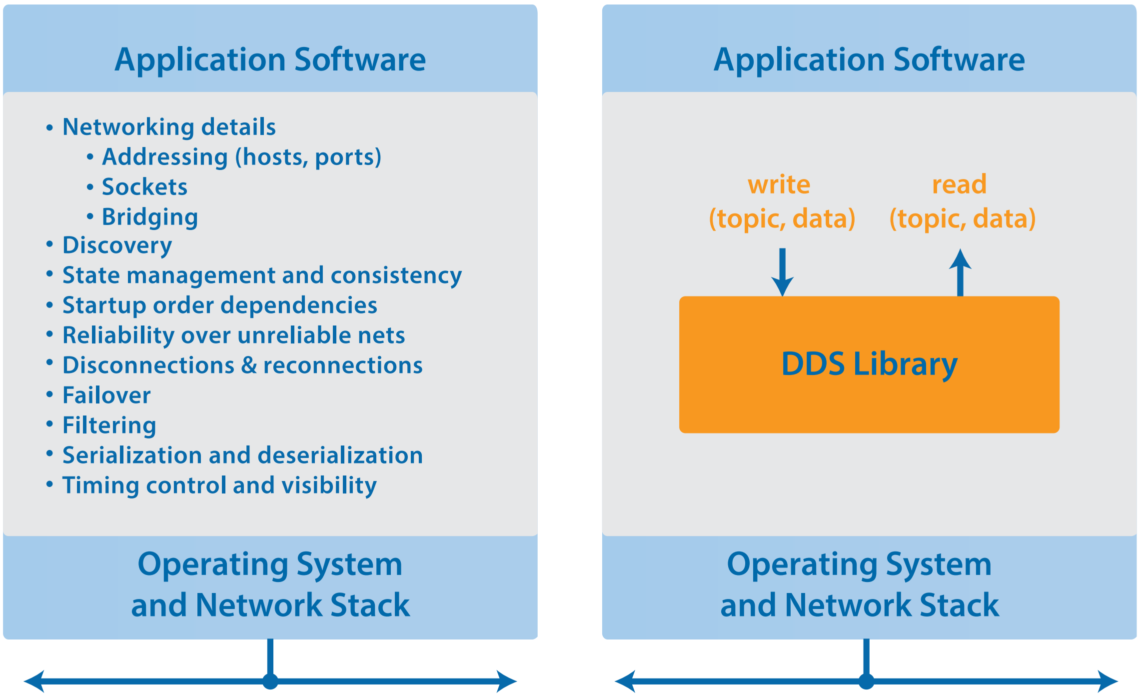

Figure 5. DDS hides low-level connectivity details and automatically handles discovery, routing, fault tolerance, and serialization. Start-up order becomes irrelevant, and DDS maintains shared, distributed state information. Application software is greatly simplified.

The data-centricity introduced by DDS simplifies applications by eliminating code relating to:

- Message parsing and filtering
- Message caching and state management
- Discovery, presence, marshalling, and 32/64-bit issues

Use Case: Asset Tracking System

In a representative application, a DDS DataBus approach shortened application development times and eliminated many lines of code. In the example, an asset tracking system, a network operations center replaced an in-house system with an application built on a DDS-based Industrial Internet platform. A comparison of the before and after highlights the incentives that are driving adoption.

In-House Platform	Industrial Internet Platform	Improvement
500K lines of code	50K lines of code	10X less code
8 years to develop	1 year to develop	8X faster
21 servers	1 laptop	20X less
20K tracked updates per second (with reliability and uptime problems; restricted to datacenter)	250K+ tracked updates per second; no single point of failure	Greatly improved reliability and uptime; mobility (laptop can be deployed anywhere)

Conclusion

The really exciting potential of the IIoT is to create bold new intelligent machines and vast distributed systems. The IIoT will change the world across many industries. The applications define the future: renewable energy, cars that drive themselves, planes that fly themselves, smart medical devices and smart hospitals.

DDS is a unique communications technology. It is designed to handle data at physics speeds. It offers controlled access to exactly the right data. It offers the extreme reliability, security and scalability that real-world infrastructure needs.

Critically, this is not just speculation. DDS is proven on real systems representing the breadth of the IIoT. From day one, DDS evolved on challenging real-world industrial systems across dozens of industries. It is the only common platform in such widespread actual use.

The future of the IIoT must integrate these proven applications into larger systems-of-systems that bring the power of cloud analytics and business intelligence to industrial systems. This is the core vision of the Industrial Internet. DDS is the right standard protocol to fulfill that vision because it provides both the extreme capabilities required by intelligent machines and the needed integration to extend to cloud-based analytics and optimization.

About Real-Time Innovations

RTI is the world leader in fast, scalable communications software that addresses the challenges of building and integrating real-time operational systems. RTI Connext solutions meet the needs of enterprise-wide integration—from the operational edge to the enterprise data center. The RTI standards-based software infrastructure improves the efficiency of operational systems while facilitating better decisions, actions and outcomes for the business enterprise.

For over ten years, RTI has delivered industry-leading products and solutions for customers in markets ranging from aerospace and defense, process automation, financial services, energy, automotive, health sciences and transportation management.

Founded in 1991, RTI is privately held and headquartered in Sunnyvale, California.

Your systems. Working as one

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