SOLUTION BRIEF

Intel IoT
Oil and Gas Industry

IoT Solutions for Upstream Oil and Gas

Intel® products, solutions, and services are enabling secure and seamless Internet of Things (IoT) solutions for upstream oil and gas.

Production and Capital Productivity

The recent low price environment is driving the oil and gas industry to focus on increasing operational and asset efficiency, improving asset portfolio grading, and maximizing capital productivity.

The use of Internet of Things (IoT) technologies renders digital oilfield implementations simpler, more effective, and economical in support of the above objectives. Intel's digital oilfield solutions, combining IoT technologies and services, offer the increased flexibility, standardization, and innovation that the industry is demanding today. Among their clear advantages, these IoT-based solutions help producers optimize their capital and operational expenditures (CapEx/OpEx) by providing a higher level of visibility and control into their asset operation.

Improving Oil and Gas Production

As wells mature, liquids often accumulate, hindering the flow of hydrocarbon. Addressing this problem for gas, the plunger-lift technology enables wells to remove liquids and resume producing at higher rates. However, plunger lift efficiency is dependent on well pressure and temperature, data that, for wells dating back to the 1950s, is provided only once per hour or day.[1]

With IoT technology, it is easier to connect to sensors throughout the well and to sample readings more frequently (e.g., every 30 seconds). Using edge analytics on sensor data, producers can optimize the plunger lift cycle and increase production by up to 30 percent (Figure 1). Moreover, producers have the data needed to rank their wells by production efficiency, information that is critical for effective asset portfolio management.

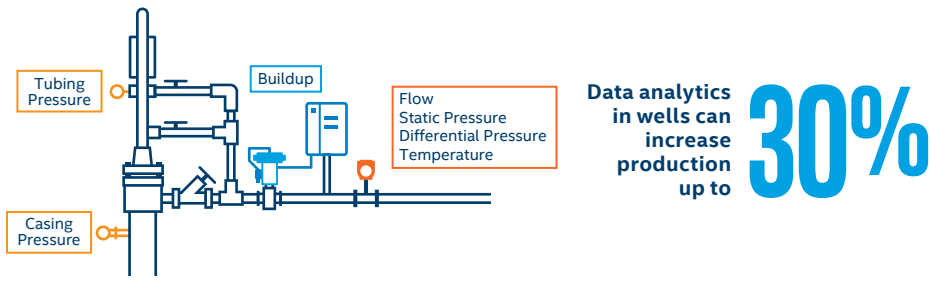

Figure 1. IoT technologies, like data analytics, can significantly help increase well production.[1]

IoT Solutions

The world is undergoing dramatic transformation, rapidly transitioning from isolated systems to ubiquitous Internet-enabled "things" capable of generating data that can be analyzed to extract valuable information. Commonly referred to as the Internet of Things (IoT), this new reality will enrich everyday life, increase business productivity, improve government efficiency, and much more.

Intel is working with a large community of solution providers to develop IoT solutions for a wide range of businesses—including manufacturing, retail, automotive, energy, and healthcare industries. These solutions generate actionable information by running analytic software and services on data that moves between devices and the data center in a manner that is always secure, manageable, and user-friendly.

Moving to open standards and Internet-based solutions—whether on private or public networks, data centers, or clouds—is key to achieving faster time-to-market, lower lifetime costs, and greater availability of engineering expertise.

Whether connecting process controllers, SCADA systems, wearable devices, or pickup trucks, everyone wants the process to be quick and seamless. Here's how Intel® products and technologies are helping make this a reality, by providing fundamental building blocks for a robust ecosystem developing end-to-end IoT solutions for the upstream oil and gas industry.

Building Blocks for Upstream Oil and Gas

The IoT vision is to create opportunities to transform businesses, people's lives, and the world in countless ways by enabling billions of systems across the globe to share and analyze data over the cloud. With these capabilities, IoT solutions can:

- Create better solutions faster
- Lower development and completion costs
- Optimize oil recovery
- Reduce well intervention and maintenance costs
- Improve safety and environmental performance
- Optimize energy generation and consumption

Moving forward, nearly every device will need built-in, secure, interconnected intelligence. Similarly, the supporting network and private cloud infrastructure (hosted or on premise) must be enhanced to better protect data, manage devices, and perform data analytics.

Applying the Intel® IoT Platform to Oil and Gas

The upstream oil and gas solution architecture is based on the Intel® IoT Platform, which is a generic platform that can be applied across multiple industry verticals.

The purpose of the Intel IoT Platform is to make the collection of data from connected objects (the "things") as simple, secure, and quick as possible. The Intel IoT Platform achieves this by providing a set of sensor-, device-, and cloud-based technologies that reduce the need for complex configurations and device programming.

