WHITEPAPER

Delivering Closed-Loop Operations to Reduce Production Costs in Oil and Gas Fields

Authored By:

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Joseph McMullen,
Marketing Director, AVEVA

Eddy Lek
Product Marketing Manager, AVEVA

Executive Summary:

This white paper will discuss the four stages of AVEVA's framework in a closed-loop process that guides the architecture of an integrated oilfield information management system to enable:

- **Connect**: Connectivity among mass quantities of disparate hardware assets
- **Collect**: Collecting and reconciling massive volumes of diverse unstructured data
- **Analyze**: Contextualising and analysing that data into actionable information
- **Act**: Closing the loop on the information provided with actions that deliver operational benefits

IoT trends in the Oil and Gas Industry

The Industrial Internet of things (IIoT) plays an important role in the operation of an oil field today. The falling cost of connectivity and data storage, processes across the entire Oil & Gas value chain are now able to gather more data from more devices, assets, operations, and processes than ever before. The foundation of this operational perspective starts with the basic principle of the closed loop process–Connect, Collect, Analyze and Act.

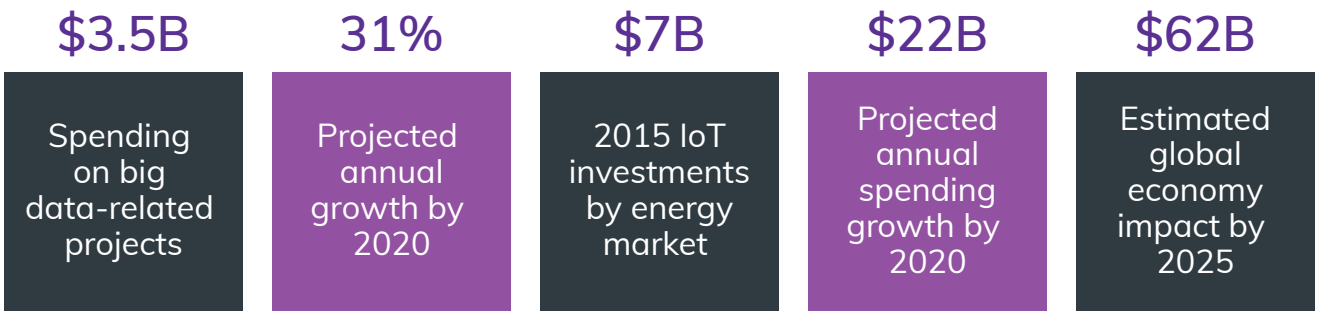
Market research shows increasing IoT growth

Among trends in the oil and gas industry, the growing use of IoT-enabling technologies can be attributed to a few principal influencers:

- Accelerated use of mobile human machine interface (HMI) technologies via smartphones, tablets, and wearables, combined with IP access to data and information are making operators and service personnel more productive
- Affordable access to cloud technology, which requires only a browser and internet access to connect, makes mobile access and working from the field or off-site and sharing that information easier than ever
- Exploration and Production operations (E&P) are using increasingly diverse data sources–from sensors to flow meters, temperature and pressure gauges, actuators and controllers, along with improved analytics applications

The oil and gas industry spent $3.5B on big data-related projects in 2015 with the projected annual growth of 31% by 2020.[1] This growth is driven by oil producers' ability to capture more detailed data in real time at lower costs to drive operating efficiencies and reduced downtime.

In 2015, the energy market spent $7B on IoT solutions. The projected compound annual growth rate of this spending is expected to climb to $22B in 2020. McKinsey Global Institute research also projects a period of aggressive growth, estimating that the impact of the IoT on the global economy might be as high as $62B by 2025.[2]



Client feedback shows the need for help with adoption

Oil & Gas executives surveyed in June 2016 by AVEVA as part of its strategic research offered numerous perspectives regarding business growth, digital transformation, and corporate culture transition. Most agreed that IoT would 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, these leaders admitted a lack of clear perspective on the concrete IoT business opportunities given the breadth of applications being developed. Moreover, while CAPEX was identified as the top motivator for initiating IIoT projects, cybersecurity concerns was the top potential obstacle among those executives when considering IoT initiatives.

