Overcoming Oil & Gas Industry Challenges with Hardened IIoT Technologies

With concerns on safety, security and the bottom line, oil & gas companies are feeling the pressure. How can emerging IIoT technologies help move the industry forward while helping to overcome every day challenges?

ADVANTECH

Enabling an Intelligent Planet

Challenges Facing the Oil & Gas Industry

No matter if you are a stakeholder of upstream, midstream, or downstream resources, companies involved with petroleum system assets and the management of these assets are feeling the pressure to implement new technologies to improve safety and increase operational efficiency in order to stay competitive in the ever-changing business environment of today.

Innovations in the Industrial Internet of Things (IIoT) have unlocked the ability to meet these business needs; however, simply having the technology available does not necessarily mean the solution is easy.

The IIoT concept of connecting system assets to enable the value streams big data offers presents a host of new challenges to companies deploying these technologies. For example, it can be a struggle to navigate the technology stack and choose the correct components. Companies must also consider future development and where the technology may take them, all while also considering workplace culture. It's important to have a workforce that will embrace and support these new technologies.

So how do companies and organizations jump these hurdles that come with implementing new IIoT solutions? Successful organizations know the answer is all about procurement and partnerships. Instead of simply managing the supply-chain in the traditional vendor/procurement means, companies of today understand the vital benefit of developing partnerships with the firms that make up their technology solution stack.

The promise of the IIoT for the Oil & Gas Industry (O&G) isn't solely on managing and monitoring existing assets, but more on enabling a new asset: system information and operation for all elements of business processes.

According to Forbes, major O&G companies are already taking steps to increase overall growth and mitigate future risks by harnessing the power of these IIoT technologies onshore. With the power of big data analytics, these companies are increasing productivity of wells and personnel. This increase in productivity is helping contribute "to global supply adequacy with stable oil and gas prices as they did from 1945 (when the U.S. was last the largest international oil producer) through 1970." (https://www.forbes.com)

Through legacy system modernization, coupled with real-time analytics and control logic-enabled at the edge, companies big and small can leverage IIoT technology to drive increased workplace safety and O&M efficiencies, as well as open new business opportunities to increase organizational profits.

How much does downtime cost oil & gas companies?

$8 Billion
per year

This is the estimated loss per year in non-productive time as engineers spend 70% of their time searching for and manipulating data, according to Teradata*

*https://www.teradata.com/Industries/Energy-and-Natural-Resources

Prevention and Planning

Top 4 benefits of edge computing, automating and securing operations

Oil and gas operations are asset-rich in remote, hazardous environments, making equipment reliability and workplace safety extremely important. In this complex operations environment, leveraging technology that will unlock big data and edge automation allows for more visibility and increases decision-making into day-to-day operations.

This shift to information-based value edge platforms—in addition to the availability of cost-effective sensors, advanced LTE and wireless networks, such as LoRa, 802.16s and more—has collectively opened the doors for organizations to implement solutions in the most remote locations. Top benefits of implementing IIoT technologies include the following:

1.   The value of predictive maintenance (PdM)

PdM relies on the continuous monitoring of asset performance through sensor data that can provide advanced warning of equipment problems and failures. According to research by the ARC Advisory Group, only 18 percent of asset failures had a pattern that increased with use or age (www.arcweb.com, 2015). This means preventative maintenance, such as regular equipment upkeep and maintenance checks, is not sufficient on its own. A more advanced approach, such as PdM, is necessary to avoid operations downtime and maintain on-site safety. We're shifting from time-based preventative maintenance to condition-based maintenance strategies.

> ## $10 Billion
>
> ### The cost of equipment failures
> $10B is the approximate annual loss due to fuel leaks and thefts in the U.S., according to Ayata Prescriptive Analytics based on a customer profile https://ayata.com/industries/oilgas/

2.   Lower CAPEx and OPex costs

Utilizing advancements—such as smart sensors, LTE gateways, wireless monitoring, wireless mesh networking, big data and more—organizations can lower total cost of ownership (TCO) in capital projects and increase utilization, lowering operational costs. At the same time, they can also improve overall efficiency to systems. These small improvements aren't trivial; they can make a notable economic difference. Using IIoT technologies allows the data to make these decisions prompt and more accurate than any previous technologies.

