Industrial Internet of Things (IIoT) Impact on the Oil & Gas Industry Value Chain

by Maurizio Rovaglio

Executive summary

IIoT concepts are transforming the Oil & Gas industry business model in fast and dramatic ways as a result of three key factors:

- The cost of connected sensors has plummeted, allowing Oil & Gas companies to accelerate digitization programs and to leverage a higher mobility of work force.
- Connectivity is now widespread and huge volumes of process data are being delivered to the cloud for management.
- New software analytics programs can monetize the astounding level of real-time data now available, thereby transforming the efficiency of the Oil & Gas value chain.

This paper reviews these concepts and examines how Oil & Gas upstream, midstream and downstream processes are impacted and how these processes can derive benefit from this advanced digitization.

Introduction

Most companies within the Oil & Gas industry have been able to withstand sharp drops in oil prices thanks in part to streamlining within their organizations and simplification of processes across their enterprises. The significant drop in oil prices— below US $40 per barrel at the end of 2015, down more than 60% from their high in the summer of 2014[1]—reflects a combination of oversupply and weak global demand along with general global economic concerns.

How Oil & Gas executives respond to these changes and to other trends (e.g., growth in popularity of renewable energy) will determine both the short and long-term survival of their organizations. Most executives are beginning to think and act differently than they have in the past. They are reassessing the purpose and strategic direction of their companies and are finding new ways to make their organizations profitable.

Low prices are forcing powerful innovations in the way oil & gas is being developed and produced. Recent developments in the area of the Industrial Internet of Things (IIoT) are facilitating changes that can result in the reduction of unit costs of oil production and ultimately higher returns on capital employed. The profound technology changes that are just beginning to manifest themselves, will result in an Oil & Gas industry that will be stronger, leaner, and more durable.

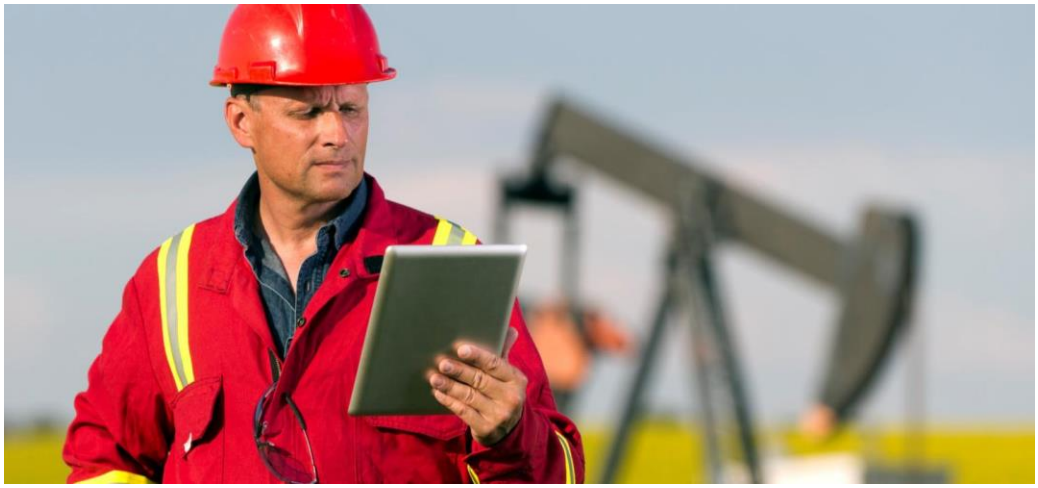

Figure 1

IIoT will result in the reductions of unit cost of oil production

The backbone of the transformative IIoT trend is the linkage of connectivity, cloud, and analytics technologies to simplify process automation. As pressure on oil prices continues, the demand for digitized upstream, midstream and downstream applications will grow. Opportunities to link multiple platforms operated remotely from a single onshore center or to deploy remote monitoring for onshore and offshore operations can dramatically reduce the need for physical on-site inspections. Consider, for example, how the use of drone technology to inspect pipelines or to discover new deposits in remote locations changes the equation.

Multiple flying drones called “aerial data collection bots” examine job sites during oil exploration. While performing their tasks, these drones generate large quantities of data in the form of high definition video. Legacy methods for performing this type of work involves manned helicopters with cameramen for shooting surveillance video. Self-piloted drones can photograph job sites 24 hours a day providing site managers

[1] Boston Commons High Tech Network, “World Oil Market Demand & Supply Trends”, July 2016

an up-to-the-minute view of how their resources are deployed. A local edge computing site allows the drones to transmit the data in real time and receive instructions in a timely fashion.

On business growth

"It would be sad if during this period of the low business volume that (oil companies) did not make the necessary changes to deliver better results when the business environment improves."

- Senior Advisor, Large US-based international Oil and Gas Company

Such a digital transformation framework empowers traditional refinery managers to re-invent their operations. By exploiting disruptive digital technologies, they can optimize CAPEX and/or OPEX while providing technologies, infrastructures and services that enable the transition towards a more sustainable business. Modernization of assets, volatility of market demand and energy efficiency are three disruptive forces that refineries will need to address in order to convert shifting business climates into opportunities.