Building the IoT business case for Upstream Production

Simply stated, IoT as a concept is about big data generated from connected devices or assets (often monitored by operators) to make smarter decisions. Alignment and integration of business and operational metrics help create the context for smarter decision making in a timely manner to improve business goals such as profitability, regulatory compliance, among others., Thus, the broad outlines of a business case for IoT in oil and gas fields is built around synchronising leading and lagging indicators, as close to real-time as possible.

Enabling smart work/worker of the future

Global market pressures—even before the current oil industry recession—put pressure on staffing levels and dramatically increased individual responsibility for plant personnel. Environmental regulations continue to increase restrictions and add costs. Capital and maintenance cutbacks add challenges to plant engineers, who already must deal with maintaining antiquated, isolated control systems and aging equipment, as well as the constant drain of experienced workers as they reach retirement age.

In this sense, IoT as an initiative goes beyond a technology-centric view to define a new way of working via new worker profiles that help attract and retain millennial talent in operational and executive roles.

Real-time visibility and situational awareness from producing wells to processing facilities

All stakeholders within the operations need timely and better quality information to make their functions perform optimally. Most managers, engineers, and operators make daily operating decisions based on instinct due to lack of timely information. Failing to act timely on impending failure of operating assets causes production outages, where early detection and appropriate action could prevent compromised throughput or plant safety, or unplanned shutdown.

Oil and gas producers have always wanted to monitor the performance of their producing wells and operating assets to help them make profitable operational decisions for both the short and long term.

However, preparation of the data for visual analytics often requires unification of data silos across multiples sources that add layers of complexity to the integration. Therefore, this activity has mostly been restricted to one-time offline analysis or comparisons to simple standards in custom spreadsheets; and generating even these basic analyzes have taken too long to enable effective responses.

A robust and scalable data integration platform is necessary to deliver trusted data from a variety of sources, unifying people, processes, and assets for continuous operational improvement and real-time decision support.

Asset integrity and reliability

The basic requirements of production control system include maximum uptime, reliability, quality, and speed to optimize operational resources. Companies must be confident that the server, computer, operating system and software in an IIoT configuration can provide equal or greater stability and reliability to that of the existing dedicated control system. Any unplanned facility shutdown can be financially disastrous, with costs estimated at from $1M a year for a typical mid-size company to over $60M for a large enterprise.[3]

Data quality and modeling fidelity

With more and more data storage moving to the cloud, the IIoT layer where enterprise systems (i.e., ERP, PLM, CRM) and next-generation functions (including asset, operations, and energy management) converge.

As a holdover from the days of high-cost computer disk storage space, most process automation systems still store historical data via compression algorithms. Unfortunately, this compression compromises much of the information that would enable modeling of producing wells. So as they modernise hard assets, producers must evolve to manage process data more productively to exploit the IIoT fully . Poor data quality causes companies to misidentify and improperly quantify KPIs, giving rise to poor decisions that impose high costs and risks to their operations.

Cybersecurity and risk

As oil & gas enterprise control systems connect to the Internet, they allow for greater business efficiency– i.e., remote process monitoring, predictive system maintenance, process control and production data analysis. However, they also make the operation more vulnerable to cyber threats. The U.S. Department of Homeland Security cyber emergency response team observed a 20% increase in the integrated control system (ICS)-related attacks in 2015 across a wide range of US industry sectors, including the petroleum industry.[4] Cloud platform and analytics layers of IIoT architectures must be designed with the security of open protocols/open connectivity. Protection must extend beyond firewalls that protect the network's outer perimeter.

AVEVA's Framework for IoT

Closed loop principle

The principle of a closed-loop process is fundamental to performance improvement. Improving a process requires the monitoring of the key performance indicators (KPIs) and detecting of any deviation from the target. This requires understanding the process context to assess various options; making a decision on the most appropriate corrective action (provided one has the authority to do so); and finally ensuring that the decision gets executed or acted on.