With IIoT integration, petroleum production can be captured in real-time. Through embedded sensors and the right automation of data communications systems, companies can gather information from assets anywhere and make informed decisions at any time. In addition to technical advantages, having diverse sets of data can help gain insights into all aspects of the business that can help uncover areas of needed improvements.

3.   More focus on the business, less on operations

By unlocking predictive maintenance and machine learning algorithms, plus analytics running on edge-computing platforms, less time is spent on legacy day-to-day operational practices. Enabling remote asset connectivity minimizes the need to constantly have to be on-site, decreases the need to place personnel resources in potentially hazardous scenarios, and also increases O&M practices between back and front office teams. Lastly, by leveraging the capabilities of IIoT, the technology can reduce troubleshooting time from days to minutes, which leaves more time to spend on other, more strategic, operational aspects of the business.

4.   A true competitive advantage

Facing bottom-line challenges, such as lower commodity prices and inefficient approaches to maintain assets, the O&G industry is beginning to see the IoT's importance to future success: lower operation costs, business streamlining, increased safety, predictive and business analytics, etc. According to Oxford Economics, industry-wide adoption of IIoT could increase the global GDP by as much as 0.8 %, or $816 billion in the next decade (www.oxfordeconomics.com). The financial gains of cost reduction and saved time will be invaluable as the industry becomes even more competitive.

Do You Need Class 1, Division 2 Devices?

Oil & gas applications are some of the most dangerous and demanding of any industrial application. Not only do they require rugged environmental consideration for product development, they have to remain reliable for years in order to provide the safety and efficiency the industry demands. Advantech leverages more than 30 years' experience in designing Industrial Automation products and solutions, and utilizes strategic technology partners when developing devices used in hazardous locations.

The Class I, Division 2 (C1D2) safety certification is an OSHA-mandated requirement for devices in many industrial applications. A C1D2 hazardous location is defined as areas where flammable liquids, gases or vapors or combustible dusts exist in sufficient quantities to produce an explosion or fire. In hazardous locations, specially designed equipment and special installation techniques must be used to protect against the explosive and flammable potential of these substances.

Due to the safety concerns of hazardous locations, the National Electrical Code (NEC) and Canadian Electrical Code (CEC) have developed standards to address these concerns. They have also outlined specific testing procedures the equipment used in these areas need to undergo in order to negate the safety risks.

Use Cases at a Glance

Oil Fluid Monitoring with LTE Technology

The Challenge
Commercial oilfield production sites, with their uniform tanks and neat rows of piping, look deceptively simple. Within and beneath these systems there is an incredibly dynamic chemical environment which, if un-checked, will quickly lead to premature equipment wear, lost productivity and potentially lethal poisonous gas. Until recently, fixed rate or "one size fits all" chemical application methods have been used to address oilfield fluids with fluctuating chemistries, which negatively impacts well production and equipment longevity.

The Solution
By integrating on-site monitoring and data collection and cloud-based analytics within a robust hardware package, ReStream's ProStream Production Monitoring Platform automates the chemical application process based on what is happening at each hazardous site.

The on-site monitoring and precision chemical dosing relies on a rock-solid network connection, which is why ReStream relies on Advantech LTE routers for the link between remote ProStream systems and cloud application. The SmartStart's on-board Wi-Fi radio provides a local connection for on-site technicians and in some cases, an access point for monitoring equipment spread throughout a well site. With a reliable LTE connection from Advantech, ReStream delivers on its commitment to gather more data, identify more problems, and offer more solutions.

Well Head Monitoring System

The oil & gas industry includes the global processes of exploration, extraction, refining, transporting, and marketing petroleum products—such as oil—which is transported through large pipes that can stretch across continents. The oil is kept in motion by pump stations along the pipeline, and usually flows at speed of about 1 to 6 meters per second.

Monitoring System Solution
The main function of an intelligent remote supervisory system is to monitor the operating status of local and remote intelligent equipment. Advantech's WebAccess software manages and controls the water injection pumps and valves, the parameters of

intelligent equipment, such as the temperature and pressure of lubricating oil, valve opening angles, the details of valves, and alerts for open/close functions.

