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Improve exploration, production and refining with 'add-at-will' wireless automation

After the technology was validated, a wireless infrastructure was installed blanketing 80% of a US refinery

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Chevron is committed to leadership in exploration, production growth and profitable refining utilization. Process automation is an important enabler of these goals. As part of its continuous focus to add business value, the company's automation experts participated in very early wireless sensor and mesh network development and testing and IEC 62591 (WirelessHART) technology. Positive results with wireless field trials in upstream installations at San Joaquin Valley, California, led Chevron to reason that new "add-at-will" wireless technology could enable improvements at all of its upstream and downstream facilities, leading to immediate and ongoing efficiencies.

To investigate the feasibility of wide scale deployment, the company conducted in-depth research of wireless technology at the Chevron Wireless Center of Excellence. After the technology was validated and a supplier selected, a wireless infrastructure was installed blanketing 80% of a US refinery. This installation verified the add-at-will capability of wireless, enabling improvement by simply installing and turning on instruments without the expense and delays of engineering and installing wiring, cable trays, conduit, trenching and more (Fig. 1). It showed the scalability that enables loop-by-loop application for entire plant coverage.

Chevron also learned how to gain the wireless advantages for improved flexibility, reliability, safety, environmental and business performance across its upstream and downstream facilities. Many of the company's global operating businesses are now leveraging the investigation results and best practices to move forward with wireless planning and installation.

Additional wireless functionality is being investigated for future use, including enhancing mobile-worker productivity, enabling wireless video for process applications and plant security, and allowing safety mustering and employee, product and equipment location tracking.

Business challenges. The opportunity for upstream is clear: Offshore platforms needed a way to get more and improved information to optimize well production—especially important, since wells can take a decade to find and another decade to begin producing. Production must continue efficiently for decades to pay back the large investments. Automation to help meet these needs must be small, lightweight and easily implemented in the compact environment of offshore platforms and floating production, storage and offloading (FPSO) facilities.

Onshore land-based fields also need to maximize well life and production. Advancements are needed to provide better production gathering system monitoring, enhanced-recovery distribution systems and process facilities, and to make the improved information available to operations centers controlling geographically dispersed wells and facilities. Through all, personnel safety, environmental protection, reliability and profitability need to be served by technology.

Automation can help improve refining margins while matching output to demand. This calls for improved equipment, instrument and process monitoring to improve uptime and performance and to reduce operating and maintenance costs while meeting new environmental regulations.

Chevron engineering and operations employees have been challenged to develop economic business cases for installing instrumentation to improve monitoring, reliability and overall business per-

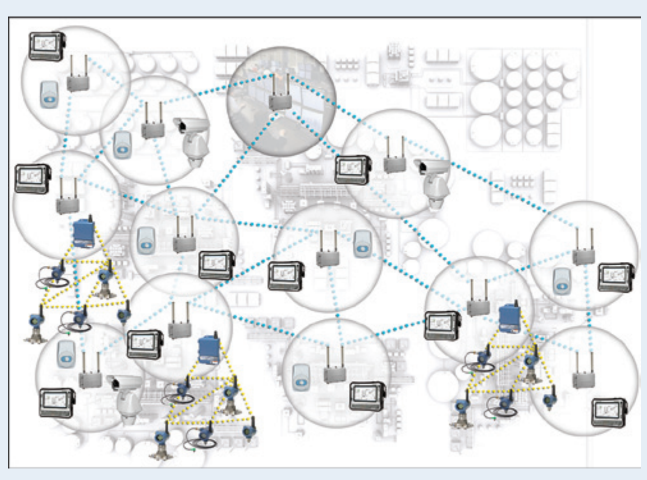

FIG. 1 Wireless networks can blanket facilities to enable add-at-will automation.

formance of existing facilities. While the instrument cost has been relatively low, planning, engineering connecting and commissioning wired instruments costs in existing plants has been prohibitive. It was estimated that a facility-wide technology to dramatically lower these capital costs would save millions of dollars and enable justifying business-improvement projects.

Could wireless help? Wireless technology has been part of the Chevron automation landscape for many years, especially as used for SCADA applications across expansive onshore and offshore fields. By contrast, the use of wireless measurement instruments and networks for more confined, contiguous industrial plants and on offshore platforms and FPSOs had previously been unsuccessful. The technology available in the 1990s was not suited for the industrial environment, with deficiencies in communications reliability, security and battery life.

These drawbacks, along with a complete lack of industrial wireless standards and a serious shortage of functionality needed for process applications, led Chevron to postpone the use of wireless field sensor networks for monitoring and measurement that would have been so valuable in their operations. Yet the needs persisted, both upstream and downstream.

Fortunately, semiconductor and battery power technologies suitable for industrial wireless technology matured and in the late 1990s, major process automation suppliers began investing in wireless research and development for the industrial plant environment. Standards development soon began in parallel, including drafting and then beta-testing approaches with Chevron and other end users to meet communications reliability and security needs.

