

Realizing the Promise of Wireless

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Innovation drives the growth of wireless technology, as successful applications demonstrate cost savings, reliability, safety, and ease of use.

Reliable wireless communications systems are removing the physical and economical barriers that previously made it difficult or impossible to access many types of information in chemical plants. In fact, wireless automation technology addresses many management priorities, including continuous process improvement, safety, and protection of the environment, with such dramatic ease and clear benefits that it is changing work practices throughout the industry. The technology of transmitting never-before-available information from processes and equipment can be put to use right now, regardless of the vintage of the plant's control system.

Wireless networks

Wireless technology includes both field networks and plant networks integrated into an overall wireless plant architecture (Figure 1).

A *wireless field network* is a group of devices capable of measuring one or several process parameters and transmitting information wirelessly to a single gateway, or receiver. Many types of wireless field instruments are available for measuring temperature, pressure, flow, level, pH, vibration, discrete switch status, and valve position.

Typically, the gateway forwards the field-generated data wirelessly to a control system via a native interface, Modbus, or a similar connection, where wireless, analog wired, and Foundation fieldbus data are combined. Two key characteristics of wireless field networks are very-low-power radio transmissions, and adherence to process industry requirements for timeliness, reliability, security and accuracy. The low-power characteristic allows for

nonrecharged battery-operated devices.

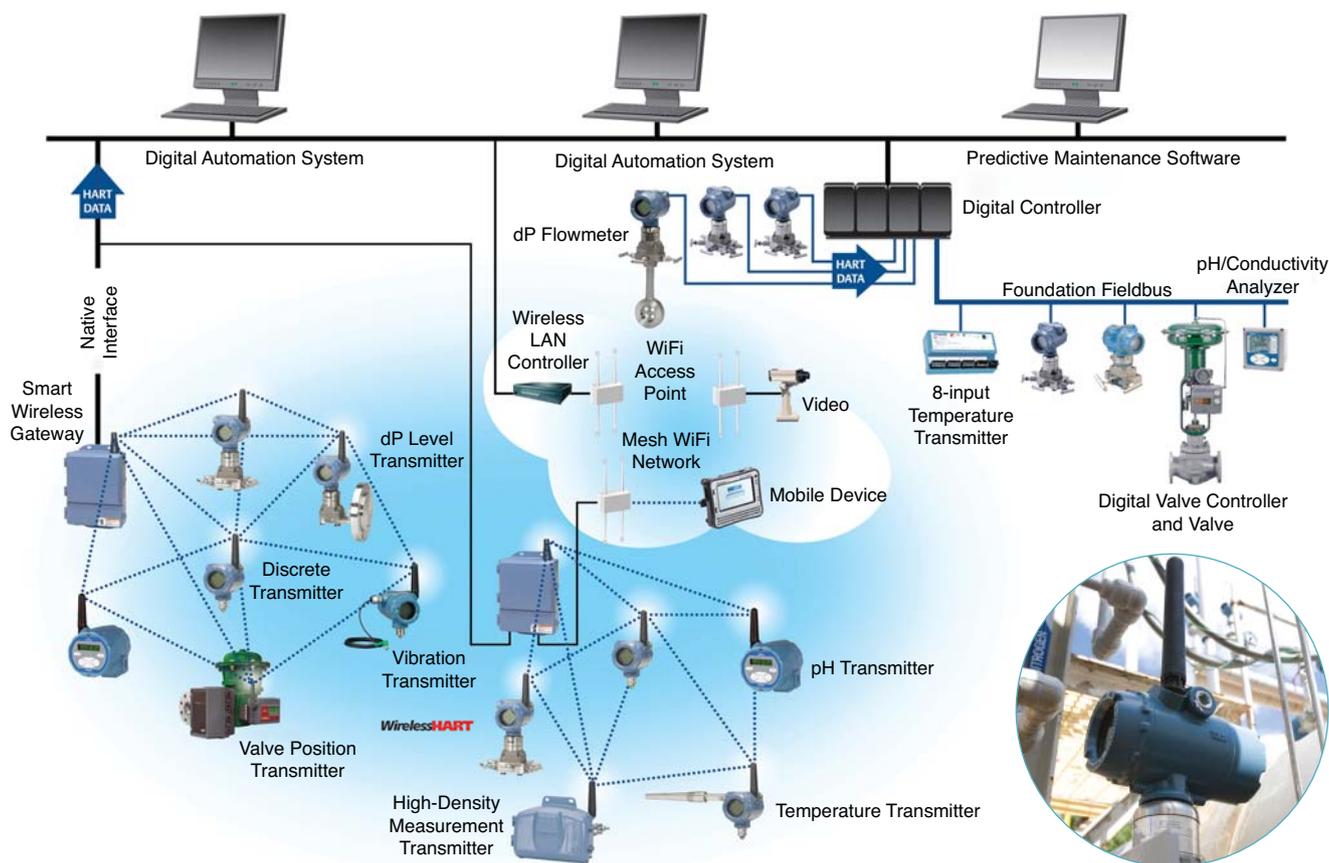
A *wireless plant network* implements Wi-Fi networking using the IEEE 802.11 standard or other higher-bandwidth network technology for communicating with mobile workers, for tracking people and/or mobile assets, and for implementing wireless video. These applications are characterized by their high bandwidth, use of devices that are rechargeable or electrical-line powered and share applications bandwidth, and transmission clarity and security.