The deployment of IIoT solutions translates into increased intelligence throughout the process workflow, more accurate and granular data collection and analytics, and higher levels of automated control and decision making. Deployment of these technologies can be viewed as disruptive to the traditional way of conducting business. In the end, however, IIoT approaches will help companies establish new benchmarks in efficiency (including energy efficiency), and productivity while fostering collaboration.

Industry outlook

In 2015 the energy market spent $7 Billion on IoT solutions. Projected compound annual growth rate of this spending is expected to climb to $22 Billion in 2020.[2] McKinsey Global Institute research also projects a period of aggressive growth, estimating that the impact of the Internet of Things on the global economy might be as high as $6.2 trillion by 2025.[3]

Oil & Gas executives surveyed in June 2016 by Schneider Electric as part of its recurrent strategic research offered numerous perspectives regarding business growth, digital transformation and corporate culture transition. Most agreed that IIoT will be an important source of growth for them over the next several years—as will be the trends in wireless computing and big data. At the same time, the corporate leaders polled admitted that they lack a clear perspective on the concrete IIoT business opportunities given the breadth of applications being developed, and the fact that the trend is still nascent.

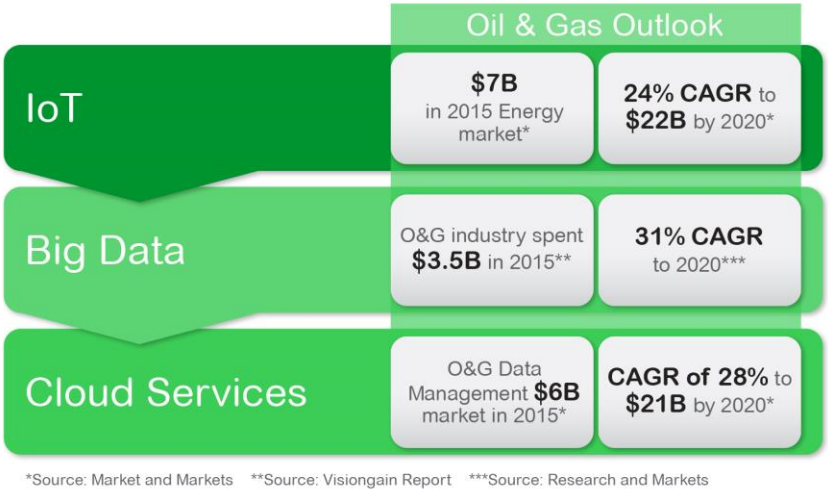

Figure 2

Industry growth forecasts surrounding the expansion of IoT, Big Data, and Cloud Services

[2] Markets & Markets, "Internet of Things Technology Market by Hardware, Platform, Software Solutions, and Services, Application, and Geography - Forecast to 2022", 2016

[3] Bauer, Harald, Patel, Mark, and Veira, Jan, McKinsey & Company, "The Internet of Things: Sizing up the opportunity", December, 2014

Below is a summary of some of the findings that resulted from the survey administered to the Oil & Gas executives:

- Cyber security was identified as the #1 potential obstacle when considering IIoT initiatives
- CAPEX savings were identified as the #1 motivator for initiating IIoT projects
- 62% of survey participants expressed a willingness to work with companies like Schneider Electric for the purpose of launching IIoT-related Software as a Service (SaaS) pilots
- 85% of survey participants indicated that they were looking to deploy SaaS solutions within next 1 to 3 years

These perspectives point to a need for Oil & Gas companies to adjust current business models. They will need to support these changes through the exploitation of new, more affordable IIoT technologies to deliver performance improvements.

All participants also expressed a high degree of interest in expanding the use of "as a service" business models for both increasing productivity and lowering costs. **Figure 3** below illustrates the solution preferences of the workshop participants.

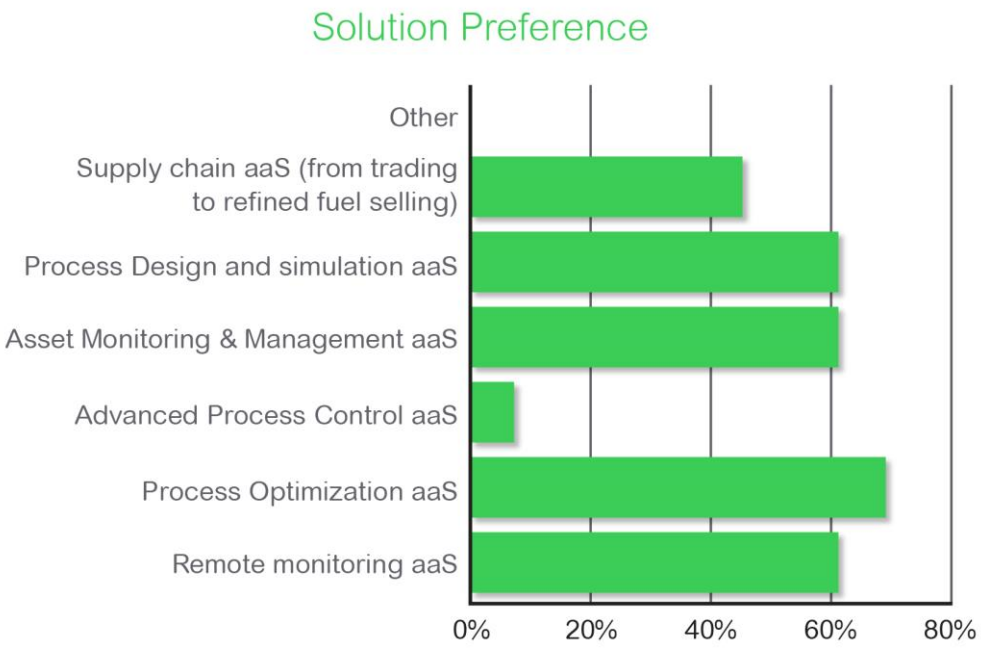

Figure 3

Software as a Service (SaaS) solutions can apply themselves in multiple Oil & Gas value chain environments