WebAccess' powerful network functions are ideal for on-site and remote monitoring of intelligent equipment. The solution also includes the following:

• The high-performance ADAM-5510 PAC controller controls all relevant parameters and control loops, which has eight I/O slot expansions to easily expand I/O modules. The ADAM-5510 controller acquires all monitoring data from the water injection pump and control valves and inverters.
• The industrial EKI-1322 alert module sends real-time alert message to designated phone numbers, effectively helping administrators handle any alerts or malfunctioning equipment.
• The industrial IP65-compliant TPC-1770H touch panel works as an on-site HMI, facilitating human-computer interaction for on-site personnel to control and operate intelligent equipment.
• The industrial EKI-7654C Ethernet switch builds a communication network, connecting the ADAM-5510, webcam, and industrial touch panel, TPC-1770H.

Gasoline Fueling Station Management

This project implemented a gasoline pump control system for the dispensing, metering, and monitoring of gasoline tanks at a gas station. This system fully automated the process of dispensing gasoline and is supported by real-time connectivity between the gas station and its corporate headquarters.

Station Management Solution

The control and management platform is an UNO-1140FH that is integrated with the ADAM-4000 series as a turn-key solution. An ADAM-4080 counter/frequency input module, with two 32-bit counter input channels and a built-in programmable timer for frequency measurement, helps to manage the details of the fuel dispenser meters data. ADAM-4117 analog input modules gather tank liquid levels and pressure information.

An ADAM-4150 digital input/output module is in charge of alarm triggers and pump on/off. Additionally, the control and management platform can transmit all information via an EKI-2728MI Ethernet switch to the corporate headquarters.

In this application, Advantech's complete turn-key system and software provided a cost-effective solution for the customer. All the products installed provide safety and reliability in the application.

The ADAM-4100 series modules are compact, versatile sensor-to-computer interface units designed for reliable operation in harsh environments. Their built-in microprocessors—encased in rugged industrial-grade ABS+PC plastic—independently provide intelligent signal conditioning, analog I/O, digital I/O, LED data display, and an address mode, all with a user-friendly design for convenient address reading.

Monitoring Oil & Gas Equipment in Hazardous Environments with Wireless Mesh Sensing

The Challenge

A major oil company was looking for a non-invasive way to monitor equipment in its terminals, such as large tanks, pumps and other outdoor equipment. The company needed to monitor tank conditions, pump status and additional equipment all with little disruption to existing process controls to maintain safety and avoid process downtime. Additionally, the company needed the data sent to its OSI PI database.

The outdoor monitoring area presented additional challenges. All sensors and associated monitoring equipment needed to be non-invasive, be easily installed and utilize wireless communications. Other environmental challenges included outdoor areas with large, metal obstructions throughout. Communications to and from sensors needed to be extremely reliable. To meet safety requirements, all monitoring devices also had to be rated for outdoor and hazardous environments.

The Solution

To meet the challenges of the application, the company decided to utilize the Wzzard Wireless Mesh product family from Advantech. The Wzzard Wireless Mesh solution provided a stable, wireless platform to connect sensors to an Advantech SmartSwarm Gateway. The Gateway seamlessly runs third-party data connector software to send data to the company's OSI PI server.

Wzzard's SmartMeshIP wireless mesh provides a stable, reliable connection even in difficult RF conditions. All Wzzard Industrial Nodes are rated Class 1, Division 2 for hazardous locations, rated IP67 for outdoor use and UL listed. Advantech supplied clamp-on current sensors, thermocouples and vibration sensors for monitoring condition of pumps, motors and gearboxes. Additional sensors, such as pressure, flow and tank level, were provided by third-party vendors and easily connected to the Wzzard nodes.
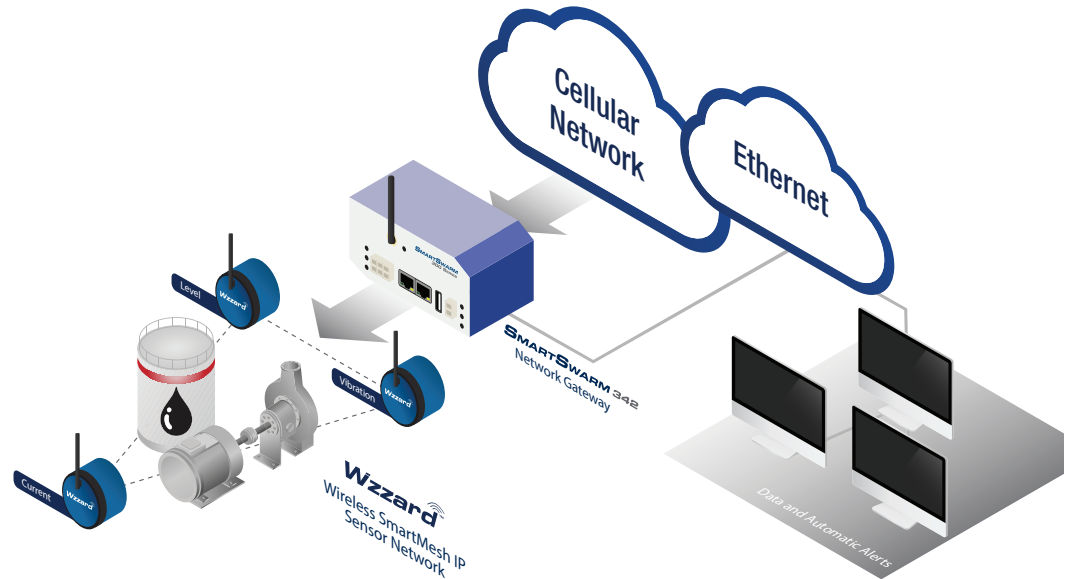
Oil Pipeline Real-Time Monitoring