Typical plant networks employ industrial-class mesh IEEE 802.11 access points, a centralized network, and security management, including overseeing a series of wireless local area network (WLAN) controllers, which are responsible for network-wide wireless functions. This provides a cohesive wireless communications platform across the physical as well as the functional areas of plant operations, so that the shared network can support diverse applications.

Chemical manufacturers can begin taking advantage of wireless technology at the plant level and work down to the field, or begin at the field level and work up. We have found that starting at the field level yields quicker returns, and this article focuses on those applications.

Standards for wireless field networks

The information technology (IT) community has evolved the standards and practices now in use for plant networks. However, the broader wireless community has not provided a rigorous, well-tested and industry-accepted standard suitable for wireless field sensor networks. Such a standard should encompass robust industrial reliability with very low power consumption for field measurement



▲ **Figure 1.** A wireless plant architecture integrates field and plant-wide applications networks. Processes and equipment are monitored by WirelessHART devices in the field network, while operator mobility, people and asset tracking, and video surveillance use Wi-Fi functionality at the plant level.

and control applications, and exhibit communications reliability approaching that of wired signals.

WirelessHART provides that, giving end-users the promise of dependable wireless field-network instruments. These come from the member companies of the industry-wide HART Communication Foundation (HCF) that approved this standard in September 2007. WirelessHART products are now being shipped, and installations in chemical plants began during the latter part of 2008. See the sidebar on p. 24 for more information on the WirelessHART standard.

The emergence of wireless field networks

Recognizable by their radio-frequency (RF) antennas and absence of wiring, wireless transmitters (Figure 2) are characterized by their low-power circuitry, onboard RF transceivers with reliable and secure mesh communications, and long-life batteries.

The devices are represented the same as wired instruments on piping and instrumentation diagrams (P&IDs), and



▲ **Figure 2.** Wireless transmitters are recognizable by their radio-frequency antennas and absence of power wiring, which is replaced by onboard long-life batteries.

operators do not see any differences in the data displayed by wireless and wired instruments. The engineering, installation, and commissioning of wireless systems are, however, much simpler. Furthermore, wiring drawings, cable tray space, conduit or armored cable, tunneling, and scheduling and performing installation are all minimized or eliminated.

Wireless instrumentation practices involve less planning, with easier and quicker installation and startup to create the network. Attractive economics and ease of use distinguish wireless technology from past process automation approaches, enabling engineers to unleash their creativity and imagination and do what previously was impossible.

Installation cost estimates for conventionally wired field networks run from \$50 to \$100 per foot, depending on the amount of engineering and construction required. Wireless devices can save as much as 90% of the installed cost. As a result, plant assets that were once prohibitively expensive to monitor, such as remote tanks or pumps, manually operated valves, safety showers, etc., can now be outfitted with wireless transmitters to return data to the control room,

THE WIRELESS HART STANDARD

There are clear reasons why WirelessHART is the one standard needed to support the global deployment of wireless technology for process field sensor networks.