SaaS offerings are an outgrowth of the convergence of Information Technologies (IT) and Operational Technologies (OT). Flexibility and a "pay as you use" approach, which has made such offerings attractive across multiple industries, are now influencing cost control initiatives across Oil & Gas industry environments.

The SaaS business model presents both advantages and disadvantages for Oil & Gas company stakeholders.

Below are listed some of the more significant advantages:

- **Time to deployment** - SaaS software solutions can be implemented in a matter of weeks rather than months

- **Fewer internal responsibilities** - Cloud service providers are responsible for maintaining the software, upgrading the hardware and supplying enhancements through upgrades.
- **Scalable and Flexible** - Cloud technology can be scaled up or down quickly to reflect changing customer requirements. Customers are only charged for what they use, without having to shoulder up-front deployment costs. Thus start-up costs are lower than similar on-premises solutions. Software integration of cloud and existing home grown applications is also made easier.
- **Anywhere Access** - Cloud technology only requires a browser and internet access to connect. This facilitates mobile access, remote work and collaborative sharing of information.
- **Resilience** - The IT infrastructure and the data generated is stored at the Cloud provider data center site. In the event of a disaster (i.e., should the data center go down for any reason), the data is backed up on a regular basis and can be easily accessed from another physical or virtual location.

On cultural change

"People employed within oil & gas enterprises need to change their working practice, and will be in the future assisted with mobile devices and apps. Our systems will increasingly use cloud technologies, in particular for our distribution business; but also potentially for upstream and downstream business. Critical data will remain the property of each company but many will experiment with the Big Data approach."

- Chief Digital Officer, Large European-based international Oil & Gas company

The disadvantages of the SaaS model include the following:

- **Security concerns** - Access management and the privacy of sensitive information are still top of mind issues when placing company data into the hands of third parties. However, surveys have shown that these concerns are decreasing every year. Advancements in encryption techniques and other technological improvements are reducing the levels of concern so that cloud data is being considered at least as secure as traditional proprietary data (i.e., service providers are motivated to provide robust security in order to remain in business).
- **Compliance** – Individual countries and industries have differing regulations in respect to where data is stored. Businesses need to ensure compliance with these regulations when implementing SaaS solutions.

In order to execute against the changing business challenges of budgetary constraints, organizational barriers, cybersecurity concerns, poor process efficiency and high costs, the core IIoT-driven contributions supported by vendors like Schneider Electric include:

- Business process efficiency (higher productivity and profitability)
- High asset availability and performance (predictive and condition based maintenance)
- Risk mitigation and safety (embedding safety into product designs)
- Enablement of faster time-to-market (securing both centralized and edge applications)
- Sustainable growth (low CO_2 emissions products and systems).

Crossing the IIoT threshold

IIoT technologies are introducing new possibilities for extracting more value from existing systems. These OT systems can now be converged with popular, standardized IT systems. In addition, large-scale analytics techniques derived from non-industrial applications such as finance, workforce management, and healthcare, are being applied to Oil & Gas industry scenarios and are creating new ways for Oil & Gas operations to extract more profit.

The ability to exploit IIoT benefits and the associated higher degrees of operational intelligence will rely on three important technology attributes:

- Connectivity - Collection of data at the local level, and delivery of much higher quantities of data to the cloud
- Cloud - Inexpensive but safe and reliable storage and management of that data
- Analytics - Conversion of that data into real-time information that drives quick but accurate business decisions

Big Data and analytics may be new to some industries, but for many years the Oil & Gas industry has processed large quantities of data in order to drive decisions. As a result of the experience of determining what lies below the earth's surface and how to bring it out, energy companies have invested in seismic software, visualization tools and other digital technologies. Now, the rise of pervasive computing devices, affordable sensors that collect and transmit data, new analytic tools and advanced cloud storage capabilities are opening new doors. (Average selling prices for all types of semiconductor sensors are forecast to fall by a compound annual growth rate of -5% in the next five years, which is double the rate of decline for the period extending from 2009 to 2014.[4] This presents a whole new universe of opportunity that will make its influence felt from exploration to production and on downstream activities as well.

