Oil and Gas
IIoT and Remote O&M

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Hot Topic Hour Participants – March 23, 2017

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Oil and Gas IIoT and Remote O&M Expenditures will rise from $31 billion this Year to $168 billion in 2030

- The oil and gas industry has already embraced IIoT and Remote O&M and will spend $31 billion for these services in 2017 rising at 13% per year through 2030
- From just a little over 1% of oil and gas capital and maintenance expenditures this year the total will rise to $168 billion in 2030 and represent 10% of all expenditures.
- NAFTA will account for 50% of the 2030 total due to the tight oil and shale gas production and extensive use of IIoT and remote O&M with these technologies.
- The Middle East will be the second largest regional purchaser with the CIS in third place and Africa ranking number 4.
- The East Asia totals reflect only a minor contribution from coal to syngas. However, if China did proceed with its ambitious plans to transmit clean syngas from Northern and Eastern coal fields to cities around the country then East Asia would rise in the rankings.

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IIoT and Remote O&M -Oil and Gas - $ billions

World Region	2016	2018	2020	2022	2024	2026	2028	2030
Total	27	36	45	57	72	99	132	168
Africa	1.70	2.27	2.83	3.59	4.53	6.23	8.31	10.57
CIS	3.05	4.07	5.09	6.45	8.15	11.20	14.93	19.01
East Asia	1.56	2.09	2.61	3.30	4.17	5.73	7.65	9.73
Eastern Europe	0.06	0.08	0.10	0.13	0.16	0.23	0.30	0.38
Middle East	4.78	6.38	7.97	10.10	12.76	17.54	23.39	29.77
NAFTA	13.47	17.96	22.45	28.44	35.92	49.39	65.86	83.82
South & Central America	1.36	1.82	2.27	2.88	3.63	5.00	6.66	8.48
West Asia	0.27	0.36	0.45	0.57	0.73	1.00	1.33	1.69
Western Europe	0.73	0.97	1.22	1.54	1.95	2.68	3.57	4.55

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IIoT and Remote O&M will Boost Sales to the Oil and Gas Industry by $13 billion this Year

- The Oil and gas industry has been an early adopter of IIoT and Remote O&M. It is also a major purchaser of flow control and treatment products. These are defined by Mcilvaine to include all products and services associated with movement or treatment of granular solids, liquids, and gases. It includes combustion, reaction, cooling, separation, drying, and other processes.
- Smart sensors, software, smart components and data analytics along with other components of IIoT will result in purchases by oil and gas companies this year of $ 13 billion above what they would spend for less robust automation and flow control and treatment smart products.

- An additional $18 billion will be influenced by IIoT players rather than the traditional decision makers. Included in this group are sales to corporate decision makers using IIoT for global sourcing as well as sales to third party O&M companies. The total market of $31 billion will be growing at 13% per year to $80 billion in 2025 and $168 billion by 2030. The market will represent 1.5% of the relevant Capex/Opex market in 2017 rising to 3.2% in 2025.

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$31 billion Opportunity this Year

World Oil and Gas IIoT and Remote O&M Revenues $ billions		
Segment	2017	2025
New Route to Market	18	48
New IIoT Revenues	13	32
Total	31	80
Industry Relevant Capex/Opex	2000	2500
IIoT/Remote %	1.5	3.2

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Oil and Gas IIoT needs to be Empowered by IIoW

- IIoT program designers include substantial input from “practice matter experts”. However, the utilization of industry knowledge is greatly handicapped by the lack of an Industrial Internet of Wisdom (IIoW).
- In a theoretical example: sensors relay critical information to an edge computer which extracts meaning and sends it on to the cloud where data analytics provide an actionable analysis.
- This actionable analysis then is incorporated in a draft of a paper sent to a publisher who undertakes per review and editing . The result is that the data appears 3 months later.
- Alternatively it could appear quickly in a “blog” but the lack of organization makes this an unattractive option.
- Subject matter experts need to be developed. IIoT will generate the equivalent of millions of white papers on a continuous basis.
- Experts who can use the data and apply it to a very narrow niche will take knowledge to a new level.
- What is needed is a way for these experts to interface with people at different plants in the same company, between suppliers, and to take advantage of experience in other industries and geographies.

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Organizing IIoW to the same Degree as IIoT

- Decisive Classification is just as necessary in IIoW as in IIoT. Mcilvaine has initiatives to classify
  - Technical options in both English and Chinese
  - Companies with a numerical financial identity number
  - Industries using U.S. Standard Industrial codes with a Mcilvaine sub class
  - Geographies with size related divisions down to the province and State level
  - Products and eliminate practices such as using “choke valve” by some to describe a design and others to describe an application
- Mcilvaine is also working to provide organized systems to gather the information on large end users such as Sinopec, Exxon Mobil etc. BHE Energy and Supplier Connect provides data on all the 70 compressor stations, gas pipelines and 200 power plants operated by BHE

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Mcilvaine Valve Decision Guides for Oil & Gas are another Tool to Empower IIoT with IIoW

IIoT promises to revolutionize the oil and gas industry but only if it is accompanied by IIoW (Industrial Internet of Wisdom). Mcilvaine has a number of programs to accelerate IIoW. One is relative to valves. Decisive classification of high performance valve applications, valve designs, and materials is critical to IIoT success

If general purpose valves are the foot soldiers of IIoT then high performance valves belong in the armored division. Their performance is much more critical to the outcome of the battle to improve plant performance. High performance valves are defined and the program is explained at **High Performance Valve Classification Program.**

Initially choke valves, gate valves for pressures greater than 5000 PSI and molecular sieve switching valves are being evaluated.

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Oil and Gas

Oil companies are utilizing Internet of Things (IoT) technology to reduce their production costs by becoming more operationally efficient.

Over the next three to five years, 62% of oil and gas executives worldwide say they will invest *more* than they currently do in digital, according to a recent Microsoft and Accenture survey.

Oil and gas companies will use IoT devices and their associated analytics to survey land for new potential drilling sites and extract the oil from the ground. Among oil and gas executives, 89% believe they can leverage analytics to improve business practices, according to Microsoft and Accenture.

One source estimates the number of devices used on oil extraction sites — primarily wells — will increase at a 70% compound annual growth rate (CAGR). The devices will primarily be internet-connected sensors used to provide environmental metrics about extraction sites.

By fully optimizing the IoT solutions available, an oil and gas company with $50 billion in annual revenue could increase its profits by nearly $1 billion, according to a Cisco study.

The number of devices with cellular or satellite connectivity deployed in oil and gas applications around the world was 423,000 at the end of 2013, according to Berg insight, an analyst firm focused on the M2M market. Berg estimates that number will rise by 21.4 percent to 1.12 million by 2018. At the end of this forecast period, the mix between cellular and satellite-based M2M devices will be around 781,000 cellular units and 244,000 satellite communication units.

Examples of transactions in the M2M world include a wireless sensor on a pump in an oil well, and devices such as cell phones mixed with human and machine-generated responses. In retail, radio-frequency identification, shipping and cell networks, machines are recording and reporting on what other machines are doing, which increases the amount of data being generated. This includes smart homes and power distribution grids, said Weber.

Internet of Things solutions are important for the oil and gas industry in that it allows oil and gas companies to manage and gather data from operations in remote environments while eliminating the need for workers in these environments. Already facing a challenge in qualified skilled labor, the global oil and gas industry faces losing even more of its workforce as Baby Boomer-aged workers begin to retire in the next few years.

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$168 billion Oil and Gas IIoT & Remote O&M Market by 2030

- The oil and gas industry is embracing the industrial internet of things (IIoT). Millions of sensors identifying leaks, corrosion and wear of stainless components will be providing the equivalent of continuous white papers on specific grades of stainless used in specific components in each application. The result should be higher revenues and profits for those stainless producers with lowest total cost of ownership (TCO). However, the challenge to the stainless producers as well as to the plant operators will be perfecting what Mcilvaine labels the Industrial Internet of Wisdom (IIoW). This requires system development similar to the development in IIoT. Mcilvaine has several initiatives in this area.[1] It also requires the development of niche experts who understand the capabilities of various alloys used in each of the myriad combinations of products and applications.
- The oil and gas market opportunity for IIoT & Remote O&M will rise to $168 billion in 2030. $110 billion will be onsite expenditures by the oil and gas companies but $58 billion will be for remote monitoring and support including Software as a Service (SaaS) and data analytics. Data analytics in turn will include IIoW. This in turn will foster Sourcing as a Service activities. There will be many new players and lots of new data to influence the choice of stainless materials. One result should be faster acceptance of new and better materials.
- NAFTA will be the largest segment with oil and gas IIoT & Remote O&M revenues rising from $13 billion in 2016 to $83 billion by 2030.