WirelessHART enables reliable and secure communications based on channel hopping and self-organizing mesh technology with end-to-end encryption, optimized for low-power process applications, including control.

WirelessHART is easy for users to adopt, because it is backwards-compatible with more than 26 million installed HART devices, and it employs existing methods of engineering, asset management, and host system (DCS, PLC, etc.) integration. Thus, when configuring and operating WirelessHART devices, users will see minimal differences from their wired counterparts, and can even retrofit existing wired devices with wireless communications for the purpose of transmitting additional information. This is critical to ensuring rapid and easy adoption.

WirelessHART is the only field network technology recognized by formal standards committees. It is based on the global standard IEEE 802.15.4 and approved by the more than 210 HART Communication Foundation (HCF) members. It was also recently approved as a Publicly Available Specification (PAS) by the International Electrotechnical Commission (IEC) and is expected to become a global standard shortly. The International Society of Automation (ISA) also has several committees working on wireless standards for the process industries, including the wireless specification ISA100.11a, and the newer WirelessHART convergence specification ISA100.12 focused on the process industries.

improving process reliability, safety and asset management.

Wireless is easy and simple to implement, requires minimal engineering effort, and improves operational effectiveness. The number of times operators or maintenance personnel must go into the field to gather information and the amount of time needed to take corrective action can be greatly reduced through structured or automated collection of data from wireless transmitters.

The business advantages of wireless technology will lead to continued growth. Last year, the Boston-based ARC Advisory Group, an industry research and consulting organization, issued a five-year analysis and forecast called “Wireless for Process Manufacturing,” saying, “The market for wireless devices in the process manufacturing industries will grow at an annual rate of 32% to reach \$1.1 billion in 2012.”

Wireless or not?

Today, wireless is being used mainly for two application areas, and a third is on the horizon.

New, must-have measurements in existing plants. As new environmental and safety laws are passed, many companies are choosing wireless as the best, least-expensive way to

comply. These new, “must-have” measurements might be required for storage tanks, pressure relief valves, or safety showers — applications where wireless devices are easy to install and can be put into operation almost immediately.

Want-to-have measurements in existing plants. The second category, and by far the larger opportunity for wireless, is the “want-to-have” measurement that could not be economically justified previously. When a plant is built, many proposed measurement points are never wired. Later, operations and process supervisors invariably find additional things they would like to measure in order to improve plant performance, but installing new single-point wiring is almost always cost-prohibitive. Cost-benefit analyses show that many of those desired measurements can now be had with wireless.

Perhaps the best example of “we’ve always wanted to monitor them, but couldn’t cost-justify the instrumentation” are the many manually operated (and even some automatic) valves that currently provide no feedback on their actual positions. Yet, incorrectly positioned valves represent a significant cause of safety-related incidents.

Infrequently used valves are not normally monitored because the cost of wiring them is too high. However, wireless monitors are much more attractive, at only 10%–20% of the cost of a wired solution. The advantages of monitoring such valves may make this the largest application area for wireless devices in chemical plants, at least in the near future.

Measurements in new plants that are normally handled by wired instruments in today’s existing facilities. In addition to monitoring, wireless can be used for closed-loop control. Current examples include applications such as steam headers and remote tanks. Just about anything with an acceptable long time constant for change can be controlled using wireless instrumentation currently available on the market.

High-speed control is also possible, but the faster device-sampling rates require the batteries to be changed more frequently. As battery performance improves over the coming years and confidence builds in the reliability of wireless, its use for control purposes will become much more commonplace.

As the performance of nonrechargeable batteries improves, the potential exists for future plants to use wireless technology in critical monitoring situations where wired instrumentation might normally be used. The most likely scenario is that a small number of devices, for example, those that are safety related, to be wired and the remaining devices to be wireless. Wireless control systems will probably appear first in major upgrades and greenfield plants.