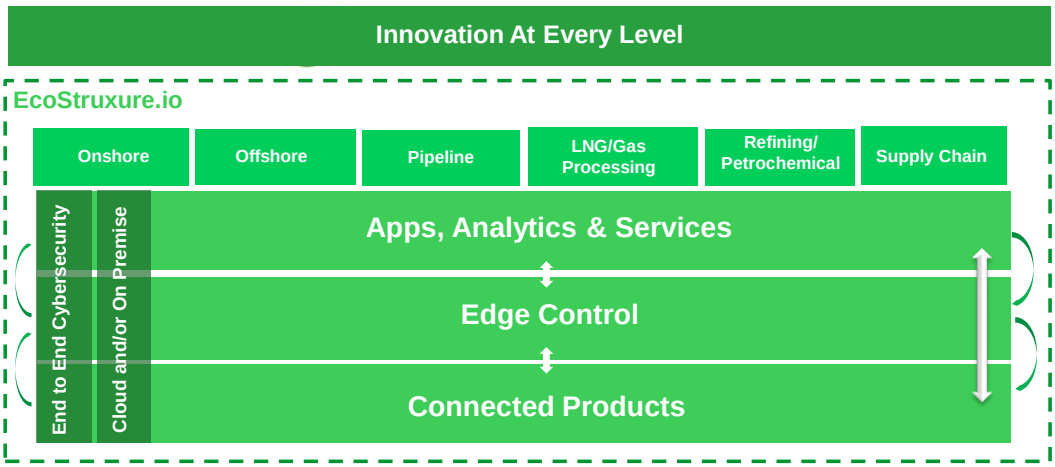

Figure 4

IIoT will influence the way Oil & Gas companies deploy connectivity, cloud and analytics

IIoT is also playing an important role in revolutionizing the way new workers are being trained and the way operators are improving the safety and efficiency of operations. For years now the Oil & Gas industry has struggled with the challenge of retirement-age workers who are leaving and not being replaced. As they depart (or are being pushed out during this crisis) they take their institutional knowledge with them and their organizations are left behind scrambling to fill the gap.

Consider how advancements in the areas of virtual and augmented reality are impacting this issue. The ability to gather all of this data at an affordable cost means that information can be applied to simulation of real-life situations. Simulation is becoming a key tool to design processes, optimize operations, and train operators. With new technologies such as immersive virtual reality, Oil & Gas industry operators are offered a safe environment where they can mimic all possible situations while reducing business interruption costs. Simulation software enables training for all kinds of applications and can be delivered in a 3-D, photorealistic, and interactive environment.

[4] IC Insights, "O-S-D Report—A Market Analysis and Forecast for Optoelectronics, Sensors/Actuators, and Discretes", 2015

From online learning modules around individual equipment and small systems to complete instructor-led virtual-reality environments of an entire upstream, midstream or downstream operation, full-scope simulators are now available. Common techniques include: photo scanning surveys, laser scanning surveys, and existing 3-D computer-aided design models; all of which engage virtual reality to create real-world situations for operators. Training and simulation augment the situational awareness of operators so they can prevent production or output problems by anticipating contingencies and preparing for remedial actions.

Most of these solutions can run today from a laptop, a tablet, or even a cell phone.

Figure 5

Augmented reality is one example of a productivity tool that is facilitated through the growth of IIoT technologies.

The look of a complex spreadsheet need no longer make new operators feel queasy. Cumbersome spreadsheets are now converted into powerful, web-based, interactive, user-friendly platforms. At an Oil & Gas distribution center, a 3D view of the pipeline network lets prospective operators see where a leak could happen, if service isn't performed within the next 3 months. In operations across the globe, Operator Training Simulators (OTS) are utilized as advanced training tools that provide young operators the skills they need to run a process or plant. Operators learn how to manage a refinery in a safe virtual control room that simulates responses to different scenarios. This provides trainees the opportunity to learn how to react appropriately when a similar situation occurs in real life.

Although user interfaces may be simple and intuitive, they mask some complex processes that represent the fundamental core of utility or manufacturing operations. For example, a Schneider Electric tool called SimSci Dynsim is a rigorous process dynamics simulation platform that predicts the time dependent future behavior of industrial processes.

The business value that is generated includes lower capital costs and improved plant design while giving the organization the opportunity of "getting it right the first time". These solutions include design checkout control systems for Programmable Logic Controllers (PLCs), Emergency Shutdown Systems (ESDs) and Distributed Control Systems (DCSs), all working together to optimize the production process.

In essence, the disruptive impact of IIoT can be attributed to three main influencers:

- The trend towards accelerated use of mobile Human Machine Interface (HMI) technologies via smartphones, tablets and wearables, combined with IP-access to data and information (and the associated analytics and augmented reality). Portable wireless devices are expanding their capabilities and are improving the operator experience. This makes the "augmented" operator more productive.
- Affordable access to Cloud technology, which requires only a browser and internet access to connect. This makes mobile access, working from remote sites, and the sharing of information easier than ever.
- The vast diversity of new data sources (from sensors to marketplace data) and enabling analytics can now be applied to new wide areas of the Oil & Gas value chain.

The following sections address the core pillars of IIoT deployment: connectivity, cloud, and analytics.

Gathering and moving data (connectivity)

The Oil & Gas industry spent $3.5 Billion in 2015 on big data-related projects[5], with projected annual growth of 31% by 2020.[6] What will drive this growth? Oil producers can capture more detailed data in real time at lower costs and drive profit from previously inaccessible areas. For example, by pairing real-time down-hole drilling data with production data of nearby wells, stakeholders can adapt new drilling strategies, especially in unconventional fields.