These efforts culminated with a broad range of wireless measurement instruments built on an open IEC 62591 (WirelessHART) technology communications standard that could deliver 99.9% communications reliability while enabling applying wireless functionality ranging from a few loops to an entire plant.

Chevron automation experts believed that these changes opened the door for another look at wireless technology. A wireless architecture with communications reliability and process functionality approaching that of wired installations could enable step-change improvements in new and existing facility performance around the world. Less engineering and installation would simplify construction and lower wireless project capital costs to enable important field measurements that were previously unaffordable. Additionally, lower installed costs would enable upgrading existing plants in applications where wired additions were precluded by economics.

Investigating wireless. Determined to pursue their wireless ideas, Chevron automation experts established a corporate Wireless Center of Excellence at their Energy Technology Company offices in Richmond, California. The center includes a wireless test bed and laboratory that is a staging area for investigating wireless technology and instrumentation from various automation manufacturers. Experts from Chevron upstream, downstream and midstream operating companies consult with corporate technologists at the center and use the laboratory for investigations leading to their own wireless applications piloting around the world.

The laboratory tested wireless communications reliability by presenting a radio frequency (RF) environment even more challenging than that of operating plants where signals must coexist with those from existing sources. Chevron checked software and performed coexistence testing with other equipment and instruments in the RF environment. The laboratory testing was followed by installation in a US refinery that presented typical obstacles including steel structures, moving vehicles, roads and challenging terrain within the approximate 2.5- by 2-mile refinery boundaries.

After validating the new wireless technologies and thoroughly testing and reviewing available wireless offerings, Chevron selected their supplier of choice that could best provide standard wireless instrumentation for Chevron's present and future needs of improving unit and plant-wide performance and profitability. Selection took into account cost, security, communications reliability, power management, breadth of offering for plant-wide functionality and resources and knowledge to grow and expand wireless in conjunction with wired technology as part of a complete plant automation architecture. As is part of The Chevron Way approach to business, the automation supplier's technologists would partner with Chevron to co-develop the technology and best practices to help achieve Chevron's vision.

Implementing wireless. One of Chevron's earliest experiences with the new wireless technology from the selected supplier was with steam injection for oil and gas recovery at its existing San Ardo, California, oil field. A network of wireless transmitters delivers reliable data that help minimize over-steaming and reduce wastewater discharge. Since the injection data are sent to the oil field's control room, personnel no longer need to visit the injection wells to collect data from traditional chart recorders or to check instruments for proper operation. In addition, operators no longer need to make and break high-pressure and temperature connections. As a result, personnel safety is improved.

A second wireless network in the oil field uses wireless battery-powered transmitters to measure downhole well pressure. Chevron uses the data collected for its proprietary oil formation calculations, including determining steam injection requirements, oil flow patterns and new well locations. The new wireless network saves installation costs and reduces maintenance compared with the existing remote telemetry units.

The California installation illustrated the benefits of select wireless applications integrated into the existing upstream fields and working with existing long-range communications.

Further exploration of the new technology was underway at a Chevron refinery where a multidiscipline engineering, operations, maintenance and IT personnel project team was leading Chevron's pursuit of an add-at-will capability. This innovative project was envisioned to

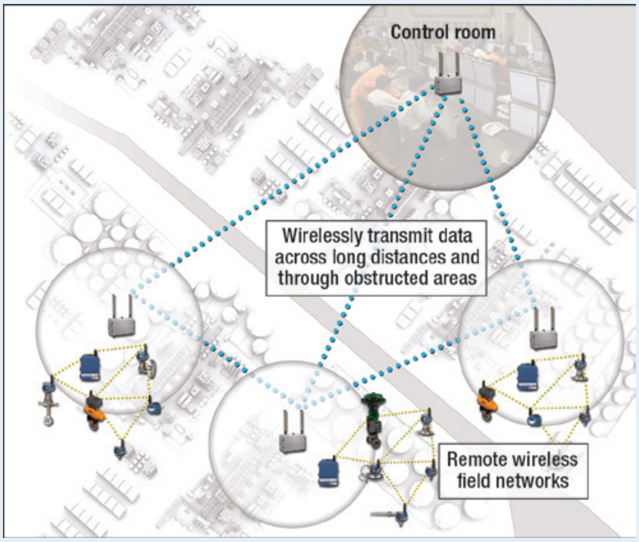

FIG. 2 Field devices are often widely and remotely distributed throughout a plant. Wireless field data backhaul solutions integrate field instrument data with the process control system.

blanket the refinery with wireless communication infrastructure consisting of an integrated network of gateways, access points and software that, once in place, would enable the refinery to quickly and easily add monitoring points to improve operations.

For this plant-wide network, Chevron would install wireless communications coverage at key locations across the refinery, using IEEE 802.11 Wi-Fi access point coverage that would integrate (or "backhaul") smaller wireless field networks (Fig. 2). Process measurement and control instruments would be added to the field networks and communicate using IEC 62591 (WirelessHART) technology.