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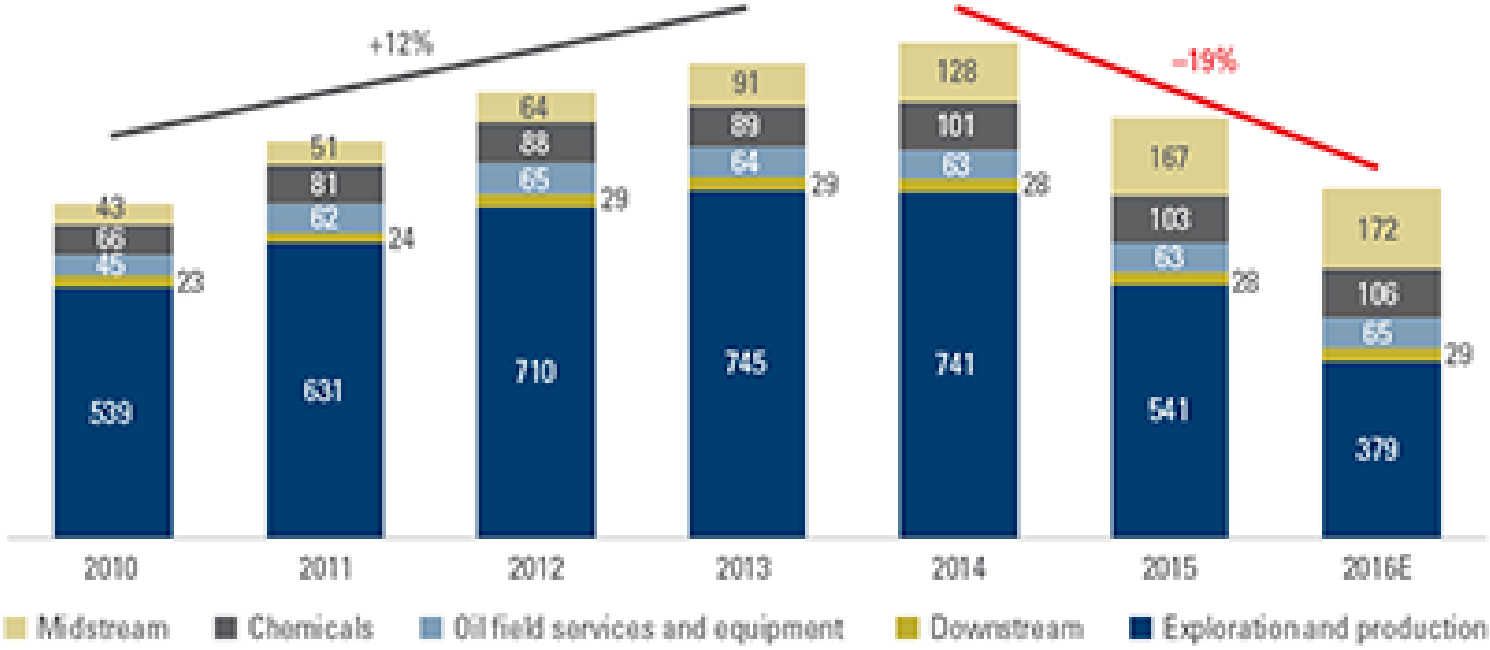
Capex Expenditures vary from $700 billion to $1 trillion

FIGURE 2: Capex cut by 20% in 2015, with more in store for 2016

Global capex spending trends and estimates, public companies (USD billions)



Note: Does not include national or state-owned oil companies.
Sources: Bloomberg, AlixPartners

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Price and Other Assumptions in the Forecast

EIA Assumptions for the Year 2040			
	Reference	High	Low
Oil Price $/bbl	109	226	49
N.G. Henry Hub $/million BTU	5	10	3
U.S. GDP % CAGR	2.2	2.6	1.6
Energy Net Trade BTU Quads	2	25	-11

The forecasts are based on the assumptions incorporated by EIA in its 2017 base case forecast. Since July 2016, there has been a 20% increase in oil rig counts. Oil producers have also increased their exports to India. These trends are showing the rejuvenation of U.S. shale oil. The shale oil market is expected to gain momentum from mid-2017.

Tight oil makes the biggest contribution to crude oil production with a 50% growth from 4 million bbl/d now to 6 million bbl/d by 2040.

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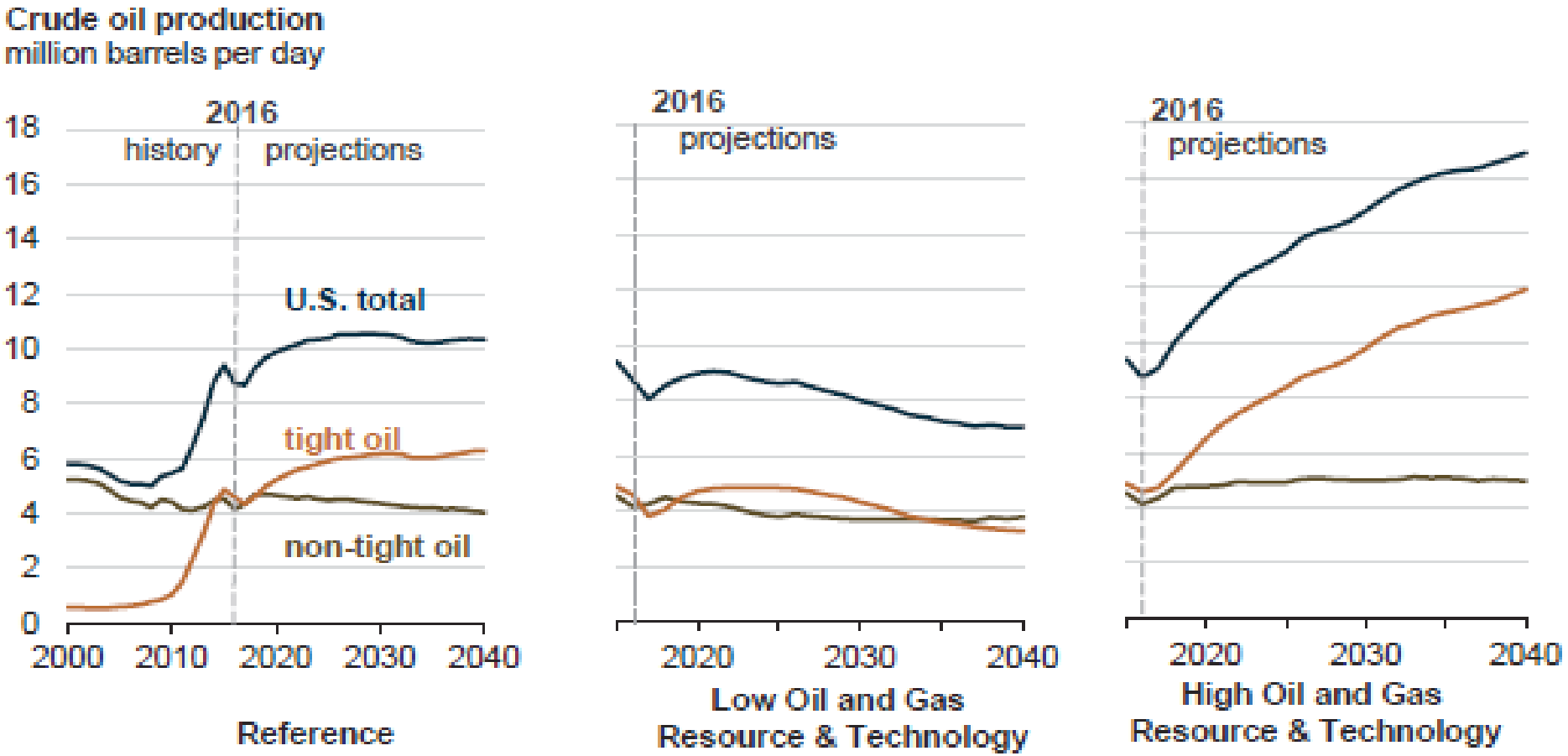
Oil Production



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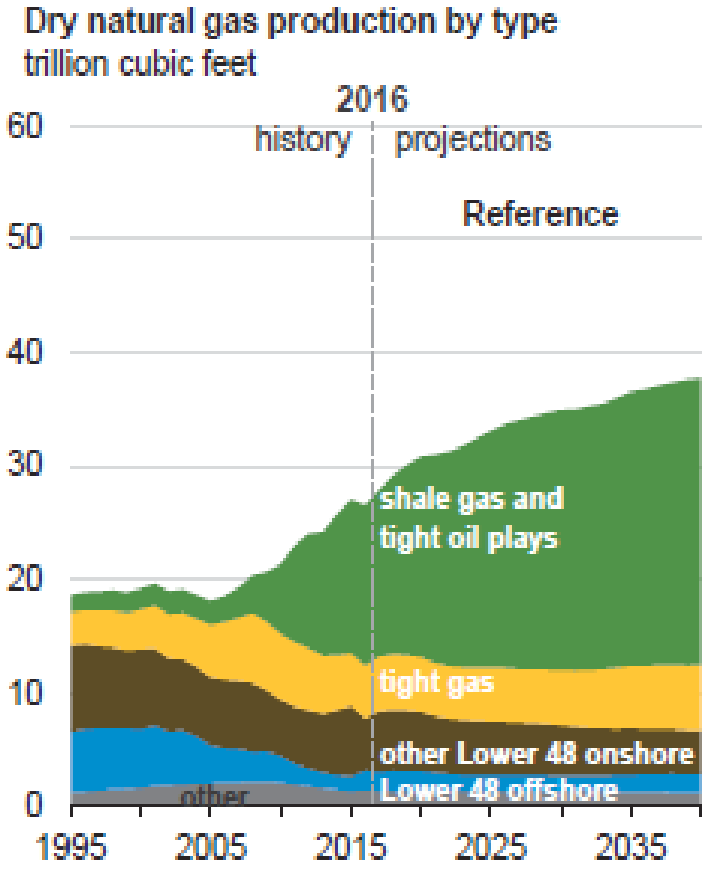
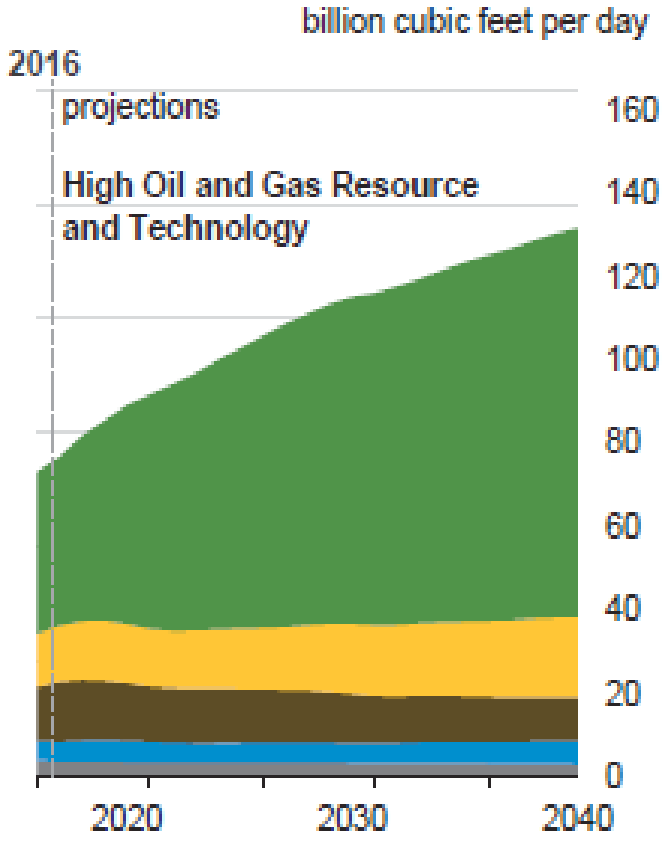
U.S. natural gas production growth is the result of continued development of shale gas and tight oil plays—