Reducing latency – i.e., compressing the time taken to close the loop – is the journey to becoming a real-time business. The four steps in the information management loop (connect, collect, analyze, act) as illustrated represents the technology-agnostic foundation of AVEVA's framework for analysing problems and designing solutions across the entire business process hierarchy.

Applying the Framework to Upstream Production

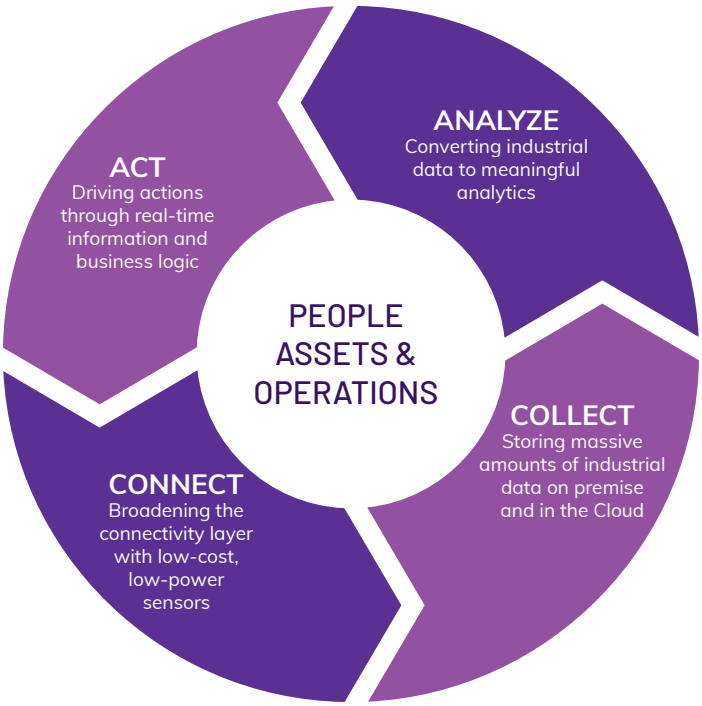
Next, we look at examples of how various advances in IoT can help improve the closed-loop process and its implications on the overall technical architecture to deliver lower operating cost, more agile process control, greater uptime, greater environmental and personnel safety and ultimately, a more profitable operation.

Internet Reliability

Industrial applications of IoT often demand real-time (or low-latency) processing of data. For example, mission-critical control processes cannot afford the delay caused by the roundtrip between the devices layer and cloud-based IoT platforms. This has led to the recognition of fog computing as a vital layer in the architectural stack.

AVEVA uses a variety of products to aggregate data in an IIoT architecture currently used in 100 oilfields and 40 unmanned offshore oil platforms, as well as in national high-speed rail and airport systems. All are applications in which 24/7 365-day uptime is crucial.

To ensure reliability, redundant on-site networks between the RTUs/PLCs and the aggregator can be comprised of software, operating system, storage, and hardware (servers, Ethernet switches). A system using this redundant architecture and incorporating 175,000 sensors is being implemented today in a major transit project in Europe.



Data Integrity

As previously noted, data collection has traditionally been compromised by compression used to reduce storage real estate. Better data means better analytics for better decisions and performance.

As most of the production fields are at remote locations, inspecting and maintaining of non-instrumented assets are often challenging. Having a robust and reliable mobile workforce management platform is critical to facilitate inspections and reliability checks of assets in a thorough and fully verifiable manner, delivering the data you need to keep your assets productive and operating at peak efficiency.

After the asset health and performance data - from remote onshore/offshore platforms to production facilities - have been systematically collected from sensors, data reconciliation must be performed rigorously by the system to ensure data accuracy before feeding into analytics for performance modeling, optimization, and monitoring. This eliminates poor quality data feed that can lead to long-term issues.

