Executive summary

This white paper will discuss the four stages of Schneider Electric’s framework that guides the architecture of an integrated refinery information management system to enable:

1. **Connect**: Connectivity among mass quantities of disparate hardware assets,
2. **Collect**: Collecting and reconciling massive volumes of diverse unstructured data,
3. **Analyze**: Contextualizing and analyzing that data into actionable information and
4. **Act**: Closing the loop on the information provided with actions that deliver operational benefits.
The industrial Internet of things (IIoT) plays an important role in the operation of a refinery 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. Refiners in particular, stand to gain value quickly because the existing IT infrastructure is more mature compared to extraction (upstream) and distribution (midstream) processes. 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 smart phones, 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.
- Refinery operations 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 projected annual growth of 31% by 2020. 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 down time.

In 2015, the energy market spent $7B on IoT solutions. 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.

Client feedback shows need for help with adoption

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

Building the IoT business case for Refining

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 helps create the context for smarter decision making in a timely manner to improve business goals such as profitability, regulatory compliance, etc. Thus, the broad outlines of a business case for IoT in Refining is built around synchronizing 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 execution roles.

Real-time visibility and situational awareness

All stakeholders within the refining operation need timely and better quality information to make their functions perform optimally. Most managers, engineers, and operators make daily operating decisions based on unreconciled snapshots of operating data. This analysis does not take into account instrument drifts or errors, bad or inaccurate data. It provides no information on impending failure of key devices or other assets, where early detection and appropriate action could prevent compromised throughput or plant safety, or an unplanned shutdown.

Plant managers have always wanted to monitor the performance of their processes and operating assets to help them make profitable operational decisions for both the short and long term. But this activity has mostly been restricted to one-time offline analysis or comparisons to simple standards in custom spreadsheets; and generating even these basic analyses has taken too long to enable effective responses. While refineries today have more process data, most lack the analytic tools to close the information loop with real-time actionable information, or comparative cost-benefit information on any given operational decision for increased efficiency.

Asset integrity and reliability

The basic requirements of refinery control system include maximum uptime, reliability, quality and speed in order to optimize facility production resources. Refineries 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.

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.
Yet, 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, or tuning a PID controller. So as they modernize hard assets, refineries must evolve to manage process data more productively to fully exploit the IIoT.

**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. But 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 integrated control system (ICS)-related attacks in 2015 across a wide range of US industry sectors, including the petroleum industry. Cloud platform and analytics layers of IIoT architectures must be designed with security of open protocols/open connectivity. Protection must extend beyond firewalls that protect the network’s outer perimeter.

**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; 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 actually 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 Schneider Electric’s framework for analyzing problems and designing solutions across the entire business process hierarchy.

**Applying the Framework to Refining**

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.

Schneider Electric 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.

Two well-known Schneider Electric Software products have served industrial markets since the beginning of the millennium. One collects, monitors and cleanses static information, such as that from sensors, as well as variable data like temperatures and flow rates. The other ensures accuracy of the data collected by devices, reconciling data and directing instrument calibrations. The latter also provides information about equipment efficiency—such as pipe fouling or catalyst weakening—and can extend to other plant information, such as, motor current loads.

Predictive Analytic Applications

With the ability to capture and preserve higher-fidelity data for more accurate models of real-world operations, this in turn enables the viability of more predictive applications.

Schneider Electric Software applications document both the gradual change of asset performance as well as the imminent change. These applications have been used for well over a decade by some of the world’s largest oil and gas production companies. Its asset failure prediction offering transforms raw data into actionable insights to help prevent equipment failure and enables smart decisions for improved operations. It is equipment agnostic, requires no programming, and can be configured to monitor assets regardless of type, vendor or age.

While predictive analytics solutions traditionally focused on rotating equipment, leading petrochemical production companies now seek to apply predictive analytics algorithms to fixed assets such as heat exchangers or reactors. For example, a rigorous dynamic simulation tool can predict the time-dependent future behavior of the process. This generates business value including lower capital costs, improved plant design, and reduced maintenance.

Actionable Data

Insight alone does not create value. Until action is taken to close the loop, nothing changes. In Refining, 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 wasn’t given to the right person; the person received it but misunderstood the action; they didn’t get it in time to make a difference; etc. This is where enablers like workflow management are critical to ensuring that actionable data actually 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.
Smart Assets

Over time, as the closed-loop process become mature, get fine-tuned and stabilize, the process 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 refineries, 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.

In summary, we believe Schneider Electric’s approach to IoT delivers higher value at lower cost and risk to the Refining 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 Schneider Electric’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 crude unit.
- 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 Schneider Electric’s global field experience to accelerate the journey.
Contacting a Schneider Electric consultant with field experience in planning and implementing IIoT architecture can help refinery 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.


About the author

Joseph McMullen, Marketing Director, Schneider Electric, manages SimSci Marketing. Joe earned his Bachelor’s degree in Chemical Engineering in 2000 & MBA in 2004, both from Villanova University. Joe started at Schneider Electric (formerly Invensys) as a Senior Technical Support Specialist in 2001. Joe spent 5 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 Schneider Electric's entire software portfolio to the process industries.

Livia Wiley, Senior Product Marketing Manager, for SimSci software at Schneider Electric. She is responsible for expanding SimSci's brand awareness and marketing of its design, simulation, training, advanced control, and optimization software. She has more than 20 years of experience in process simulation, assisting clients model, troubleshoot, and optimize their processes through technical and economic studies. She holds a B.Sc. in Chemical Engineering from Queen's University, and a M.Eng in Chemical Engineering from the University of Houston.