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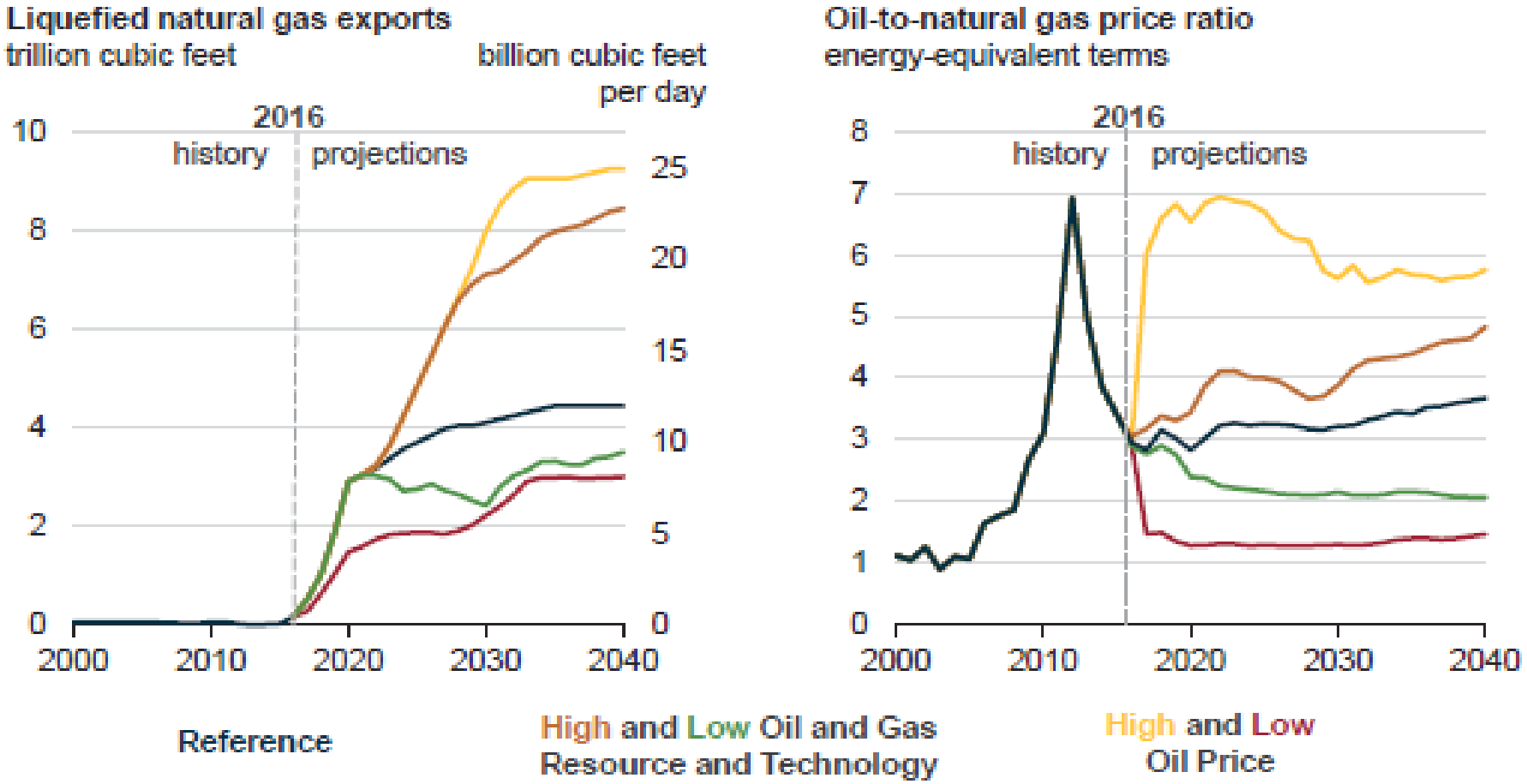
U.S. LNG export levels vary across cases and reflect both the level of global demand—



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IIoT will be utilized to meet New Regulations

- The oil and gas industry is already ahead of other industries in the use of IIoT. More than half of the oil and gas companies are deploying IIoT-enabled technology for remote monitoring. Asset reliability and energy efficiency round out the top three non-product use cases.
- Some of the biggest opportunities will be created by regulations restricting flaring in the U.S. Honeywell and Aereon will collaborate on solutions to help industrial customers boost the safety, efficiency and reliability of their operations by leveraging Honeywell's Industrial Internet of Things (IIoT) ecosystem.
- Aereon provides air emissions solutions for the complete oil and gas sector, from the wellhead to the gas station. It offers products for flare systems, enclosed combustion systems, high efficiency thermal oxidizers and vapor/gas recovery units. "Aereon's fundamental strength is its wide array of fit-for-purpose combustion and vapor recovery products supported by in-house expertise to design, manufacture and support its field-installed base," said Mark Zyskowski, Senior Global Vice President, Aereon. "We are pleased to be able to bring our expertise to the IIoT ecosystem that Honeywell is developing to help customers around the globe maximize value from their operations by tapping into the power of the IIoT."

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Software

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Honeywell Software and Dover Energy Domain Knowledge are being leveraged in O&G

The Honeywell INspire program brings together customers, equipment vendors, process licensors and Honeywell experts to jointly develop answers to operational challenges. Honeywell and its collaborators are leveraging IIoT to help customers minimize unplanned shutdowns, maximize output, minimize safety risk and optimize supply chain strategies.

Dover Energy Automation, which provides productivity tools and related automation software, is focused specifically on the energy sector, helping oil and gas operators monitor, predict and optimize performance to improve productivity. Products include Windrock monitoring and analytical systems for rotating and vibrating equipment, Quartzdyne downhole pressure transducers, and the Well Site Automation suite for onshore well performance optimization.

Honeywell is looking to combine its capabilities in data consolidation, cybersecurity and software development with Dover's deep domain knowledge in condition monitoring and asset optimization. The goal is a simple-to-use infrastructure that gives customers secure methods to capture and aggregate data so that it can be leveraged by using analytics and applying a range of domain knowledge from suppliers

With a larger, consolidated data set, manufacturers can apply higher analytics for more detailed insights, scale the data as needed to meet the varied needs of single-site or enterprise-wide operations, and leverage a wider pool of data experts for monitoring and analysis.

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Emission Control Collaboration between Aereon and Honeywell

Honeywell and Aereon are collaborating on solutions to help industrial IoT boost the safety, efficiency and reliability of their operations by leveraging Honeywell's "INspire". Aereon is known for its air emissions solutions for the complete oil and gas sector, from the wellhead to the gas station. It offers products for flare systems, enclosed combustion systems, high efficiency thermal oxidizers and vapor/gas recovery units.

There are complexities to these processes which make the more robust analytical approach desirable. For example additional CO and VOCs can be eliminated by increasing NOx and CO2. Regulations vary from State to State so that what might be the best tradeoff in one case may not be in another. Fugitive emissions are another consideration. Measurement of these emissions is now possible with emission sensors. So the proper amount of fugitive emission control can be achieved. This means finding the right balance between lower emissions and higher emission control cost.

In some cases gas can be recovered and compressed for use as engine fuel on site. In fact Wyoming and several other states have regulations pushing toward this option. So the operator has a number of options to consider.

Honeywell HPS, is a leader in development of advanced model-based, real-time optimization solutions for the Oil and Gas industry. So it can use its optimization approach with the flaring decisions.

Experion PKS® from Honeywell is the first step to driving down costs, remaining within emission norms, maximizing capacity utilization and rationalizing assets. The next logical step for improving efficiencies and reducing waste is adding a layer of sophisticated advanced solutions.

Honeywell's suite of Advanced Applications helps increase throughput of a gas plant, increase NGL's and liquids separation and help lower energy input within existing capital resources. Process conditions are also stabilized with Advanced Process Control resulting in fewer plant trips and production deferral.

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Schneider Electric Software Suite

- The software suite addresses both internal and external pressures refineries face in maintaining a responsive, decisive and collaborative workforce amid industry challenges of dynamic demand, tightened regulations and technology evolution.
- It uses a portfolio of world class applications from the company's software library and an application integration framework that can be used with other legacy third party content.
- It is pulled together with a user-configurable unified data model, and includes KPI Management and Decision Management with Workflows to enable the digital workforce.
- With clearer and earlier visibility into the state of the business, the enterprise is better equipped to make intelligent, more informed decisions.
- Suite components include Performance Manager, for trending and reporting, KPI management, unified data model and Decision Manager; plus an application integration framework for orchestration, translation and enterprise connectivity.
- Included in the offering is the company's Customer FIRST software maintenance and support program, which allows access to the latest software upgrades, expert technical assistance and self-help tools to improve operational effectiveness.