Predictive Analytics Applications from Producing Wells to Processing facilities

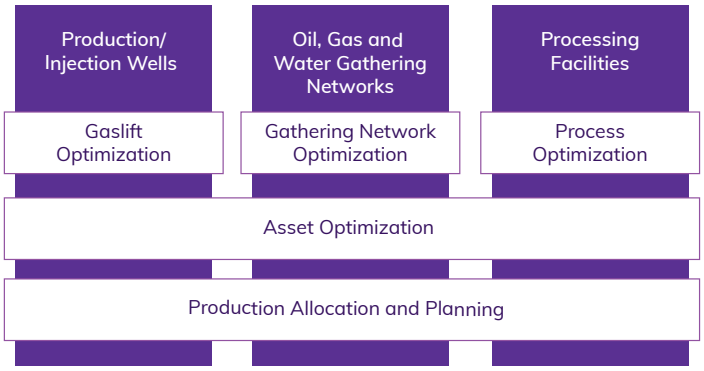
The advancement in technology – cloud platform, analytics and computing power – is revolutionising the way how oil and gas producers attain greater operational efficiency from big data and analytics. Turning raw data into insights for business improvement, predictive analytics are increasingly adopted by oil and gas producers to help optimize operations and reduce unplanned shutdown, generating higher cashflow and profitability in the volatile business environment. Analytics leverage advanced pattern recognition, statistical models and machine learning technology to model an asset's operating profile and predict future performance, recommending appropriate, timely actions to improve production uptime and to reduce energy costs in production.

With the advancement of analytics in capturing and preserving higher-fidelity data for more accurate models of real-world operations, this, in turn, enables the expansion of more predictive applications from producing wells to surface facilities:

- **Production Allocation & Planning:** Advanced simulation and analytics tools can be used to model and predict the performance of producing wells. This cost-effective solution not only allows proper production recording and planning but also helps uncover production potential in existing assets with improved insight. The improved performance visibility of the producing wells enables producers to optimize production, and to plan for future facilities' expansion that drives efficiencies, throughput and improve competitive advantage

- **Gaslift Optimization:** Advanced analytics can be used to optimize allocation of injection gas to maximise production. The analytics, integrated with optimization algorithm, models the full production fields to predict the optimal operating conditions, optimising gas injection for each well to boost production

- **Gathering Network Optimization:** Analytics can be used to model fluid flow behaviours in pipeline-multiphase or single-phase flow - to predict pipeline holdup and potential slugging in the network. Understanding flow performance is key to optimising the gathering network design and pump head requirements, reducing CAPEX, production and transportation costs



Advanced analytics enable oil and gas producers to do "more with less".

- **Asset Optimization:** Predictive asset analytics have been gaining grounds in oil and gas operations to help reduce abrupted equipment failure that can cause costly production outages. The advanced pattern recognition and machine learning algorithms in predictive analytics have enabled reliability and maintenance teams to identify and diagnose asset problems before failure, effectively improving asset reliability through early warning before failures happen, resulting in reduced unplanned downtime and improved asset availability

- **Process Optimization:** Process optimization analytics reconcile dynamic process data – such as pressure, flow rate, and temperature - in real time and predict the optimum operating model based on thermodynamic laws. The analytics, combined with Advanced Process Control, helps push the operating envelope to optimize operating process conditions at processing facilities, improving yield while reducing energy consumption

Whether the asset is an offshore pumping station, compressor, drilling rig or processing facilities, a robust and scalable industry software platform allows producers the ability to implement specialised analytics in a step-wise manner, as economic and resources allow, a step-wise approach allows the producers to progressively scale up to cover the entire oil and gas value chain, driving efficiencies and improving competitive advantage at every step.

Actionable Data

Insight alone does not create value. Until action is taken to close the loop, nothing changes. In oil and gas fields, managers often clamor for better dashboards, but all too often value is lost as a result of failing the close the loop. There are many reasons this fails to happen: a decision was not given to the right person; the person received it but misunderstood the action; they did not get it in time to make a difference; etc. This is where enablers like workflow management are critical to ensuring that actionable data gets executed on.

Workflow is a critical component of an effective IIoT architecture in bringing together the information from these disparate sources and “close the loop,” making it useful to operators, management, and the enterprise.