User confidence in the reliability of wireless will be the key factor that determines how quickly the technology will be implemented. Some believe that wireless is inherently

less reliable than wired. This is not necessarily true. Wired signals can be unreliable, especially where grounding is difficult, and in those instances, wireless may be much more reliable. The typical process plant's "canyons of steel" and moving obstacles, such as trucks and equipment, are also believed to cause problems for wireless systems. This, however, is being overcome with advances such as time-synchronized mesh protocols (TSMPs) in self-organizing mesh RF networks, which have delivered wireless reliability exceeding 99% in numerous applications around the world.

Wireless field network applications

The chemical industry's interest in wireless instrumentation is reflected in the growing number of requests for information related to this technology, and approximately 90% of those requests are for information on field networks. In addition to the monitoring of manually operated valve position (as previously discussed), the following are some common applications and real-world examples of successful solutions.

Heat exchangers are often allowed to run until fouling adversely affects performance. Instruments are rarely installed, even in newer plants. Wireless monitors give plant personnel the advance warning they need to plan for cleaning at the next regularly scheduled shutdown.

A major process company in Europe developed an equipment health system for improving heat exchanger maintenance. One of the company's engineers explained, "Wireless monitoring of heat exchangers enabled us to determine which unit was the most fouled. This knowledge let us compare the cost of cleaning with potential increases in throughput to be gained, so our maintenance efforts could be most productive."

Filters normally run until they become clogged, but their performance can be improved significantly and energy consumption reduced by attaching wireless monitors to important filtering systems.

A European polyethylene maker uses wireless devices to detect blocked filters and prevent production downtime at its plant in Cologne, Germany (Figure 3). Finished polyethylene pellets are transferred to a storage silo through pneumatic conveying systems, and the incoming air is filtered to prevent product contamination. When the hard-to-reach filters become blocked, they lose efficiency, and the quality of the final product is reduced. Wireless differential-pressure meters enable the maintenance team to determine which filters need cleaning or replacement in order to minimize production disruptions.

Tanks pose a unique instrumentation problem, especially where dozens of vessels across a remote tank



▲ **Figure 3.** Wireless monitors improve the performance of filter systems.

farm need to be monitored for level, temperature, pressure, etc. Because of the cost of underground wiring over the long distances involved, such tanks are rarely instrumented, so a network of wireless devices provides an ideal solution.

In a phosphate fertilizer plant, a self-organizing mesh network provides accurate minute-by-minute readings from 16 pressure and temperature measurement points on a reaction tank located about 250 ft from the central control room (Figure 4). The remote tank is 40 ft tall and has four different beds of gases that react with various process chemicals. Although not classified as a hazardous area, the tank layout and distance involved made wiring both difficult and expensive. According to a distributed control system (DCS) specialist at the plant, "The self-organizing architecture was the clincher for this application, and we already have plans to add more devices to the established network."

Pump and motor health need to be checked frequently to warn of developing bearing problems that could shut down a vital pump or motor, which in the worst-case scenario would cause a very expensive process shutdown. Wireless vibration monitors transmit data to software that detects and pinpoints problems long before a failure, so maintenance can be scheduled at a convenient time.

At one plant where it was difficult for personnel to collect vibration data using portable instruments, an automated collection system was sought. The solution — wireless vibration transmitters plus a smart gateway — was operational in just a few days. Accurate vibration data are now available continuously, so personnel do not need to enter the hazardous area to obtain the needed data.

Monitoring mobile assets, such as skids, pumps, compressors, portable laboratories and test equipment, is generally not possible with conventional wired instruments. Wireless devices can be used to monitor various parameters

▲ **Figure 4.** A self-organizing wireless network monitors 16 points on a reaction tank at a fertilizer plant.

Instrumentation

on mobile assets, even as they are moved from one place to another.

An international specialty-chemicals manufacturer faced a problem of monitoring temperatures in railcars at its plant. The problem was solved by mounting on each railcar a wireless temperature transmitter that sends continuous temperature readings to a central host no matter where the car is positioned at the site. Operators are made aware of any unexpected temperature rise, and the company saves about \$15,000/yr since workers no longer need to climb onto the cars periodically to measure and record internal temperatures.

Environmental standards frequently specify that water taken from a lake or river can be no more than one or two degrees warmer when it is returned. Regulations often also stipulate that a continuous record of water temperature at both inlet and outlet points be maintained.