As OT systems (OT representing a vast collection of physical infrastructure systems such as power and control, heating, cooling and ventilation systems) are now being equipped with either built-in connectivity intelligence, or field upgraded connectivity, much more operational performance data is being forwarded to the cloud and analyzed. This is forming a much more pervasive “sensing” layer for data gathering.

On digital transformation

“Digital emphasis is now on the process control network (PCN) and higher level planning tools (e.g. pipeline management - controlling input gas or oil field production from multi-party ownership on the basis of commercial agreements). Cyber-security continues to be high priority. It is increasingly a challenge to find resources that have appropriate IT and process control systems knowledge.”

– I&P lead engineer, Large European-based international Oil & Gas company

The technologies included in this sensing layer are fundamentally the same IoT technologies used in the enterprise cloud layer, but are optimized for real time deterministic communications. The OT devices that comprise this time sensitive layer (sensors, actuators and controllers) are cloud-ready and capable of interfacing transparently with the IT business systems.

In pipeline operations, as a result of open standards and centralized data management, IIoT allows seamless integration and operation across different pipeline operation systems such as simulation, forecasting and planning, measurement and asset management. IIoT increases system availability through accurate, timely data, and a resulting improved response to abnormal operations.

As part of the IIoT evolution, optical fiber is increasingly being deployed in many upstream and midstream applications. Optical fiber is used to provide high bandwidth telecommunications and infrastructure for Supervisory Control and Data Acquisition (SCADA), and is being used more to sense pressure, temperature and strain along buried onshore pipelines, on subsea pipelines and down hole. With Distributed Acoustic Sensing (DAS), an optical fiber is used for both sensing and telemetry, collecting a huge amount of data used to map the impact of earthquakes on pipelines.

Despite the developing industry trends, the fundamental principles of pipeline operators have not changed. Pipelines must operate 24 hours a day and 365 days a year,

[5] Visiongain, “Big Data in Oil & Gas Market 2015-2025”, September, 2015

[6] Technavio, “Global Big Data in Oil and Gas Sector Set to Grow at a CAGR of 31% by 2020”, December, 2015

and, as such, safety, high availability and reliability are key requirements for pipeline management systems and the supporting infrastructure.

Figure 6

In the realm of pipeline operation, IIoT increases system availability through accurate, timely data, and resulting improved response to abnormal operations.

Oil & Gas pipeline communications and technologies are constantly evolving to address a multitude of new entry points. Such an evolution represents the trade-off of processing increased amounts of data to ensure efficient, optimized, and streamlined pipeline operations while opening the door to higher risk of compromising operational systems security.

Vendors can help Oil & Gas companies achieve these goals through dedication to high-quality engineering and to processes that ensure consistent levels of security in products that are developed across global research facilities. Manufacturers like Schneider Electric have invested millions of dollars in the ongoing development of secure software, core product enhancements and expanded application suites.

Storing and managing the data (cloud)

The Oil & Gas industry spent $6 Billion in 2015 on data management with a projected annual compound spending growth rate of 28% to $21 Billion by 2020.[7] With more and more data storage moving to the cloud, this represents the IIoT layer where enterprise systems (e.g., ERP, PLM, CRM) and next-generation functions including asset, operations and energy management converge.

The cloud layer is where Big Data, gathered from intelligent devices across the value chain of operations, is stored. This layer helps to accelerate the monetization of IIoT deployment. For example, by implementing cloud-based well management solutions, operational savings can reach 50% during the first year while achieving 30% in the subsequent years.

Cloud-based predictive maintenance represents another opportunity for streamlined operations. In the area of pump maintenance, for instance, a typical planned maintenance schedule would change pump seals every 2 years, whether or not these changes were needed. By implementing cloud base predictive solution, the predictive model and algorithm help forecast future failures and seals are only changed once they begin to exhibit warning signs of potential future failure. Thus, unnecessary maintenance interventions are reduced.

The cloud enables shared information within the whole supply chain to keep operations running smoothly and efficiently. Direct back office integration of critical data

[7] Markets & Markets, “Oil and Gas Data Management Market by Type”, May, 2015

provides all parties the information they need, eliminates time consuming manual entry, and reduces potential keystroke errors.

Figure 7

The cloud enables shared information within the fuel supply chain to keep operations running smoothly & efficiently.

Using cloud technologies to connect existing automation in the oil field aids in the distribution of the data sources, data aggregation levels, and defines processes where the results of the analysis can be applied back to the field. Actionable information derived from cloud-based analysis helps to close the loop with automation systems, service providers, operators or other entities that are capable of performing actions in the field.

This allows the implementation of a system that integrates well management, for instance, with the functionalities of pump control, production monitoring, alarm analysis, failure tracking and work order management. This system can provide guidance on data models standardization across the field devices and software platforms. The result is a highly scalable solution that allows remote/fast deployment and minimal software configuration for optimized well automation.