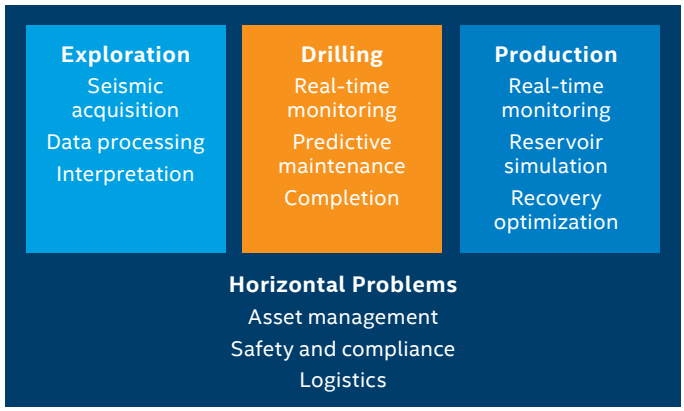

Figure 2. Business segments in upstream oil and gas have both unique and common problems.

From this common foundation, the upstream oil and gas solution architecture supports the functional and business requirements of the existing upstream oil and gas value chain of geologists, drilling contractors, operators, and other oil field services.

Upstream oil and gas is often divided into three business segments: exploration, drilling, and production. Each of these segments has unique problems (the nature of the job) while some problems cross all three segments.

As illustrated in Figure 2, exploration often involves seismic acquisition, data processing, and interpretation. Drilling includes real-time process monitoring, predictive maintenance, and completion. Production includes remote pump and tank monitoring, reservoir simulation, and recovery optimization. Common to all three segments are problems related to asset management, transportation, and safety.

By standardizing around a reference architecture, the upstream oil and gas industry can move from expensive customized and proprietary components toward commercial off-the-shelf (COTS) solutions. In addition to reducing costs, this unlocks engineering expertise and enables innovation focused on the unique challenges of oil and gas, rather than generic computing infrastructure.

Conceptual Architecture

The upstream oil and gas architecture consists of a collection of distributed components, the relationships and connections of those components, and a set of deployment topologies.

With this architecture, the computing infrastructure is distributed across multiple geographies, beyond the walls of the data center, and across a variety of locations—from well sites, to work camps, to wearables, to pickup trucks.

Design Objectives

The conceptual architecture was designed to address the challenges of large-scale, highly distributed sensing and monitoring systems requiring near-real-time IoT services (e.g., nondeterministic time delays introduced by the network). These large-scale geographically dispersed IoT services represent a significant scalability and distributed data management challenge.

The ultimate goal of this architecture is to provide a platform for the orchestration of IoT services through intuitive user interfaces and associated APIs. This is accomplished by abstracting the complexity of creating large-scale IoT services to such an extent that a regular end user can provision such services, with little or no understanding of the underlying technologies.

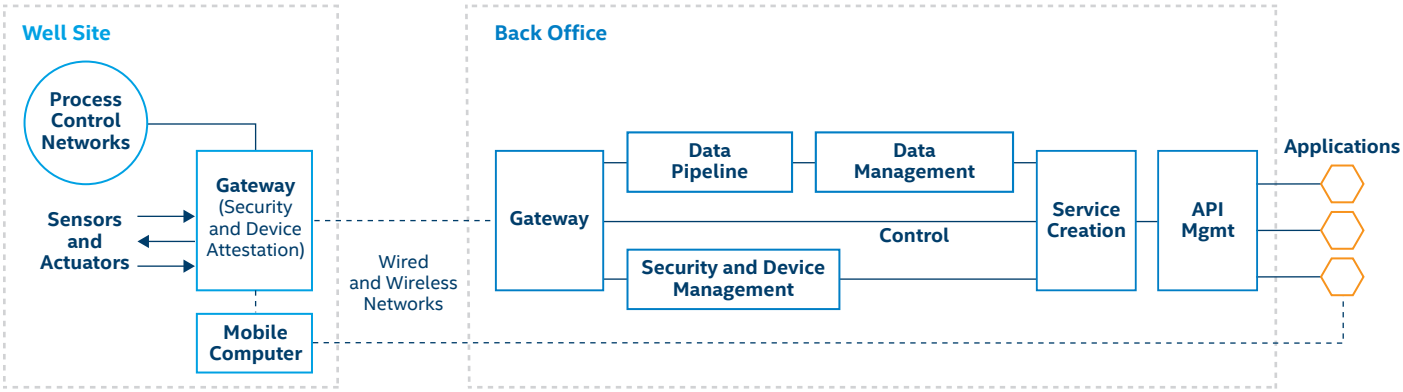

Figure 3. Conceptual architecture for upstream oil and gas

Architecture Components

The architecture, illustrated in Figure 3, consists of four components at the well site (often referred to as "the edge"), a network connecting the well site to a back office, several components in the back office, and a collection of end-user applications.

Sensors, Actuators, and Process Control Networks

The Internet of Things would not be the Internet of Things without things. In upstream oil and gas, these things are likely to be sensors reading process-related data, legacy process control networks (via brownfield data historians), and actuators that change the process in some manner (changing a valve, for example).

Well Site Gateways

Gateways at the well site provide security; connection to wired, mobile, and satellite networks; connectivity to field engineers' and the company's laptops and tablets; as well as compute resources for on-premise (in this case, the well site) applications.

Mobile Computers

While not always present, many jobs at the well site require a field engineer to perform real time analysis and process optimization. In producing wells, oil field services workers will likely need to upload historical data and perform maintenance on the pump, workover the well, stimulate the well, or perform other jobs requiring job-specific compute.