Operators, service managers, maintenance supervisors, and other facility personnel are empowered to set up and change roles, responsibilities, duties and schedules, escalation policies, displays, and alerts, with permissions to connect information to smart phones or tablets, or to remote contractors. Operations work is widely distributed, with actions recorded for accountability, best practices conformance and proof of regulatory compliance.

Combining performance monitoring tools with advanced workflow on the integrated platform enables companies to focus their resources on immediate performance or asset issues, closing the loop swiftly to reduce unplanned downtime and to optimize production. This is key to unlocking business values from big data and analytics.

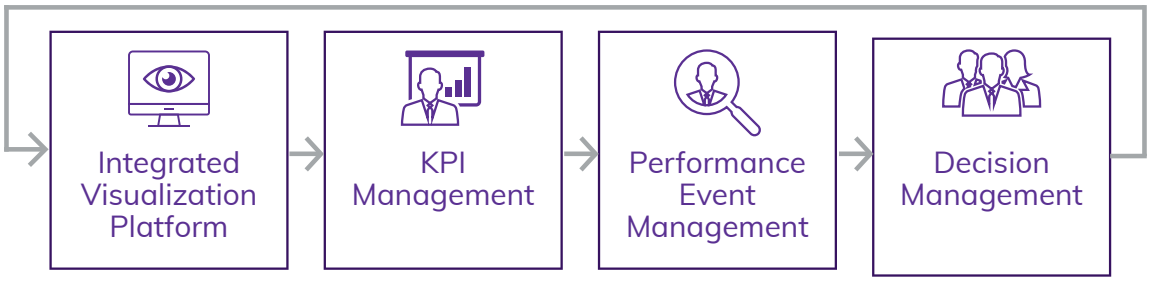
Smart Assets

Over time, as the closed-loop process become mature, get fine-tuned and stabilise, the processing logic can be codified and embedded into the asset itself.

Today, some of this intelligence is embedded into smart sensors and switching gear to provide increased information on attributes like flow, pH, etc. along with motor sensing and voltage readings. In oilfields, hundreds of thousands of sensors provide information for control and safety, electrical distribution, corrosion and other equipment conditions.

In operational environments that are difficult, dangerous and expensive to access for inspection, IoT-enabled (wireless) smart sensors eliminate much of this time and cost, while greatly increasing the quality and frequency of information provided. Depending on the IoT strategy for a particular asset, or a network of assets that enable a larger process, information about the process can exist anywhere along the IoT stack.

Automated Workflow to close the loop



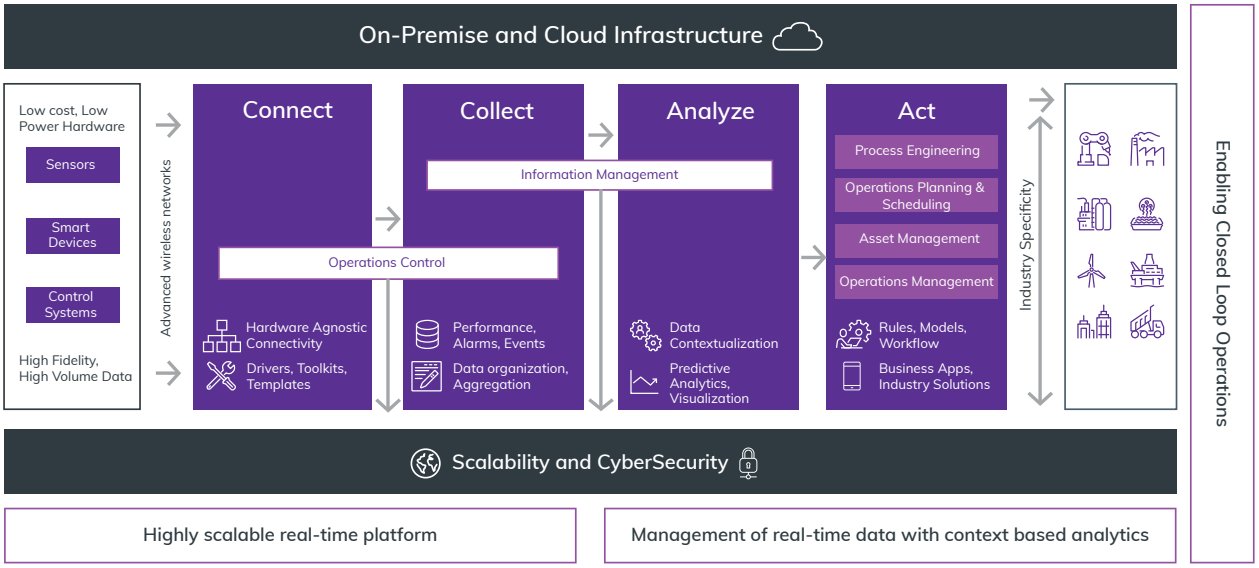
Closing the loop is key to extract business values from big data and analytics.