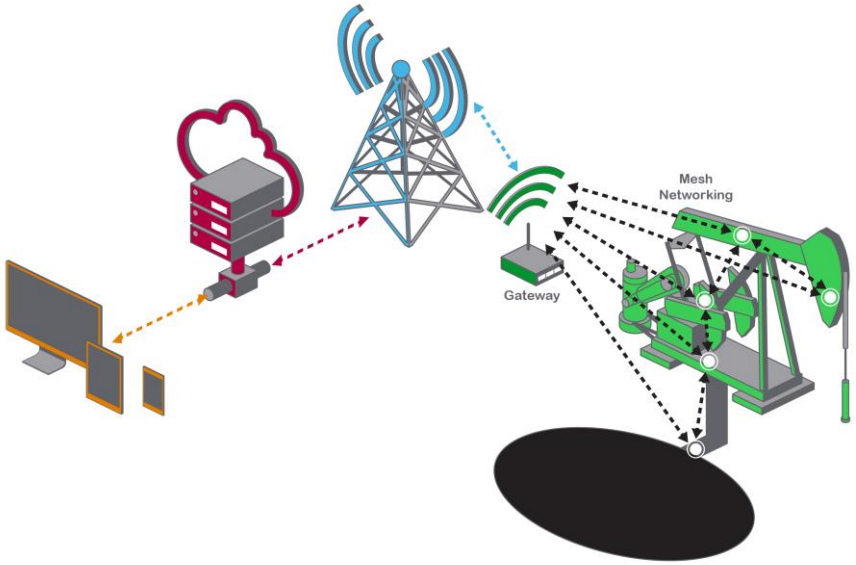

Figure 8

IIoT solution in a well management environment

Cloud Wells Management is a web-enabled monitoring application generating information and KPIs from real-time process data historians, production databases, field devices and simulation well models. From a desktop computer or a tablet, operators can visualize key performance data, access different hierarchical views of the field and manage all assets. A simulated view of oil and gas well performance and diagnostic displays allows timely response to emerging well issues for faster recovery of optimal operation. Such identification of underperforming oil wells helps operators avoid deferred production, reduce maintenance costs, increase production and maximize field efficiency and oil recovery. Designed to highlight the benefits of "as a service" solution, Cloud Wells Management is easy to deploy and can demonstrate immediate returns on investment within two to six months.

Translating data into action (analytics)

Digital applications and services are critical to end users achieving the business performance gains promised by IIoT. Data collection must be extended to include analytics that are simple to interpret and that deliver pertinent and valuable business information.

By linking the information derived through analytics via wireless connectivity and cloud-based architectures, the result is the correlation of differentiating analytics at the process control level. Simple measurements plus complex analytics equate to customer value.

Dashboards that compile the analytics gathered from the field utilize contextual information, such as real time events, alarms, drifts, and historical data, to help operators make more precise resource allocation decisions.

In these early stages of IIoT rollout, applications which benefit the most from these advanced analytics include installation optimization, asset management and protection, condition based monitoring, and augmented reality applications.

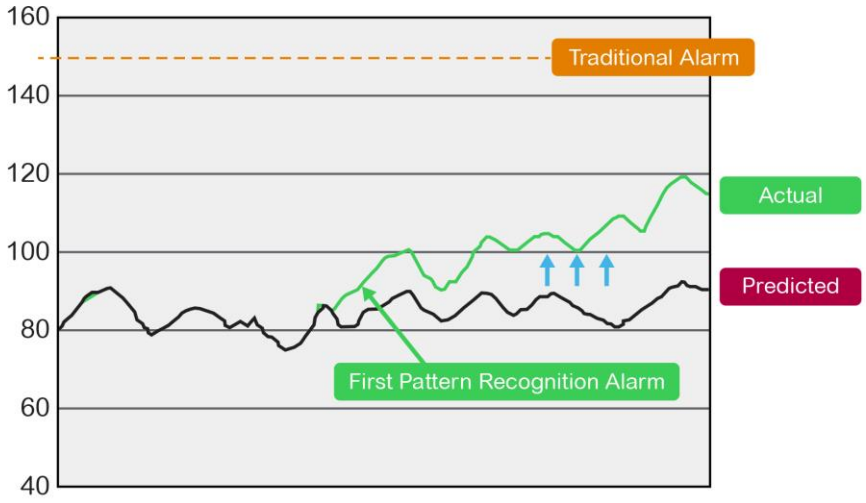

Figure 9

Predictive analytics makes it easy to identify anomalies and provides notification of abnormal conditions before operational alarms

For example, predictive asset analytics solutions are typically based on algorithms called Advanced Pattern Recognition (APR) and machine learning technology. The tool learns an asset's unique operating profile during all loading, ambient and operational process conditions. Existing machinery sensor data is input into the software modeling process and compared to real-time operating data to determine subtle deviations from expected equipment behavior and to alert operators of any deviations as appropriate.

Process performance as a service

In the past, Oil & Gas industry supply chain operations used a host of different tools and software applications to address a particular aspect of the operation. This resulted in hundreds of people working in isolated silos — with limited visibility into or knowledge of the implications their individual decisions had on the overall supply chain performance.

This lack of alignment cost Oil & Gas organizations tens of millions of dollars annually. By using a cloud-based approach to implement a unified supply chain management solution to the Oil & Gas market, collaboration can be enabled across the entire supply chain to help traders, planners, and schedulers make reliable decisions, manage risks, and increase profitability.

The huge momentum towards the implementation of computing systems in the cloud, is also impacting automation and control. The marriage of control systems and the cloud is central to helping industrial stakeholders leverage the potential benefit of IIoT business performance gains.