Back Office Gateways

Gateways in the back office (whether they be in the cloud or in the data center) provide security, integration of third-party data (such as weather or market prices), edge abstraction, and brokering between different consumers.

There are three general types of information propagated from the well site to the compute infrastructure:

- Data pipeline and management decision propagation
- Control and event propagation
- Security and device management path

There might be different data pipelines based on real-time or end-of-job data, data specific to different business units, control data generating alarms, security events, or responses to device management provisioning commands.

In addition to integration with third-party data (for example, integrating weather, tidal, or traffic information into the real-time stream), the back office gateway is a good location to normalize protocols coming from the well site—in essence, creating an abstraction layer that handles brownfield protocols.

Data Pipeline and Data Management (the Data Path)
The data pipeline processes or conditions incoming data and distributes that data to the proper data management solution. The data management solution provides storage, data retrieval, and, when needed, domain-agnostic data analytics. In some cases, the data pipeline might perform quality checks on the data to ensure faulty data is not stored or analyzed. In other cases, the data pipeline might concurrently distribute the data to multiple data management solutions (to both a SQL solution and a Hadoop* solution, for example). This is likely if and when legacy applications require the data to be stored in one paradigm but newer applications require a different paradigm.

Control Path
The control path directly connects the well site to applications. This is important when events or alerts coming from the well site need to trigger an application or when an application needs to send information or trigger some event back at the well site. Subscribe and publish messaging models are very effective in this scenario.

Note that it is not uncommon for an event processor in the data path to also generate events when data values meet or exceed certain conditions.

Security and Device Management
Security management is responsible for managing policy and detecting potential threats across all threat surfaces. In addition to reacting to threats, security management should provide preventive measures such as assuring that devices (or things) and software throughout the architecture are who they say they are (authentication and attestation).

Device management is responsible for provisioning parameters particular to devices (or things) in the architecture, updating software in devices, and performing health checks on the devices.

While not shown in Figure 3, security and device management would connect to most, if not all, components in the solution to ensure coherent policy management.

Service Creation
Service creation supports development of a common set of reusable domain-specific software services. These services typically expose application programming interfaces (APIs). Services can also be built that leverage mash-ups, existing ERP solutions, and other business IT and OT systems.

Application Programming Interface (API) Management
API management provides versioning, metering, access, and rate controls of the service APIs.

The reference architecture is based on the concept of a service-oriented architecture (SOA). Together with protocol transformation, APIs are the primary means for keeping components loosely coupled.

Applications
Applications are what the end users touch and feel on a regular basis. Applications can be control panels, analysis tools, visualization tools and dashboards, diagnostics solutions, and any number of solutions running on desktops, laptops, and mobile phones.

Toward an Open Architecture Solution

Ultimately, there may be no single implementation of the conceptual architecture that optimally solves all upstream business problems. The nature of the process data, network constraints, and analytics performed will likely drive different computing requirements at the well site and different data management solutions in the data center or cloud.

Intel anticipates this need by taking a service-oriented approach to its architecture for upstream oil and gas. Each of the functional components in the architecture can be realized by a variety of products from different vendors or open source projects.

Engineers planning future products, developing applications, or migrating existing solutions will benefit from a wide range of Intel processors, technologies, and tools.

Resources

Intel® Internet of Things Solutions Alliance
Members of the Intel® Internet of Things Solutions Alliance provide the hardware, software, firmware, tools, and systems integration that developers need to take a leading role in IoT.

Intel® IoT Gateway Development Kits
Intel® IoT Gateway development kits enable solution providers to quickly develop, prototype, and deploy intelligent gateways. Available for purchase from several vendors, the kits also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and data center servers.

Intel IoT Technologies
Intel technology is the backbone of proven IoT solutions in smart home, industrial, and mobile applications, as well as for vertical markets, including transportation, healthcare, and retail. This technology is helping billions of devices talk to each other and share valuable information, protecting sensitive data, and providing critical analytics and API offerings.

Intel's Hardware and Software IoT Solutions Include:

Intel® IoT Developer Kit: Supporting Intel® IoT Gateway DK series, Intel® Galileo board, and Intel® Edison board.

Intel® Enhanced Privacy ID (Intel® EPID): Provides hardware-enforced integrity and anomaly detection with implementation licensing.

Intel® IoT Gateway: Seamlessly interconnects industrial infrastructure devices and secure data flow between devices and the cloud.

Intel® Enterprise Security Solutions: Provides next-generation network and device security.

Intel® Security Critical Infrastructure Protection (Intel® Security CIP): Separates security management functions from operational applications, allowing the operational layer to be secured, monitored, and managed.

Wind River Intelligent Device Platform* and Wind River Edge Management System*: Provides embedded software for intelligent systems.

For more information, visit intel.com/energy.

1. Doug Henschen, "ConocoPhillips Taps Big Data For Gas Well Gains," informationweek.com/big-data/big-data-analytics/conocophillips-taps-big-data-for-gas-well-gains/d/d-id/1111434?

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