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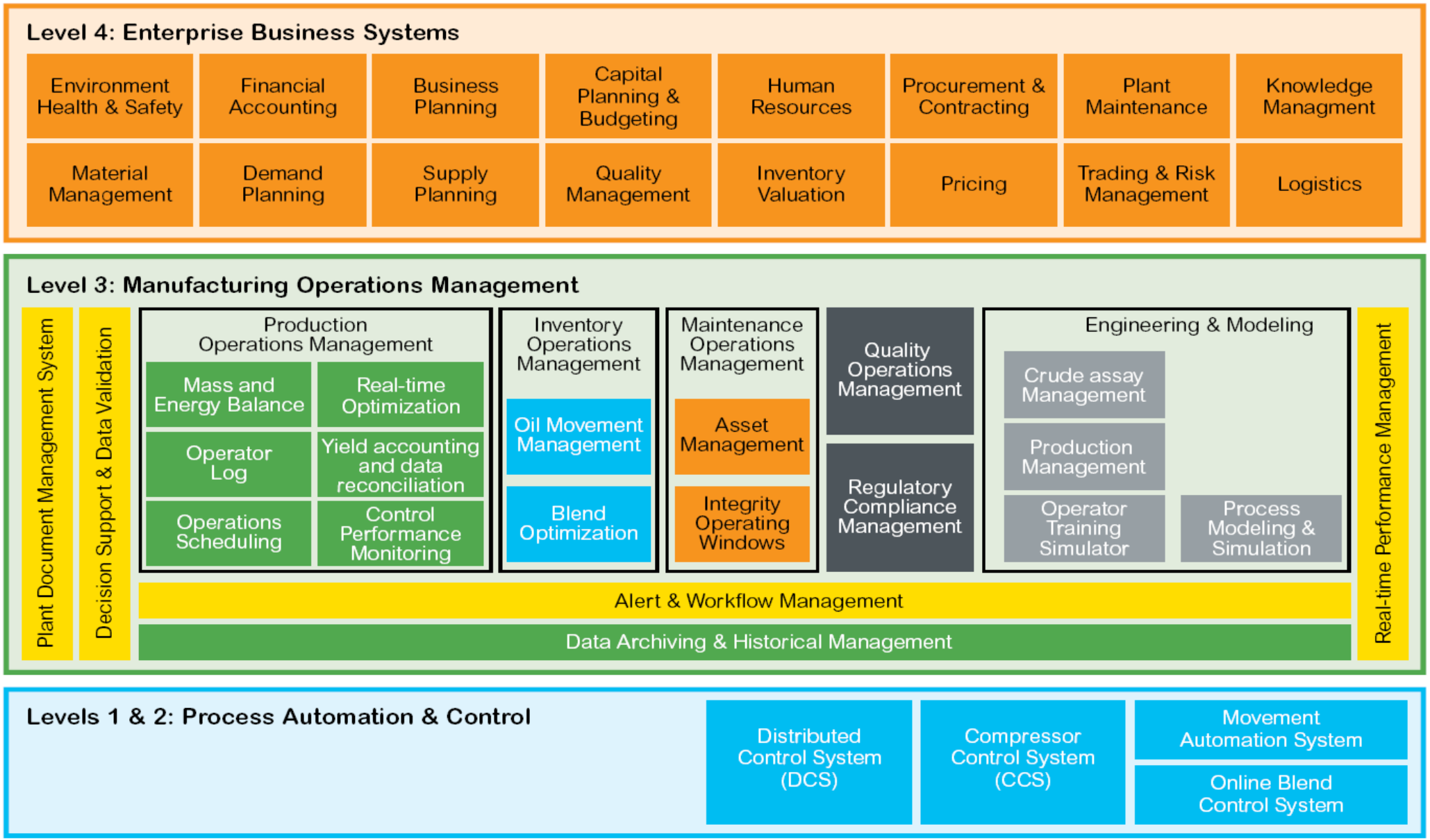
Schneider Electric



Implico automating the Complete Supply Chain

- Implico consulting services for oil and gas companies, focus on the use of SAP's downstream solutions SAP SDM and SAP RFNO for optimizing and automating the complete supply chain.
- As the digital transformation proceeds, oil and gas companies are generating ever-larger volumes of data. The challenge now is to process and utilize these data repositories more efficiently – and to turn big data into smart data. To do so, solutions are needed that are capable of ensuring that data exchange and processes are almost entirely automated, and that manual intervention is necessary only in exceptional situations. This means that employees monitor business operations with the help of control cockpits while the system performs all routine postings entirely on its own.
- Implico can draw on extensive knowledge of the industry and long expertise in the rollout of the SAP SDM and SAP RFNO downstream solutions, which are also soon to be available as SAP S/4HANA versions. SAP SDM (Secondary Distribution Management) controls and optimizes the entire order-to-cash process, while SAP RFNO (Retail Fuel Network Operations) manages and automates the handling of the processes and data that are generated when operating a service station network. The solutions help to reduce manual effort and thereby significantly reduce associated costs.

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Standardized Automation Systems

- Sandy Vasser, now retired facilities instrumentation and electrical manager for ExxonMobil Development Co., has long been on a mission to bring automation suppliers around to his list of demands. And those demands have been a huge factor behind the development of more standardized systems from all of the automation suppliers—suppliers that want a piece of the ExxonMobil action, that is.
- Vasser was a key driving force behind several developments to come from automation suppliers over the past few years. Smart configurable I/O, remote I/O and virtualization, to name a few, will enable a more standardized approach to project execution. These technologies not only simplify the commissioning process, but also allow engineers to take automation off the critical path.
- “All those things are technologies that allowed the contracting engineer that’s doing the work for ExxonMobil to continue changing their designs and still allow us to build a control system,” says Chris Lyden, senior vice president for process automation at Schneider Electric.

Ways to reduce Automation Costs

- The typical project has been overrun with hundreds of custom-engineered junction boxes and miles of wire and cable from the field, but work on automation often has to be done and redone as changes are made to facility plans according to Vasser.
- Taking automation off the critical path”—allowing designs to be changed without making the automation team scrap their work over and over again. Smart configurable I/O (or universal I/O), placed in standard cabinets and/or field junction boxes, is a big part of this.
- Whether called universal I/O, intelligent marshalling, soft marshalling, electronic marshalling, etc., all the key automation providers have introduced some form of this, enabling more flexibility for I/O changes even as projects near completion

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Reduce Customization and Complexity

Other key technology pursuits, as outlined by Vasser, include:

- Virtualization, to a broader extent than is being done already.
- DICED I/O (auto-detect, auto-interrogate, auto-configure, auto-document) so that systems can be automatically commissioned without the need for human interaction.
- SIS logic solver directly programmed using translated cause and effect. This product has actually been out for many years, Vasser says, but people weren't buying it.
- Seamless integration between automation and electrical systems.
- Use of smart I/O to replace control wiring for motor control centers (MCCs). This is an evolution of smart I/O that would eliminate most of the hard wiring.
- Standard assembly to convert multiple discrete signals to a single analog signal (a need borne out of expanded use of smart I/O).
- Simplified package interfaces.
- Wireless field instruments.
- Increased use of DC power to eliminate many of the inverters.

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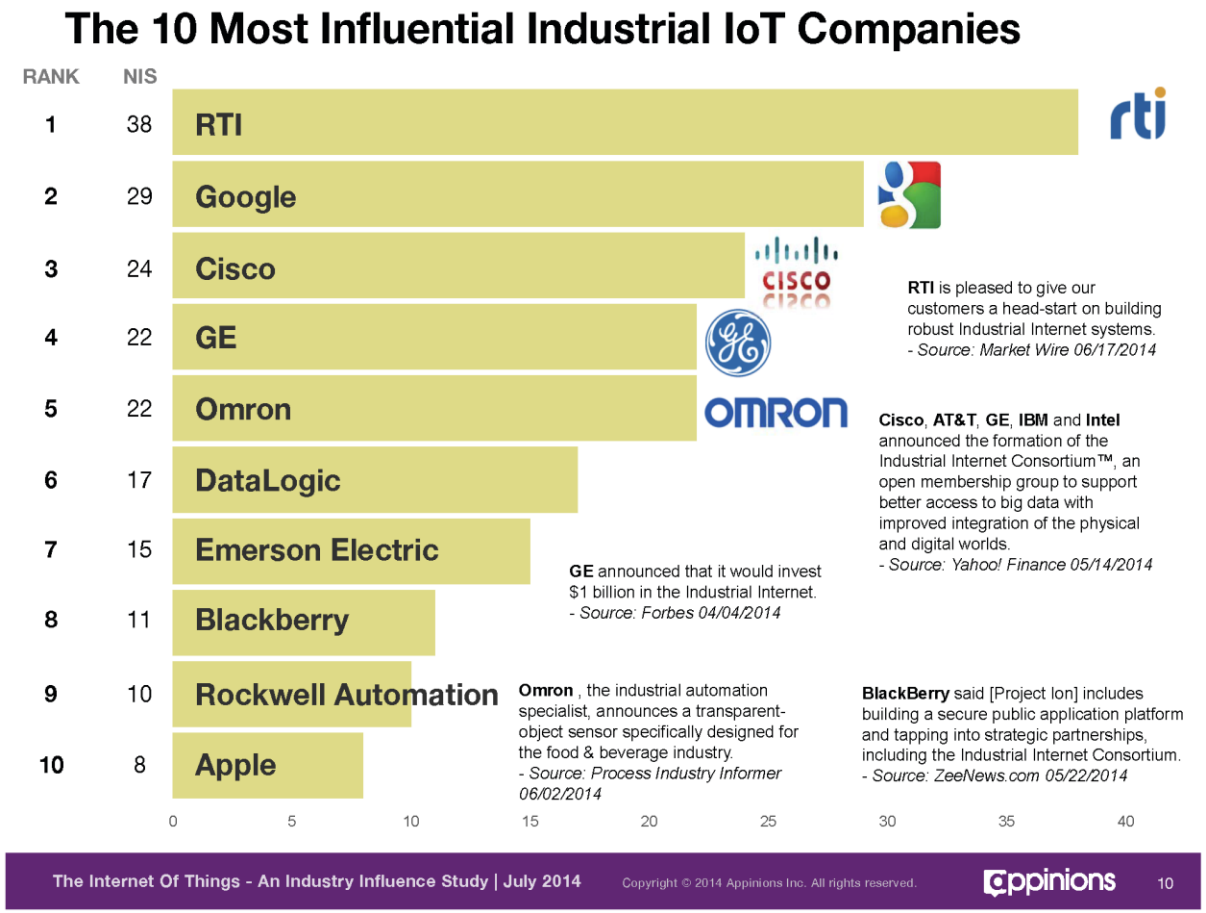
RTI is one of the Companies contributing to the use of IIoT According to Survey