Conclusion

In summary, we believe AVEVA's approach to IoT delivers higher value at lower cost and risk to the Oil and Gas industry for the following reasons:

The closed-loop framework enables Operational Excellence by helping business stakeholders to take a process-focused approach that quickly identifies and builds the business case.

The breadth and depth of products and services in AVEVA's portfolio offers greater choices and flexibility to solutions architects in designing a path to IoT that best meets the needs of an individual client.



Ultimately, it is a journey, and what we have learned from successful customers are the following:

- Start with pilot projects in specific areas such as utilities or production planning
- Integrate asset monitoring and management along with predictive modeling and analytics technologies
- Evaluate ROI before broadening project scope
- Move to comprehensive asset coverage within a dynamic network that merges IT and OT infrastructure
- Take advantage of AVEVA's global field experience to accelerate the journey

Step 1	Step 2	Step 3	Step 4	Step 5
Start with complete architecture in a pilot area	Evaluate ROI before broadening project scope	Integrate asset monitoring & management projects	Merge IT and OT infrastructure	Consult with experienced partner

Contacting an AVEVA consultant with field experience in planning and implementing IIoT architecture can help operations management teams exploit the IIoT's affordable internet connectivity to improve reliability and run-time, environmental and personnel safety and ultimately the business bottom line.

1. Visiongain, "Big Data in Oil & Gas Market 2015-2025," September 2015
2. Bauer, Harald, Patel, Mark, and Viera, Jan, McKinsey & Company, "The Internet of Things; Sizing up the Opportunity," December 2014
3. IHS Markit, "Business Losing $700 Billion a Year to IT Downtime, Says HIS,"January, 2016
4. IC Insights, "O-S-D Report—A Market Analysis and Forecast for Optoelectronics, Sensors/Actuators and Discretes," 2015

To read more about how AVEVA can support your Oil and Gas production, please visit: sw.aveva.com/oil-and-gas/upstream

About the Author

Joseph McMullen, Marketing Director, AVEVA, manages SimSci Marketing. He earned his Bachelor's degree in Chemical Engineering in 2000 & MBA in 2004, both from Villanova University. Joe started at AVEVA (formerly AVEVA Software) as a Senior Technical Support Specialist in 2001. Joe spent five years as the Product Manager for steady-state simulation software products for the SimSci brand. In April 2011 he began his new role in Product Marketing, responsible for developing and expanding the SimSci brand awareness and strengthening the marketing behind SimSci software for design, simulation, training, advanced control, and optimization. Recently Joe has taken a role responsible for effectively marketing AVEVA's entire software portfolio to the process industries.

Eddy Lek, Product Marketing Manager, AVEVA, is responsible for expanding awareness and marketing of its design, simulation, training, analytics and advanced control software. He has more than 15 years of experience in product management, product marketing and regional channel management in the process and industrial automation space and has managed a wide range of IIoT Sensors, control systems and software. He holds a Master's in Business Administration from National University of Singaore and a Bachelor of Engineering from Nanyang Technological University.

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