On digital transformation

“Digital should first enable oil companies to develop projects faster and operate making the right decisions in a timely manner. Second, it is critical to ‘Keep it simple’. Installations (connected points, etc...) should not be over-engineered and risk introducing complexity for the sake of digital.”

– Deputy SVP Development & Support Operations, Large European-based international Oil & Gas company

The basic requirements of control systems include maximum uptime, reliability, quality and speed in order to make optimal use of the enterprise's production resources. At the same time, operating security and the confidentiality of sensitive information within these systems needs to be preserved.

No enterprise is going to want to rely on a server or personal computer if the operating system and the software are less stable and their uptime inferior to a dedicated control system. Stopping a production facility will result in huge financial costs.

Cloud computing providers are assessed by the uptime of their systems. They invest extensively in the security of the computing infrastructure; they have far greater incentive to invest in uptime and security than any individual enterprise that is more focused on their core business (like production and delivery of Oil & Gas). As a result, computing systems of cloud service providers are among some of the most stable and secure computing options. Stability is crucial, as the cost of downtime is estimated to be is substantial, from $1 million a year for a typical mid-size company to over $60 million for a large enterprise.[8]

Numerous process performance Software as a Service (SaaS) models are springing up across industries offering users a flexible and economic means for streamlining key business processes. In the Oil & Gas industry these “as a service” flavors include the following:

- Supply chain (from trading to refined fuel selling)
- Process design and simulation
- Asset monitoring and management
- Advanced process control
- Process automation
- Remote monitoring

[8] IHS Markit, “Businesses Losing $700 Billion a Year to IT Downtime, Says HIS”, January, 2016

As an example, the benefit generated by process performance SaaS through online real time asset monitoring and optimization could be very high. In a refinery, for example, a CDU (primary distillation unit) of 250,000 barrels a day can generate, through online optimization, an additional value of more than $5 Million a year.

However, if managed internally, the maintenance of updated, tuned and effective online applications presents some significant challenges in terms of infrastructure costs and skilled resource availability. In many cases, early attempts at deployment have resulted in the application being turned off due to poor performance resulting from process to infrastructure mismatches or hardware obsolescence.

A Cloud process performance "as a service" solution running in a dedicated secure data center can directly address these challenges in the following ways:

- Updated “best in class” infrastructure is always available as service providers are constantly updating their hardware and software.
- The cloud business model is kept up to date as this represents the provider’s core business
- Scalable, easy to install infrastructures are available that are paid for only on an “as needed” basis (elimination of significant up-front costs).

As a long term vision, only the sensors and the final control devices will be installed at a production site, each equipped with its own individual IP address and some edge computing capabilities in specific cases. The full control system will be driven more and more by a Software Defined Architecture (SDA) based on a platform running in the cloud (public or private). The architecture will enable operators to identify every device, will allow for the remote execution of the corresponding operating logic and will exchange only the required data. This approach has already been applied to productivity tools such as Historians, Human Machine Interfaces (HMIs) and Programmable Logic Controllers (PLCs).

Figure 10

Open automation: a view on process control of tomorrow

The cyber security challenge

As oil & gas enterprise control systems connect to the Internet they allow for greater business efficiency (e.g., remote process monitoring, predictive system maintenance, process control and production data analysis). However, at the same time, they also make businesses more vulnerable to cyber threats. According to the U.S. Department of Homeland Security ICS Cyber Emergency Response Team, a 20% increase in Integrated Control System (ICS)-related attacks was observed in 2015, across a wide range of US industry sectors, including the petroleum industry.[9] Hackers are targeting critical infrastructures such as power grids, water networks, and oil pipeline networks.

These cyber attacks are being generated from numerous sources including individuals, rogue groups, and nation states. Attacks are increasing in intensity and sophistication and are capable of changing system settings or derailing systems that sustain business processes.

Cloud platform and analytics layers of the aforementioned architectures must be designed within a balanced envelope for security (physical security and cyber security) of open protocols/open connectivity. The protection from cyber attacks can come in many different flavors. Most casual observers are familiar with firewalls that protect the outer perimeter (threats from outside) of the network.

Although many components make up the overall security landscape, two in particular are applicable to industries like Oil & Gas that operate control systems (i.e., SCADA, power systems, water networks, building management) at multiple levels: Network Intrusion Detection Systems (NIDS) and Dynamic Endpoint Modeling systems.