RTI's Approaches to utilizing IIoW in Oil and Gas including Five Contributions

- 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 and gas industry

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RTI - Automating Remote Operations

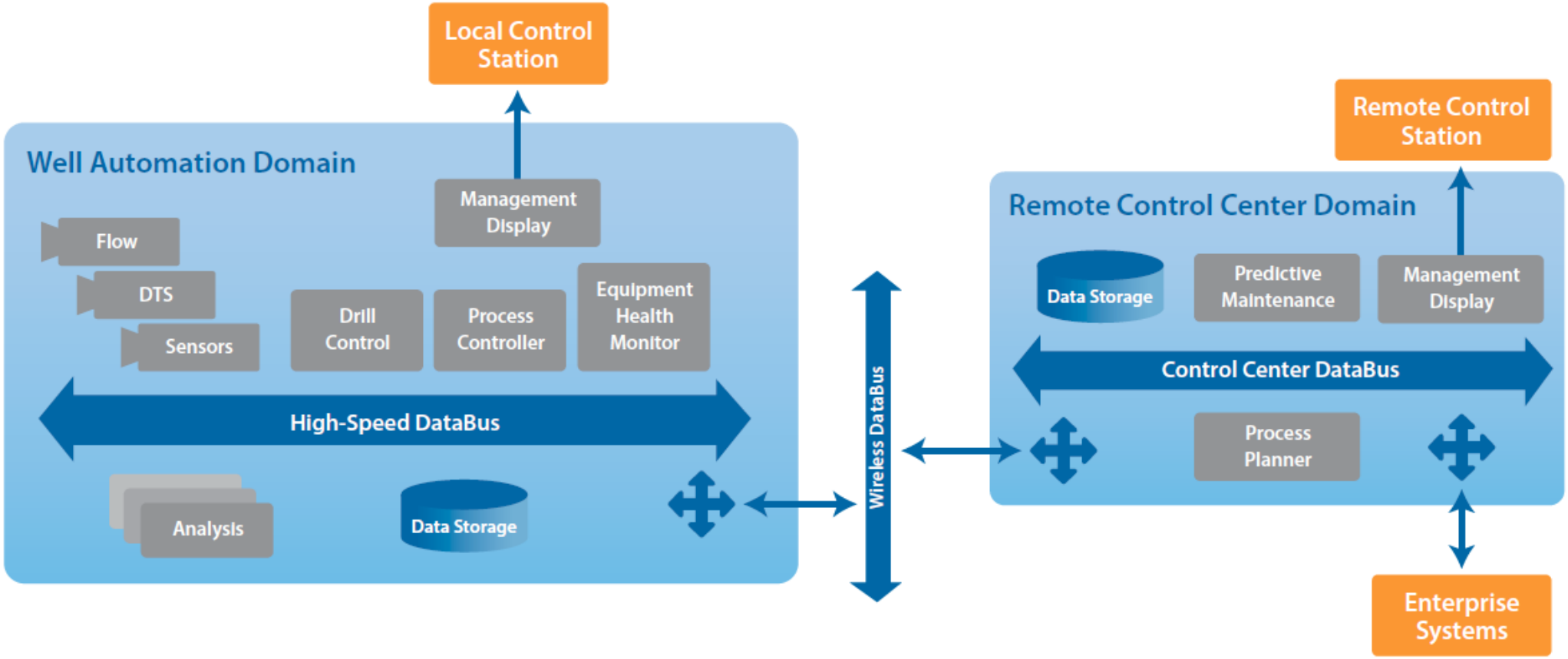

Figure 1. At the well site, a high-speed DDS DataBus connects all the sensors (e.g., temperature sensors, flow monitoring) and actuators (e.g., top drive, key drive, flow controllers) along with a process controller to automate the process of drilling and completion. The high-speed connections can also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

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RTI - Enable Massive Data Collection

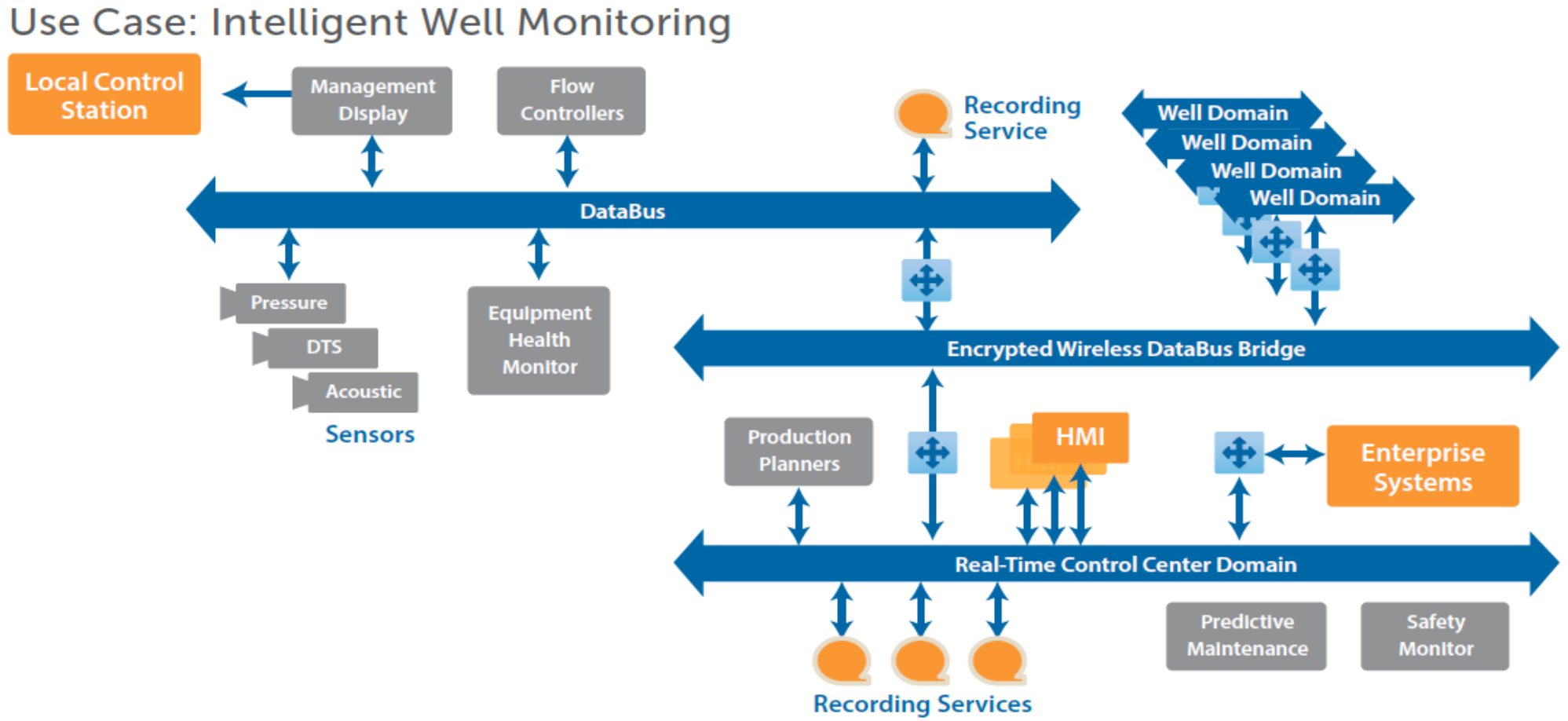

Figure 2. An entire field can be integrated by combining local DataBus instances. The system can aggregate hundreds of thousands of sensors, providing data to a control center for easy analysis, health monitoring, and data storage.