A cellulose-fiber producer in Europe employed wireless temperature transmitters to monitor water temperatures remotely (Figure 5), and avoided the cost of installing a buried cable. "This technology was easy to install and integrate in terms of data transfer," said a company spokesman, "and the network has been 100% percent reliable."

Rotating equipment and turbomachinery are commonly monitored manually using a portable vibration data collector on a periodic basis. Wireless analyzers now do this job continuously on rotating equipment such as turbines, generator sets, reciprocating engines, compressors, and other motor-driven machines. When pending problems are diagnosed, technicians are generally able to fix them before they become serious problems.

A specialty-chemicals manufacturer installed wireless monitors on a large number of pressure, temperature, and vibration points as a cost-saving measure. The network includes several wireless vibration monitors on brine centrifuges that had not been monitored in the past. In one instance, analysis of the vibration data revealed a lubrication deficiency that could have resulted in severe bearing damage, but the issue was corrected before the problem surfaced.

Contents inside rotating process equipment can be especially difficult to measure with wired instruments. At an Australian chemical company, leaking slip-ring seals allowed the entry of moisture into the wired instruments on a rotating reactor, resulting in unreliable readings.



▲ **Figure 5.** Wireless transmitters monitor the returned-water temperatures needed for environmental compliance by a cellulose-fiber producer.

After wireless pressure and temperature transmitters were mounted on one end of the moving vessel, measurement reliability increased and the once-frequent reactor breakdowns and associated lost production time became things of the past.

Electrical heat tracing on pipelines and process vessels maintains the correct internal temperature, but wired monitors to assure heater integrity are expensive to install and maintain on lengthy pipelines. At a facility in Australia, bitumen unloaded from ships passes through a pipeline that is heated to keep the bitumen hot (160°C) and fluid. If a heater segment fails, a cold spot could form, causing the bitumen to solidify and plug the line, an expensive problem to correct that is made worse if a delay in unloading keeps a ship at the pier longer than planned, with demurrage costing up to \$30,000 per day. The terminal installed eight wireless temperature transmitters along the 3,000-ft-long (900 m), 8-in.-dia. (200 mm) pipeline, sending temperature readings at one-minute intervals to an onshore gateway that channels data to asset maintenance software for instrument configuration and performance monitoring. The data collected are also forwarded via fiber-optic cable to a supervisory control and data acquisition (SCADA) system in the terminal control center, so operators are informed of the status of the heat tracing system.

Temporary measurements are easily handled by wireless, because systems integrators and end users can install temporary transmitters in various parts of the process to check on specific points during process startups or turnarounds and for troubleshooting.

An incineration manager in Singapore explains that it is fairly simple to move a pressure transmitter from one location to another to troubleshoot a problem. "I can often determine what's going on in just five minutes, address the issue, and quickly return the transmitter to its original application. The flexibility of the self-organizing wireless technology makes it much easier to troubleshoot problems as well as evaluate new applications."

Implementing wireless field communications

The all-digital WirelessHART communications protocol is capable of working with any industrial instrument application, whether for control or monitoring, just as all HART products do currently.

Its mesh-based network offers many different paths that transmissions can follow to reach the network gateway. The self-organizing network responds to changes that affect the way radio signals propagate, whether those changes are physical, such as equipment starting or stopping, trucks passing by, or other radio traffic, or due to an outside influence such as a thunderstorm.

Transmissions can follow any one of several different

paths to the gateway and are not limited to line-of-sight routings. Thus, there is no need for preliminary RF site surveys or assumptions as to what the RF characteristics will be at any particular time.

The WirelessHART standard is based on the assumption that changes will occur fast and often. The environment will be very dynamic, and technicians will not have the time or ability to react accordingly. Therefore, the wireless network must react and reorganize automatically.

This is consistent with the legacy of HART in terms of how data are acquired and utilized, and all modern control systems today support that methodology. It will be very easy for any existing control system that is compatible with HART devices to integrate WirelessHART.

Rules for network design

Begin with the supposition that all wireless networks are easier and less costly to install than traditional wired systems. Although self-organizing mesh networks do not require site surveys, a certain amount of planning will make the network operate more efficiently and reliably.

Some rules of thumb for designing a WirelessHART network follow.