Oil pipelines are made from steel or plastic tubes with an inner diameter typically in range of 4 inches to 48 inches. Most pipelines are buried at a typical depth of about 3 to 6 feet. As crude oil contains varying amounts of wax, buildup may occur within a pipeline. Often these pipelines are inspected and cleaned using pipeline inspection gauges; they detect anomalies in the pipe, such as dents, metal loss caused by corrosion, cracking or other mechanical damage.

Pipeline Monitoring Solution

To ensure transmission quality, there are a lot of stations along long-distance oil and gas pipelines. The control system of the pipeline needs to perform real-time monitoring and control of each station. To guarantee safety and stability, a communication system has to be stable, reliable, safe, and rugged.

With long-term cooperation with many professional oil and gas pipeline companies, Advantech's gateway and industrial Ethernet switch products have been successfully applied to many similar systems. Features of successful systems include the following:

- The UNO-2174A/2178A embedded computer with WebAccess software includes features, such as multiple serial ports, Ethernet ports, a wide operating temperature, etc. UNO-2174A/2178A serves as protocol converter gateway at stations to convert protocols, such as electronic control system, compressor system, etc., for connecting to PLCs.
- Other than serving as a unified data protocol gateway at stations, UNO-2174A/2178A embedded computers also serve as protocol converter gateways. For example, the device can convert Modbus RTU/TCP to IEC-60870-5-104 for control centers.
- The UNO series, with flexible and high-performance protocol converting functions, is ideal for on-site systems.
- The control center utilizes a high-performance communication server, UNO-4683 with an Intel Core i7 processor, to process uploaded data, and to receive data with IEC-60870-5-104 protocol.

Solutions for Oil & Gas Industry Networking

Throughout energy production and distribution infrastructures, Advantech is there. We have experience serving the full spectrum of energy industry applications, whether upstream exploration and production or downstream refineries, pipelines and local gas stations.

We bring wired and wireless networking expertise into all types of harsh and hazardous environments. Whether you're building a new system or expanding or reorganizing an existing one, Advantech can help you envision a new network configuration and install the right data communication solutions and products.

We offer industrial IoT solutions for oil and gas industry applications for trouble-free connectivity and data communications:

- LTE wired and wireless routers
- Data acquisition modules
- Wireless radio modems and remote I/O
- Industrial Monitors and Controllers
- Wi-Fi routers, bridges, serial servers, embedded modules, access points
- Ethernet switches, routers, extenders
- Serial servers & gateways
- Serial converters, repeaters, isolators, surge protectors, cards
- Software packages
- Turn-key and custom-engineered solutions and more

Class 1, Division 2 Certified Product Offerings

Data Acquisition Modules

Advantech's remote I/O modules—including repeaters, converters, and both RS-485-based and Ethernet-based remote data acquisition modules—provide ideal industrial automation, control, and measurement solutions for confronting harsh environments and demanding applications. What's more, with wide operating temperatures and multiple mounting methods, Advantech's ADAM series can be implemented in diverse applications, making the system always connected and reliable.