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RTI - Integrating Analytics

Use Case: Intelligent Real-Time Reservoir Management

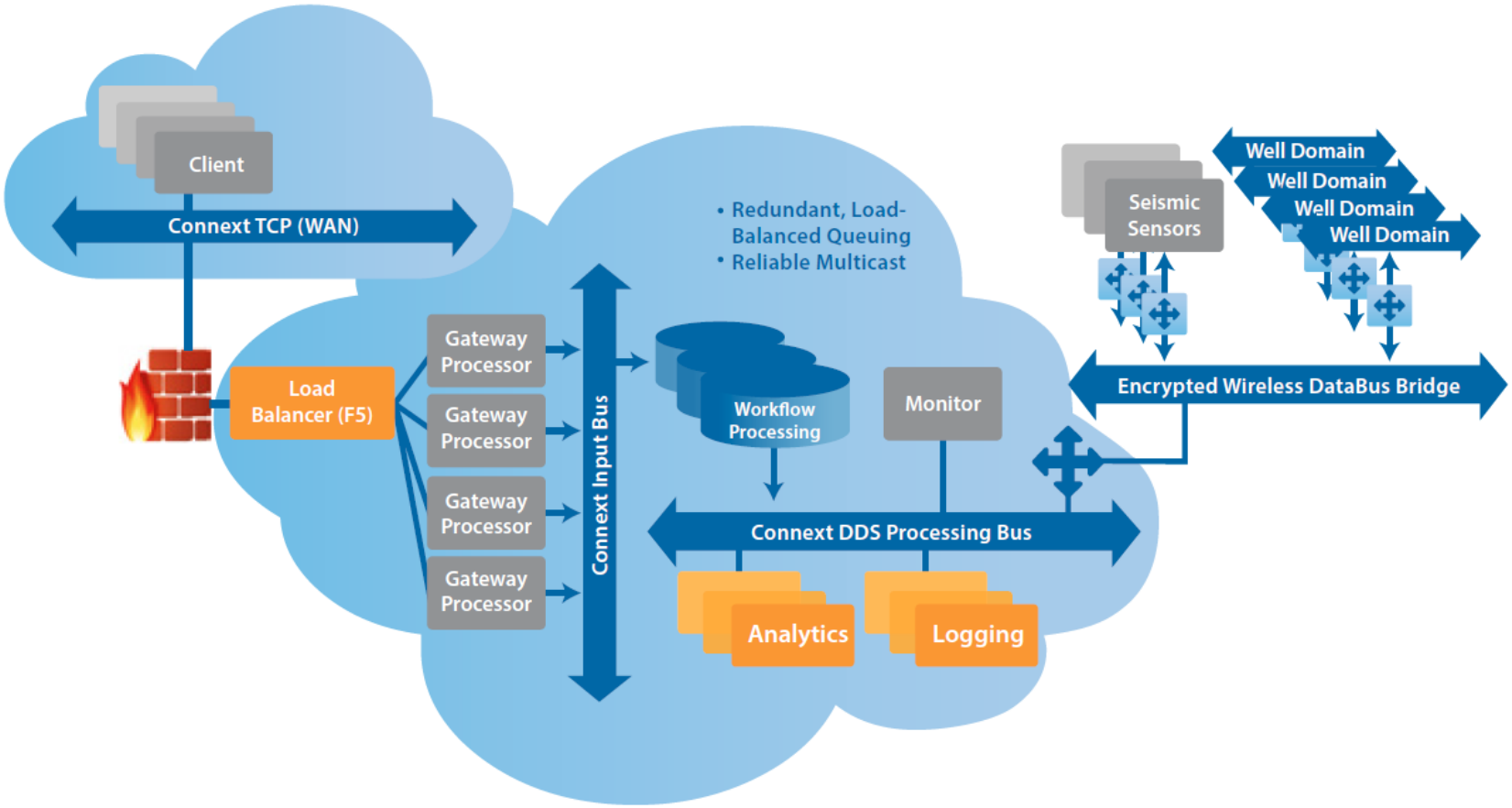

Figure 3. This example of a deployment model for a cloud-based analytics application connects well domains to a private datacenter cloud. The DDS processing bus facilitates the real-time collection and logging of well data, creating a repository for analytics applications. For high performance, a load 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.

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RTI - Securing Operations

Use Case: Security Breach Detection

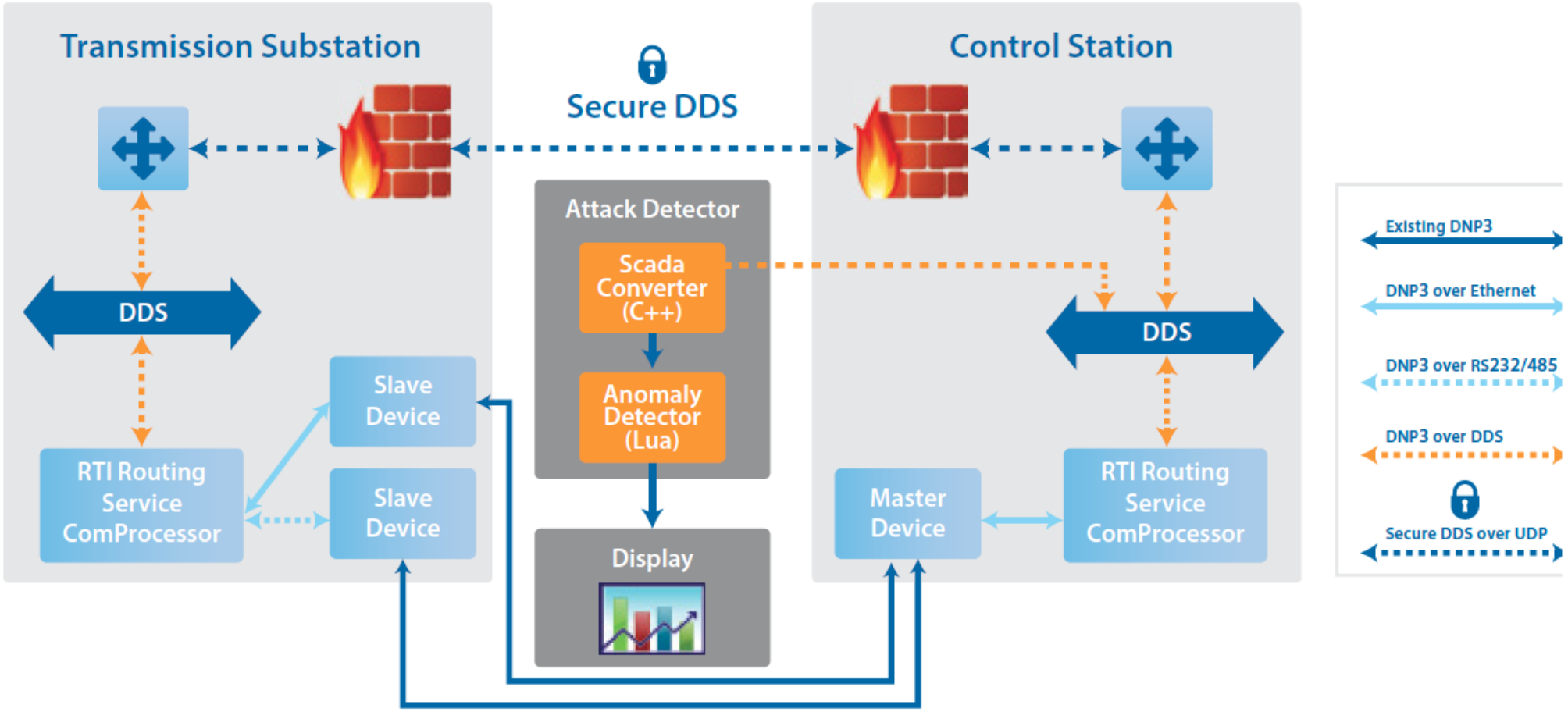

Figure 4. This system demonstrated both protection of a previously-insecure link and detection of many attack vectors through simple scripted analytics.

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Replacing Specialized Software with Internet Platforms

RTI

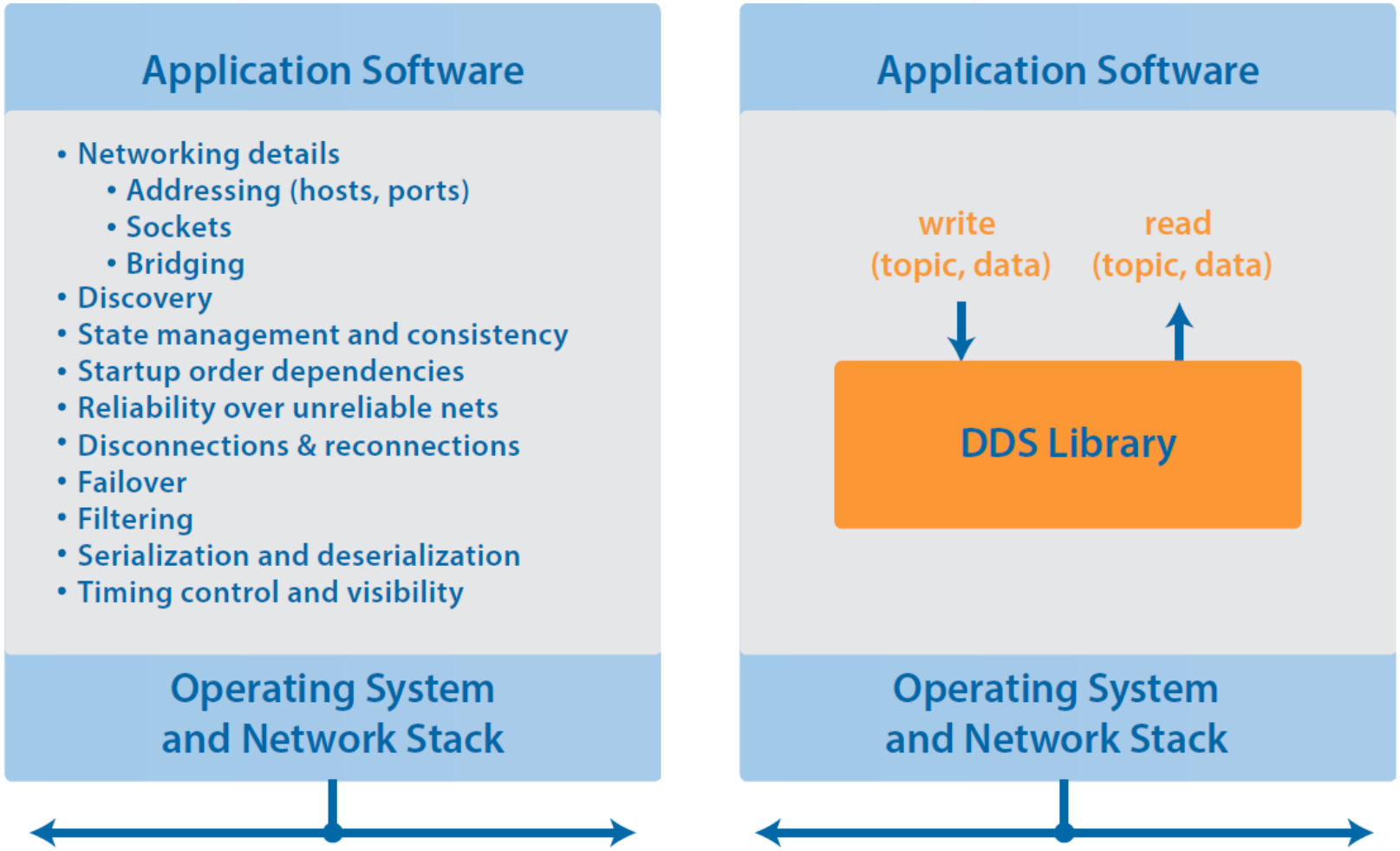

Figure 5. DDS hides low-level connectivity details and automatically handles discovery, routing, fault tolerance, and serialization. Start-up order becomes irrelevant, and DDS maintains shared, distributed state information. Application software is greatly simplified.