Plan to apply a field network project to a process unit or area and obtain a scale drawing. Asset drawings are good starting points. On a scale layout of the process unit or area, identify the locations of desired field devices according to the following criteria:

- The maximum effective range for wireless devices with no obstructions is 750 ft (230 m).
- The maximum effective range for wireless devices within moderate infrastructure is 250 ft (75 m).
- The maximum effective range for wireless devices within heavy infrastructure is 100 ft (30 m).
- For the best functionality of the mesh network, each wireless device should be connected to three other such devices in the design of the network. The wireless connection distances between the devices may vary depending on conditions, but should be within the previously stated maximums. This assures a minimum of two pathways when installed. If a wireless device does not have three connections within maximum distance during the design phase, additional measurement points or repeater devices can be installed to fortify connectivity.
- Line-of-sight connections are not required in most instances, but if a large building obstructs a wireless pathway or isolates a cluster of wireless devices, it may be best to install another gateway to handle the traffic on each side of the building.
- Devices installed in enclosed areas, such as an equipment room, may need to have an external antenna. Or a repeater may need to be installed just outside the enclosure.

CONSIDER A WIRELESS FIELD NETWORK WHEN YOUR APPLICATION HAS ...

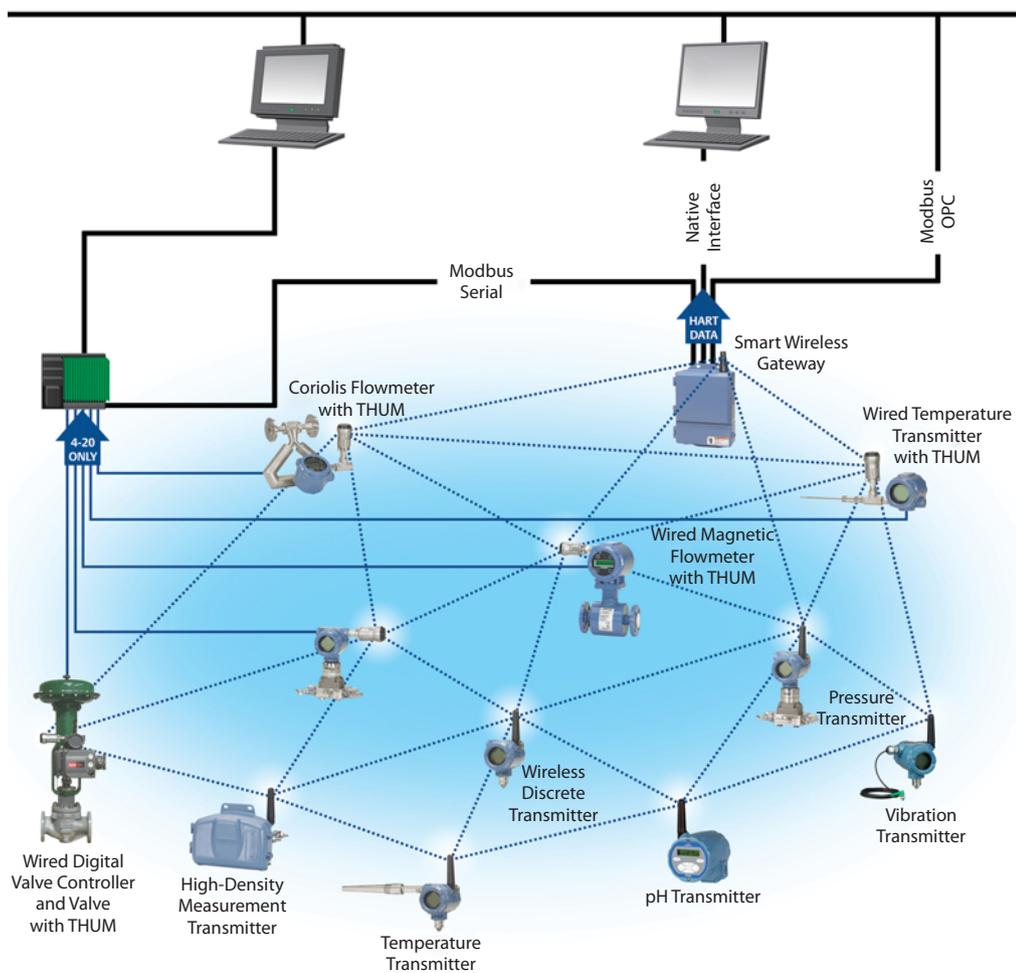
- manually collected data — wireless can eliminate the need to send technicians into the field to read gages
- “must-have” measurements to satisfy environmental or safety regulations — wireless allows the placement of instruments where needed
- the need for diagnostics from HART-based instruments
- electrical classification problems — wireless instruments can be installed in hazardous environments more easily than wired instruments
- “want-to-have” measurements from locations that could not be justified previously
- long distances involved — wireless can eliminate the need for long cable runs and trenching to connect tank farms and similar assets spread over a wide area
- remote pumps and motors — wireless provides an easy way to monitor many pumps and motors where installing sensors would be prohibitively expensive
- extreme environments — hot, dangerous, and/or hazardous environments make it difficult to install instruments and run wire; wireless minimizes the problem
- crowded environments — wireless eliminates the need to snake new wires through crowded enclosures and conduit
- the need for feedback from manual valves that have no connection to the DCS — wireless monitoring can cost as little as 10% of a wired solution
- mobile assets, remote sites, and rotating equipment where using wired instruments is impossible, impractical, or too expensive