- **ADAM-4000 Series**: RS-485 I/O Analog Input / Output Modules and RS-485 I/O Digital Input / Output Modules
- **ADAM-6000 Series**: Ethernet I/O Modules
- **ADAM-4500 Series**: Repeaters / Converters
- **ADAM-3000 Series**: Isolated Signal Conditioning Modules
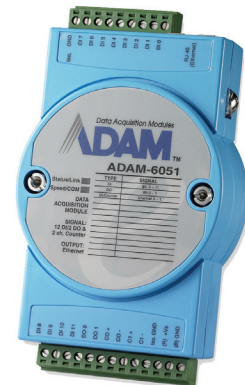
Industrial Communications

With industrial-grade product design, Advantech's industrial communication products have passed the harsh tests of various vertical markets, such as IEC 61850 for substation automation and UL508 safety for industrial control equipment. In order to fulfill the networking needs for hazardous applications, Advantech offers a comprehensive line of UL-approved Class I, Division 2 Groups A, B, C, D industrial communication solutions: Industrial Ethernet Switches, Media Converters, Serial Device Servers, and Modbus Gateways.

- **EKI-7000 Series**: Managed Ethernet Switches
- **EKI-2000 Series**: Unmanaged Ethernet Switches
- **EKI-1000 Series**: Serial Device Servers, Programmable Device Servers, Modbus Gateways, Media Converters

Industrial Panel PCs and Monitors

Carrying industrial automation technology into the oil and gas industry, Advantech offers industrial monitors in the FPM series. The FPM-8151H is a particularly rugged and reliable 15" XGA wide temperature industrial monitor for a variety of industry applications. Equipped with a wide operating temperature range of -20 ~ 60oC (-4 ~140oF), it can satisfy the demands of a wide range of harsh industrial applications. The TPC-1881WPH panel PC features an Intel 4th Generation Core i5-4300U 1.9GHz processor with 4GB/8GB. It's designed to be safely operated for a variety of C1D2 industry applications.

- **FPM-8151H**: 15" XGA Industrial Monitor for Hazardous Locations
- **TPC-1881WPH**: 15" XGA Industrial Monitor for Hazardous Locations
- **TPC-1251T-E3BE:** 12" XGA Industrial Monitor Thin-Client Terminal for Hazardous Locations with Intel® Atom™ Processor

Embedded Automation Computers

The UNO-1372GH is designed to be safely operated in locations that are UL listed for Hazardous Locations with Class I, Division 2, groups A, B, C, D T4A certification. The UNO-1372GH is an Intel Atom DIN-rail PC, which features innovative iDOOR Technology for automation applications. It provides rich I/O, including: 3 x GbE, 3 x USB, 2 x COM, 1 x VGA, 1 x HDMI, Audio, iDoor,8 x DIO, all of which can be locked with a lockable kit to ensure a spark-free in harsh environment.


- **UNO-1372GH**: C1D2 Intel® Atom™ Quad-Core Control DIN-rail PC
- **Coming Soon UNO-430**: Intel Atom IP66 Ruggedized Outdoor Gateway with LTE M.2 3042 key B, WIFI/BT M.2 2230 key A/E, GPS C1D2 + IEC-ATEX Standalone Type

LTE-WiFi Gateway

The SmartFlex LTE-WiFi Gateway from Advantech provides secure, carrier-flexible connectivity for devices and LANs via LTE networks. The gateway can be used to provide automatic wireless fail-over for wired networks, wireless connectivity for mobile assets, and wireless connectivity for devices in remote locations where cable connections are impractical. SmartFlex is rated C1D2, meeting requirements for hazardous environments.

- **BB-SR305**: SmartFlex for North America
- **BB-SR300 Series**: SmartFlex without 3G/LTE function
- **BB-SR303 Series**: SmartFlex for Europe
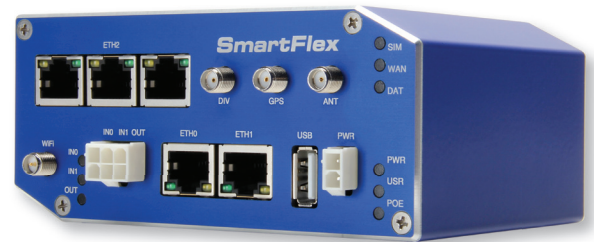
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