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Open Process Automation Forum

- The Open Process Automation™ Forum is focused on developing a standards-based, open, secure, interoperable process control architecture. The forum is a consensus-based group of end users, system integrators, suppliers, academia, and standards organizations. It addresses both technical and business issues for process automation.
- The Automation Forum addresses real challenges experienced by customer organizations in these industries:
- Food and Beverage
- Mining and Metals
- Oil and Gas
- Petrochemical
- Pharmaceutical
- Pulp and Paper
- Utilities
- Others
- The Open Process Automation Forum will be of interest to process control professionals in process industries.
- The next-generation process control framework design and implementation will be based on open architectural standards that will ensure cybersecurity, modularity, interoperability, extensibility, reuse, portability and scalability of the new system.

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Wireless

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Wireless invaluable for Remote Facilities (Siemens)

- Wireless communications are well-suited for the oil and gas industry, especially in remote production facility locations, both on- and offshore. In the past, satellites provided producers with high-latency, low-bandwidth communications sufficient for transmitting telemetry data. But satellites fell short for system automation controls requiring much less latency. They also were not sufficient for fixed and mobile multi-services, including voice and video that require much more bandwidth. Siemens three terrestrial wireless technologies – WiMAX, WLAN and cellular networks – meet those requirements with high levels of security

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Wireless Applications (Siemens)

Wireless communications have a wide range of applications for the oil and gas industry, both on- and offshore. Among them are:

- Multiservice alternatives to high-latency satellite communications
- Wireless connection of mobile applications
- Wellhead monitoring and control
- Gas field control and monitoring
- Rig power management and monitoring
- Rig internal communications
- Pipeline telemetry
- Data aggregation in rugged environments
- Process analytics

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Siemens Wireless in Gulf of Mexico

Wireless communications are already connecting remote oil and gas production facilities around the world.

One offshore wireless network using Siemens RUGGEDCOM WIN wireless broadband technology spans thousands of square miles in the Gulf of Mexico and has operated since 2011.

With more than 120 base stations, the network provides multiple services, including SCADA telemetry, voice and video on platform-to-platform and platform-to-shore as well as approaching and departing supply vessels servicing the platforms.

Compared to satellite communications, it performs these tasks with more bandwidth, less latency and reduced cost.

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Siemens RUGGEDCOM designed for Harsh Environments

- Wireless networks used in the remote, harsh operating conditions of the oil and gas industry must be flexible, durable and secure. They must also be extremely reliable.
- RUGGEDCOM's centralized network management system helps troubleshoot and localize any component problem. This helps reduce the need to send a technician to repair or replace parts, a service that can be extremely expensive in costs and communications system breakdown.
- The key to reliability is simplicity via solid-state components (i.e., no moving parts to fail) and straightforward engineering.
- For example, base stations and subscriber units are engineered to eliminate the need for a $250,000 Access Service Network (ASN) gateway and to use power-over-Ethernet (PoE), to simplify cabling.
- Also, each unit can operate in standalone mode, so scaling is simple – just add repeater or receiver subscriber units. A Layer 2 feature set creates a "CAT 5 network in the air." Orthogonal Frequency-Division Multiple Access (OFDMA) helps provide reliable, multiservice connections, especially in the radio-reflective properties of open water.

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Condition Monitoring

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Shell Ormen Lange provides Condition Monitoring for all Moving Components

- Ormen Lange is one of the world's most advanced gas processing plants but is operated by a skeleton crew. In fact, Shell's goal for the facility is to operate and maintain the plant with as few people as possible. In order to accomplish this, online condition monitoring systems are employed to monitor virtually everything that moves in the plant including pumps and compressors, control valves, certain structures and critical shutdown isolation valves. A stated goal for the plant is that 70% of the maintenance budget and maintenance spending should be based on the results of condition monitoring.
- *This data was in a paper by Stan Hale now with MRC but with Score Atlanta at the time*

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Condition Monitoring of the 41 most Critical Shutdown Isolation Valves

- Condition monitoring is used for the 41 most critical shutdown isolation valves at Ormen Lange. The population of critical valves includes a mix of single and double acting pneumatic and hydraulic gate, ball and flow control valves. These valves are instrumented with strain gages, pressure transducers and acoustic leakage sensors.
- The sensor data is continually streamed to a data acquisition system that combines other important data pulled from the plant's distributed control system (DCS) such as command signals, limit switch signals and upstream and downstream system pressures to create a complete picture of what is occurring at the valve during operation.
- Acceptance criteria for key parameters such as thrust or torque output at various points in the cycle, stroke time, leakage and other critical measures are automatically evaluated by the valve monitoring system after each cycle and icons in the system display software provide a visual indication of current valve condition.
- The monitoring approach is essentially the same as having a motor-operated valve (MOV) or air operated control valve (AOV) diagnostic system continually attached to these valves at all times

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Leaks detected with Acoustic Emission Sensors

- A critical requirement of the Ormen Lange valve monitoring system was the ability to detect through-valve leakage after the valve closes. Through-valve leakage is one of the most important test parameters for the oil and gas industry and certain valves must be tested periodically to verify they will not leak when needed in an emergency. Broadband acoustic emission sensors are employed by V-MAP to detect the high frequency noise caused by very small leaks at high pressure.
- The leakage noise elevates the broad band emission output of the sensor and also creates an initial peak above 100 KHz that spreads in both directions from the peak when the amplitude increases as a result of increasing leak size.
- The sensors and amplifiers used in the field provide the conditioned data in a format needed for automated recording in a safe area away from the valves

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Challenge with Very Large Valves and High Pressures

- The actuators are hydraulic or pneumatic, pressure transducers installed in the supply lines between the hydraulic control solenoids and the actuator cylinder.
- The actuators and valves used at Ormen Lange are much larger than the typical nuclear plant valve. The isolation valves at the landfall accommodate the 30” pipeline from the subsea wells. The critical shutdown valves on the export side of the plant are 42” in diameter with a maximum gas pressure at the valve of 3,600 PSI.
- The hydraulic actuators for these large gate valves can easily apply greater than 250,000 pounds of force to the valve at the maximum hydraulic system pressure of 4,700 PSI. The leakage criteria for each valve vary by valve and application but the typical acceptance criterion is .02 Kg/sec and .05 Kg/sec. The leakage criteria seem tight but when converted to flow it would be over 100 liters per minute depending on the gas density. The acoustic sensors and signal processing used will detect a leak as low as .1 liters per minute.

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Data is Captured and Utilized within and without the Shell Network

- All of the data is captured automatically without user intervention. The data is processed and analyzed and the results made available through the site network, the wider Shell network and outside of the Shell network through the internet.
- The end result is continuous real time confidence in the condition of critical valves versus the unknown and often changing condition not detectable by periodic testing programs.
- Growing Adoption in Oil & Gas: The growing adoption of on line valve condition monitoring in oil and gas closely mirrors what occurred in the nuclear power industry when portable valve diagnostic systems were first introduced.
- In the early days of adoption by nuclear plants the targets were problem valves known to directly affect safety or plant operations. In the Ormen Lange case it is about getting the most out of the plant at the highest level of safety.

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Hortonworks supplying big Data Technologies to Noble Energy and Centrica

Noble Energy is an independent, global oil and gas company. The company began using Hortonworks Data Platform to predict and prevent down time in their infrastructure. Those predictive analytics help the company maintain their hydrocarbon infrastructure, and they also hope to use HDP to improve safety.

Centrica supplies energy and energy-related services to around 28 million customer accounts mainly in the UK, Ireland and North America through brands such as British Gas, Direct Energy and Bord Gáis Energy, supported by around 12,000 engineers and technicians. With revenues of £28 billion, Centrica is a FTSE 50 company based in Windsor, UK and is concentrating its growth efforts in five key areas – Energy Supply, Services, the Connected Home, Distributed Energy & Power and Energy Marketing & Trading. It has 39,000 employees worldwide.

Prompted by the increased focus on the use of data and customer satisfaction, Centrica evaluated its mission critical infrastructure with a view to improve business processes and completely re-think how energy services were delivered to customers. Its overall objectives included reducing costs, improving data accuracy with smart metering, changing the way its engineers operated and interacted with customers daily and overall, putting every customer at the heart of the business.