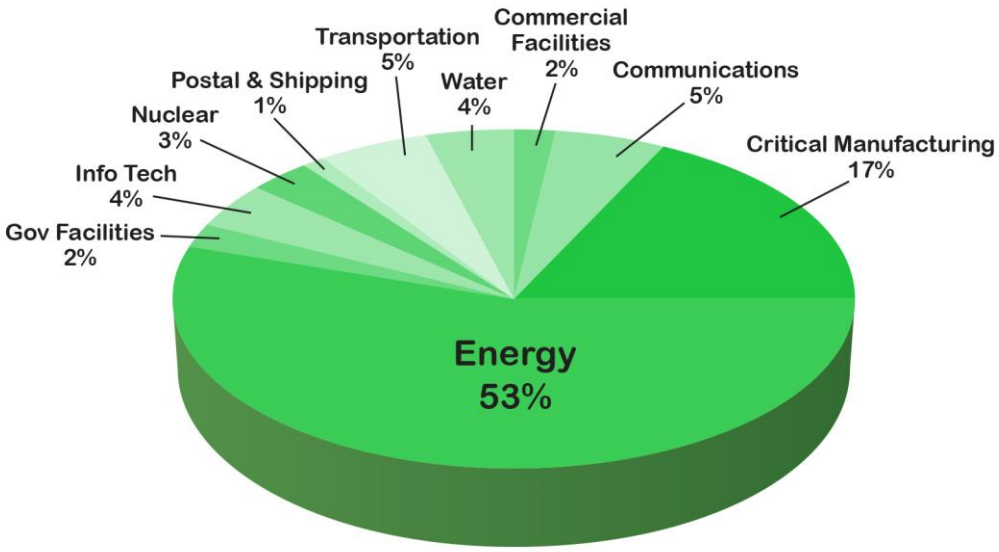

Figure 11

Number of cyber security incidents and percentage of total by industry in the US (courtesy of US Homeland Security Department)

NIDS are network security systems that monitor the network and focus on the attacks that come from authorized users inside of the network. NIDS systems perform pre-emptive analysis by searching for anomalies and signatures on the network. Once detected, an alert is forwarded to a security analyst for review. The analysts' role is important to determine which alerts are false positives and which alerts are

[9] Industrial Control Systems Cybersecurity Emergency Response Team (ICS-CERT), "ICS-CERT Fiscal Year 2015: Final Incident Response Statistics", 2016

legitimate attacks. Some NIDS also have a defensive capability (prevention) that enables them to block an anomaly or signature before it can cause damage.

NIDS are deployed at key entry points on a network and report their information to a central server where all alerts appear on a console. Analysts who are trained in viewing such alerts monitor network traffic to determine if the alert and signatures are legitimate attacks. In the event of an attack, appropriate action is taken by the network defense team to resist the attack according to the organizations internal process and procedures.

Dynamic Endpoint Modeling, on the other hand, is a newly emerging technology that provides an additional layer of control system network cyber security. Dynamic Endpoint Modeling learns and models the behavior of all devices on the network and triggers alerts when algorithms detect changes in learned behavior. Any changes that divert from the baseline will alert that a possible compromise or malicious activity has occurred on an endpoint. These systems also know when a new device appears on the network or accesses the Internet for the first time.

Endpoint Modeling offers a quick and cost-effective deployment in a passive mode without any impact to network performance. Unlike traditional intrusion detection preventions systems, the skill sets needed to deploy and maintain the system are not demanding, and the costs for implementing are comparatively low.

On the security front, manufacturers like Schneider Electric are involved in the development of security-certified products and standards and in the development of secure remote solutions and services. Schneider Electric designs its software and systems according to the highest cyber security software engineering standards. In the Oil & Gas industry, Schneider Electric also offers services to system architects to assess the state of vulnerability of their upstream, midstream and downstream electrical, water, and control systems and recommends risk mitigation actions. In addition, Schneider Electric also provides assistance on how to best implement both NIDS and Dynamic Endpoint Modeling cyber security approaches.

Conclusion

IIoT is a new horizon being driven by the availability of affordable internet interfaces and less expensive and powerful Wi-Fi bandwidth. The Oil & Gas industry is being carried in this direction and existing business models are being disrupted.

Decisions influenced by either manual or automatic, feedback or predictive controls need to be made fast enough to positively impact the operation of a process. Fast and accurate decisions will result in true asset performance control which will then lead to optimal enterprise performance. This is the ultimate promise of IIoT enablement.

How, then, to proceed? The proper approach to IIoT project implementation should be planned and measured and should encompass a roadmap similar to the following:

1. Start small with pilot projects and stay focused
2. Evaluate ROI before broadening project scope
3. Make early strides with efficiency projects that are simple to deploy and manage
4. Integrate asset monitoring and management projects
5. Move to comprehensive asset coverage within a dynamic network that merges both IT and OT infrastructure

6. Consult or partner with Schneider Electric in order to gain from Schneider's accumulated global field experience in these areas.

In order to fully exploit the opportunities presented by IIoT, Oil & Gas industry specialists will need to work with resources that have appropriate IT, process control and operation management knowledge and experience. Collaboration and interdisciplinary skills are becoming more and more crucial for a reliable evolution of technology, business and life.

About the author

Maurizio Rovaglio is Vice President of Oil & Gas Technology and Alliances at Schneider Electric. Mr. Rovaglio holds a PhD and a Master's degree in Chemical Engineering. He also holds multiple patents and has authored over 100 technical articles published in international scientific journals, and has delivered presentations at multiple international conferences. Mr. Rovaglio has over 15 years' experience in software sales, marketing, resource planning and project execution in the O&G domain across the world. A passion for knowledge-sharing has led to almost 20 years' experience as a University Professor at Politecnico di Milano where he teaches various control, instrumentation and process design courses. Mr. Rovaglio is a specialist in the fields of IIoT, virtual reality applications, simulation, process control, Manufacturing Execution Systems, performance monitoring and optimization solutions in the refining, petrochemical and chemical industries.