Integrating a wireless network

Integration of wireless field networks with plant networks will make business and process applications easier to use and more robust, giving workers more power and increasing their oversight of operations and the environment. Valuable information will stream from field networks based on the open interoperable WirelessHART standard and from plant networks using industrial Wi-Fi standards.

Enterprise software architecture will improve, too, as new web-based service-oriented architecture (SOA) makes enterprise-to-factory-floor communication easier than ever. For example, performance monitoring in plant field networks feeds plant and corporate optimization software, or level monitoring in tank farms feeds inventory applications to enable communications with customers, or diagnostics from critical field devices are delivered directly to computerized maintenance management systems.

As with the transition between any two disparate networks, the integration of wireless into a host control or



◀ **Figure 6.** Existing process units can be made wireless using various protocols for host communications and adaptors to transform wired devices into wireless devices.

sensed” and “auto-configured” for quick and easy startup and commissioning. In addition, HART alerts from WirelessHART devices pass directly through to predictive maintenance software, eliminating the need for an additional network.

Serial limitations. For applications using a serial Modbus communication link, like that depicted in Figure 6, the host system must have enough connection capacity available. To enable remote monitoring of the process variable and device status indicators, multiple Modbus registers are needed for each data point. With serial systems, security measures are limited to physical isolation

of the components — due to protocol limitations in the existing DCS/host systems, data cannot be encrypted and access cannot be managed.

information system relies on a gateway to translate signals, for example, WirelessHART into Ethernet. When adding a wireless network to an existing process unit, the interface requirements of the host system typically dictate the type of gateway interface that will be needed. A wireless gateway can be integrated with a wide range of host systems, as well as a wide range of programmable logic controllers (PLCs), process historians, and other installed control systems (Figure 6) and protocols (Table 1). A wireless adaptor can also be added to field devices in the existing process unit, enabling collection and use of diagnostics or measurements not previously accessible in a central host.

Go native. The best-case scenario for wireless integration is a host system that includes native support for wireless devices, as depicted in Figure 1. Indeed, for users of these systems, wired and wireless field devices appear transparently on the host system with no special software or communication know-how.

In the latest versions of systems with a native interface, more-advanced wireless gateways can even be “auto-

Ethernet options. If the host application requires integration via Modbus TCP, OPC, or HTML, then either a wireless or wired Ethernet connection is needed. Ethernet communications have fewer restrictions than serial systems, but may require the involvement of the plant’s IT personnel, who can identify the connection point, navigate the gateway through Ethernet firewalls, and provide remote access to the gateway. Ethernet also allows the gateway to be securely managed like any other device in an IT network.

Wireless Ethernet provides enough bandwidth to communicate both diagnostic and measurement data. In fact, with power as its only need, the gateway can be placed almost anywhere within range of the devices and the host connection. The gateway can generally be moved, if necessary.