Big data technologies have had a tremendous impact on the way Centrica is handling both internal and external processes. Specifically, the introduction of Hortonworks Data Platform (HDP) and Hortonworks DataFlow (HDF) have reshaped the way datasets are analyzed in order to gain valuable insights which has paved the way for new products and services based on data analysis.

By decommissioning its legacy data warehouses and databases, the company has been able to gain an unprecedented level of insight into energy consumption via smart metering, billing, but also customer service experience and the way engineers can work in a smarter and more efficient way. Centrica has also been able to create several mobile applications that harness the value of the company's datasets, in order to provide a personalized customer service, increase safety in the workplace and a smarter way of calculating insurance policies.

McILVAINE

Rotork Wireless Valve Monitors for Oil and Gas Remote Locations facilitate Preventive Maintenance

Designed for new and existing plants in the process industries and utilities, RI Wireless products are certified as Zone 1 Intrinsically Safe for use in hazardous areas. By introducing comprehensive plant monitoring, the system enhances operational efficiencies and eliminates unnecessary shutdowns. Predictive maintenance is facilitated through the monitoring of valve opening and closing profiles and the detection of variations from reference profiles.

The system comprises of a small, battery powered Valve Monitoring Device (VMD) that is installed on existing or new valve actuators using a NAMUR interface, or on manual valves with an ISO 5211 interface. The VMD collects dynamics-of-state data from the actuator or valve and transmits it as a 64-point packet, providing the information required for preventative maintenance.

A network of Valve Device Routers (VDR) transfer the monitoring data from the VMDs on a wireless MESH network to the Tunneling VDR (TVDR), which is the 'last hop' VDR that transfers the data to the RI Wireless Gateway, an industrial computer that manages the RI Wireless system. Several TVDRs can be connected to the RI Wireless Gateway via Transmission Control Protocol (TCP) or Internet Protocol (IP) networks.

The final element in the structure is the RI Wireless Management System (WMS), a software management tool that provides operational and maintenance data in common industrial standard connections to an HMI, DCS or PLC.

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Compressor IIoT

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BHP Billiton and L&T Infotech develop Method to anticipate Compressor Problems

- While each oil platform is equipped with a spare compressor, it takes up to five days to swap-out and replace one. If this replacement causes an unplanned shutdown, the missed production can result in $20 million in lost revenue.
- In an effort to avoid these kinds of losses, BHP Billiton and L&T Infotech developed a solution using an Industrial Internet of Things (IIoT) approach. Analytics are applied to data gathered from sensors mounted on the remote offshore equipment to generate appropriate alerts before something bad occurs. This often enables needed repairs/replacements to be performed during scheduled maintenance outages, so no production is lost.
- Modeling the behavior of a compressor required research and engineering to understand the operating parameters and performance characteristics. An on-line and real-time aerodynamic performance modeling capability was developed. The two main components that determine compressor performance are head (foot-pound force per pound mass) and efficiency (aerodynamic). The calculations include some geometry (impeller diameters), and have non-dimensional parameters that make it easier to apply to variable speed machines. This research, documented in the paper “Centrifugal Compressor Performance Modeling and Monitoring,” by Todd A. Barham, BHP Billiton and published by Pipeline Simulation Interest Group in May 2015, provided the basis for determining an algorithm and calculations to predict compressor failures.

McILVAINE

Logilube Compressor Condition Monitoring

- Successful installation of a SmartOil™ real-time oil condition monitoring (OCM) system on an Ariel RECIP compressor (Texas natural gas processing plant).
- Compressor mounted, edge-processed system captures 30-second snapshot of volumetric measurement of lube oil used in force-feed injection of cylinders, monitors oil quality of frame lube oil, and autonomously (non-human) draws in-service ROUTINE and EXCEPTION-based oil samples….all presented on a web-enabled dashboard.
- LogiLube, LLC is a technology development company focused on predictive data analytic solutions for the oil and natural gas compression industry.

McILVAINE

RoviSys provides Compressor Monitoring System to Columbia Pipeline

Houston-based Columbia Pipeline Group (CPG) had a compression asset failure that interrupted service and had the potential to create customer dissatisfaction. CPG owns 15,000 miles of interstate pipeline across 16 states. They operate more than 100 stations with approximately 1.1 million horsepower of compression, delivering approximately 1.3 tcf of natural gas per year. The company needed a swift, reactive approach to resolve the problem.

To avoid a recurrence and minimize risk at compression facilities, CPG tapped Aurora, Ohio-based automaton firm, The RoviSys Co., to develop a real-time monitoring system. The new enterprise analytics program uses SharePoint, PI, and SQL technologies to analyze data and drive proactive and corrective actions. Its objectives are to avoid a facility shutdown and to minimize failures in compressor stations. The solution is a program which includes

- A redundant architecture given that data-driven decisions require a system that's available 24/7 with as little downtime as possible.
- The data in the system must be available to all authorized members of the organization, such as operators at a compressor station and the executive staff at corporate headquarters. The system must be scalable, because more than 1,000 users have access to the data. The data must be presented in formats compatible with a broad audience.
- CPG's prior PI system lacked the tools necessary to do predictive analytics, present information in the form of a dashboard, and notify analysts of issues that require attention. The architecture needed significant expansion to support the desired tools.
- CPG wanted more than 10 years of valuable data transferred to the new architecture so the company could add more data points for analytics. CPG collected data at compressor stations and other operational points using dozens of interfaces to PI that needed to be migrated as well.

McILVAINE

Detecting and Reacting to Problems such as Caustic Fumes Arundo

- In the oil & gas industry, a lack of updated information can hinder management from optimizing drilling logistics and minimizing non-productive downtime. With as many as 40,000 data tags at a drilling site, sensors can track constantly-changing flow rates, pressures, and temperatures to adjust drilling parameters based on real-time data. However, this sensor data is frequently locked in data stores with limited integration and access to other oil well data.
- Arundo's Q Enterprise solution can generate actionable insights from wells and allow for improved decision-making by managers during critical operations. For example, associated gas from crude production often contains caustic fumes that increase stress on critical components of compressors, a phenomenon that is visible in the sensor data.
- Arundo’s Q Foresight is able to read and detect this condition, providing an alert to engineers before this critical piece of equipment fails, thus preventing expensive and unforeseen downtime.

McILVAINE

SKF Condition Monitoring for Reciprocating Compressors

- SKF condition monitoring systems for reciprocating compressors include three main components – sensors; data acquisition systems; and operator interfaces. These systems can be fitted as retrofits, but also can be done on new machines.
- Sensor measurements may be taken in a reciprocating compressor application for each cylinder. By analyzing common problems experienced in the past as well as the available access to transducer locations, SKF helps decide which measurements to take. The data is then acquired through an identified route, and then made available for analysis.

McILVAINE

GE Bently Nevada detects Dry Seal Problems

One of GE's Bently Nevada customers owns and operates several oil and gas production platforms in the United Kingdom sector of the North Sea. The customer currently uses common dry gas seals that incorporate a tandem (redundant) design to improve reliability and prevent a single point seal failure. However, as the customers' total number of installations continued to grow, the number of unexpected outages began increasing too, so the customer needed a better way to monitor the health of its dry gas seals.

GE's System 1 optimization & diagnostic software continuously provides timely and accurate assessments of critical machinery assets at the site – all monitored remotely at the customers' onshore engineering offices. Since installing System 1 Dry Gas Seal RulePaks, three significant events have been reported by the software, and working collaboratively, GE and customer engineers confirmed the reported conditions and then utilized System 1 diagnostic capabilities to determine that continued operation was acceptable, avoiding any unplanned outages.

System 1 helps customers detect early warning symptoms associated with common failure modes. In this example, three significant events were detected by the System 1 Dry Gas Seal RulePak solution, resulting in the avoidance of unplanned outages estimated at a potential $1 million in lost production. The events included:

- *A dry gas secondary seal degradation event was reported on the low/medium pressure compressor non-drive end, and upon inspection, the advisory of the degradation on the secondary was confirmed.
- *A bearing oil migration event on the off-gas compressor seal reported that the bearing oil lubrication system was still on, while the separation seal supply pressure had dropped below the permissive start set-point. The timely advisory prevented bearing oil migration into the secondary seal.
- *System 1 advised that the nitrogen buffer gas supply temperature was low, and the team confirmed the temperature had dropped to the ambient level of 13 degrees Celsius. Platform personnel were notified immediately, and after a quick investigation, they discovered that the heater was non-functional. The problem was quickly remedied.

McILVAINE

KOC deals with Problems by Close Monitoring with Bentley Nevada System 1

Kuwait Oil Company (KOC), a major crude oil and natural gas producer in the Middle East leveraged the System 1 features from GE's Bently Nevada product line to address a high vibration issue on a compressor at a critical booster station complex.

A critical booster station complex, BS-150, is located in KOC's southeast Kuwait oil fields, consisting of three gas compressor trains. Each train consists of two compressor sections, one low-pressure (LP) casing and one high-pressure (HP) casing, driven independently by GE MS5002 gas turbines. The combined capacity of the three trains exceeds 730 million cubic feet per day.

Unexpectedly, one of the gas compressors tripped on high vibration at the drive end bearing while trying to increase the load to 4300 rotations per minute (rpm) from an idling speed of 3300 rpm. Upon detailed review of System 1* data and comparing multiple transient events, the possibility of a rub occurring between rotor and stationary elements inside compressor casing during compressor loading was suspected.

The machine train was observed to start successfully after several hours at standstill, whereas loading after hot startups resulted in the machine tripping at high critical speed

The KOC engineers assessed the consequences of conducting an internal inspection of the compressor, which would have resulted in several days of machine downtime. KOC decided against performing a machine inspection and instead opted to keep the machine operating under close monitoring. Transient plots were carefully monitored during cold starts to assess and avoid the possibility of an internal compressor rub.

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