The plant-wide network development began with a site assessment. As a first step, the automation supplier used satellite mapping to help envision where the Wi-Fi access points might best be mounted. Then Chevron and the automation supplier used the supplier's kit of access points and communications equipment to test and measure locations around numerous tanks and facility units to complete the site assessment for the plant-wide Wi-Fi infrastructure. This process allowed determining the Wi-Fi equipment optimum location.

Using this information, Chevron and the supplier planned, engineered and specified the equipment to be installed. This was followed by factory acceptance testing to ensure that all devices in the plant-wide Wi-Fi network would communicate. Finally, site acceptance testing was conducted to ensure reliable facility-wide communications. The resulting plant-wide installation included 16 Wi-Fi access points providing wireless communications for 12 field device networks distributed across the refinery grounds. Field devices communicate within their own networks using IEC 62591 (WirelessHART) technology. Added devices serve as range extenders where needed to help with difficult, more distant refinery areas. The access points in the Wi-Fi network connect, or backhaul, all of the field network data to the central process control facility and IT computers.

A broad range of field instruments would eventually be commissioned for applications such as pump and motor vibration monitoring, utilities monitoring, column temperature profiling, water flows, tank overfill protection and corrosion. It is easy to optimally locate additional wireless field devices since further site assessments are not required. The time span from device installation to providing measurements is relatively quick. A graphical software package provides a clear network view for maintenance or network administration personnel, as well as for continuous online views for operators to verify data reliability passing through the network.

The plant's IT department took plant-wide network ownership. IT best practices for wireless were established and internal security standards ensured. Security was easily achieved and managed by having only one connection between IT and process networks. This firewall safe zone connection enabled secure communication between networks.

Through the firewall safe zone (demilitarized zone—DMZ—in IT parlance), field data were sent up-network to an historian and asset optimization software for functions like machinery health management. The software enabled maintenance personnel to observe and manage equipment, such as reactors, using current and historic information in maintenance console displays. Condition monitoring and predictive maintenance information was sent down-network to process automation systems for use by operators. Data were also represented on operator screens for process operation.

A wireless governance team was established to evaluate and prioritize field network applications. The team included the corporate wireless technology leader and engineering, maintenance and operation representatives. The team tracks the wireless measurement application results that have been implemented and reviews proposals for new applications.

Results and lessons learned. Now that the infrastructure has been installed, requests for projects to add field measurements are frequently received from operating, reliability and engineering groups. The Wireless Governance Committee meets regularly to evaluate these proposals for wireless applicability. This is exactly what was expected from the infrastructure project—the applications that have been stalled for many years due to cost or difficulty are now being easily implemented. The original estimate of millions of dollars in savings for electrical construction and associated engineering related to the wireless applications is being validated.

Although the original infrastructure project included only enough field measurement devices to allow verifying backhaul operation, the wireless device count is already growing and expansion continues.

The following wireless findings and practices were among those from the overall wireless investigation:

- The IEC 62591 (WirelessHART) technology performs very well in the industrial environment.
- Small field network projects deliver high returns; wireless plant-wide infrastructures extend the benefit by enabling improvements to be added at will.
- Site assessments are the valuable starting point for locating access points and gateways in plant-wide Wi-Fi networks; additional site assessments are not required for optimally adding wireless field devices.
- Wireless support group roles and responsibilities need to be clearly defined (IT infrastructure, instrument technicians, process control, etc.).
- Engage IT security staff, wireless subject-matter experts and operations and engineering staff early in project design.
- Implement a cross-functional Wireless Governance team to prioritize and manage installing new wireless applications.
- Clearly define how wireless instrumentation will be used in your facilities (example: control vs. monitor).
- Use open standard communications: e.g., IEEE 802.11 (Wi-Fi) for plant-wide networks; IEC 62591 (WirelessHART) for field networks.

Future outlook. Following successful testing, laboratory validation and refinery installation, various Chevron operating businesses are developing their plans for wireless applications. The ability to economically add wireless measurements at will has been demonstrated. Additional projects are currently under investigation around the world in both upstream and downstream businesses. **HP**

Greg LaFramboise has worked in instrumentation, automation and electrical for Chevron for 29 years. He has been involved in many automation project phases including project development, engineering and construction. Mr. LaFramboise has worked in several locations within the US and overseas, including a resident assignment in Indonesia. For the past five years, his position has been wireless technology lead, focusing on wireless sensor technologies.

Bob Karschnia, vice president of wireless for the Rosemount Measurement Division, has over 18 years of experience in the process control industry. He currently manages the Wireless Business Unit for Rosemount's wide wireless product offering and coordinates wireless initiatives across all of Emerson Process Management. Prior to his current role, Mr. Karschnia held various design engineering and management roles throughout the company. Before joining Rosemount, he developed rotating equipment control systems at Compressor Controls Corp. and satellite control systems for Lockheed Martin. Mr. Karschnia also served as an officer in the United States Air Force, working on satellite control and communications systems. He has a BS degree in aerospace engineering from the University of Minnesota and an MS degree in electrical engineering from the University of Colorado.