The gateway can generally be moved, if necessary.

Getting started

A wireless infrastructure can be installed very easily for use with a plant’s existing devices and control system.

Table 1. Primary wireless integration protocols

Protocol	Typical Host
Modbus / Remote Terminal Unit (RTU)	Distributed control systems (DCSs) and programmable logic controllers (PLCs)
Modbus / Transmission Control Protocol (TCP)	DCSs, PLCs, and human-machine interfaces (HMIs)
OLE for Process Control (OPC)	Data historians and HMIs
Ethernet	Asset management systems and other applications on the plant local area network (LAN)
Hypertext Transfer Protocol (HTTP)	Web interfaces used for configuration and simple monitoring
Extensible Markup Language (XML) and Comma Separated Values (CSV)	Bulk data transfer

Many plants start small with a wireless field network of a few devices communicating with a single gateway. The first wireless point is inevitably the most expensive — to deploy one transmitter, it is also necessary to install the gateway, computer, software, etc. However, once this infrastructure is in place, installing each subsequent transmitter will cost very little more than the device itself, since one gateway typically supports up to 100 transmitters. Many gateways can be added to the network, each with up to 100 devices — allowing for massive scalability.

Monitoring applications offer a good opportunity to evaluate the technology with little or no risk. You can obtain a relatively inexpensive wireless starter kit without a capital expenditure. Then, involve all departments — engineering, operations, maintenance, etc. — to allow everyone to see how wireless technology can enhance equipment reliability, reduce plant downtime, improve process control, and create a safer workplace.

Once the first wireless network begins to function, the operations and maintenance staffs will find other applications around the plant for additional process data collection and asset monitoring.

As noted earlier, the wired and wireless worlds are easily integrated in a single, scalable infrastructure. As a result, the benefits of the digital plant architecture are extended to assets that were previously out of physical and economic reach. Since this approach is based wholly on open standards, system designers can choose from a variety of wireless solutions without being tied to a specific technology or vendor.

Looking ahead

The evolution from a wired world to a wired-and-wireless world will continue as management recognizes the enormous potential for continuous improvement. Corporate technology groups, as well as IT and process automation personnel, are collaborating in cross-functional teams to investigate and implement new technology for operations, always working to improve safety, the environment, and production. In addition

to existing-facility upgrades, there is potential for wireless to replace wired instrumentation in new plants.

The door to the world of wireless is open for suppliers to develop new wireless products and users to develop applications that add value to an industrial process without concern about the underlying technology. This is somewhat like the emergence of the Internet, which turned loose a proliferation of innovative applications not even imagined before. We are on the cusp of a similar revolution in this new age of wireless for industrial process automation.

On the strength of the high reliability and performance qualities of self-organizing WirelessHART mesh networks, and the clear economic advantages they offer, we believe WirelessHART technology will account for 20% of the signals in new plants within five years.

CEP

PETER ZORNIO, chief strategic officer for Emerson Process Management, directs strategic initiatives for Emerson, including the expansion of PlantWeb digital plant architecture to include process and plant networks that deliver a complete solution for improved productivity, safety, and operational efficiency of process manufacturing facilities. Zornio has a leadership role in prioritizing technology investments and identifying acquisition candidates. He has strong background with fieldbus technologies, which combine with emerging wireless technologies as the communications foundation of PlantWeb and other leading Emerson Process Management technologies. A 24-year veteran of the process automation industry, he was most recently director of product marketing for Honeywell, where he was responsible for control systems, safety systems, and software for asset management and manufacturing execution. He also worked with measurement products, and the acquisition and integration of a major automation company. He has a BS in chemical engineering from the Univ. of New Hampshire.

BOB KARSCHNIA, vice president of wireless for the Rosemount Measurement Div., has over 16 years of experience in the process control industry. He currently manages the Wireless Business Unit for Rosemount's wireless product offerings and coordinates wireless initiatives across all of Emerson Process Management. Previously, he 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. He also served as an officer in the U.S. Air Force working on satellite control and communications systems. He has a BS in aerospace engineering from the Univ. of Minnesota and an MS in electrical engineering from the Univ. of Colorado.