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Wireless architecture with WiFi-based plant network and WirelessHART-based field network. Courtesy Emerson Process Management.

Wireless Proves Its Value

Smart wireless field devices provide useful data from remote, hard-to-reach locations.

By John Blaney, Emerson Process Management

The wireless field communication technologies currently gaining wide approval in the process industries are finding useful applications in the power industry as well. The low cost, reliability, security and ease-of-use of the newest wireless systems are increasing awareness of their possibilities in power plants, bringing about some innovative applications with excellent results. For example:

- A 500 MW gas-fired turbine unit saved as much as $75,000 putting wireless devices into remote buildings to protect pumping equipment against freezing temperatures.
- Continuous performance data on a boiler feedwater pump and air heaters delivered via wireless transmissions saved 50 percent versus the cost of installing wired instruments.
- Analytical teams charged with monitoring performance of 140 power plants in Mexico improved coverage and increased service revenues by more than $500,000 by using wireless instruments to obtain key flow, pressure and temperature measurements for thermal efficiency models.

First and foremost, the cost structure of wireless is so compelling that plants can save up to 90 percent versus wired installations. Besides eliminating the cost of cable, engineering, site surveys, construction and documentation, plus costs associated with adhering to health and safety guidelines, wireless technology makes it possible to obtain never-before-available measurements and monitor critical points. Wireless transmitters are often installed in remote, or hard-to-reach areas, providing continuous data on temperatures, pressures, tank levels and the condition of essential equipment, including motors, pumps, fans, compressors and turbines.

Potential power industry applications include continuous monitoring of pressure relief valves and stacks to avoid accidental releases, monitoring temperatures at pre-heaters and pumps to improve thermal efficiencies, and analyzing vibration on all kinds of rotating equipment.

Two Wireless Technologies

Two wireless technologies are currently available to power producers: point-to-point and self-organizing mesh. The latter meets the WirelessHART standard, built on self-organizing mesh network technology. The standard was approved in 2007 by more than 200 members of the HART Communication Foundation representing both instrument users and manufacturers. A substantial number of components meeting this standard—including field devices, digital valve controllers, vibration data transmitters and gateways (receivers)—are already in use in power plants.

Wireless instruments can be widely and remotely distributed throughout a plant, across roads and ponds or on mobile platforms like railcars, barges or trucks where traditional wired data collection is not feasible. Small amounts of bandwidth are used for high-priority bursts of data from each device serving as a transmitter. The self-organizing mesh network continuously monitors signals for signs of degradation and repairs itself as necessary, automatically finding the optimum communication route to the network gateway. If a temporary obstruction blocks a connection, signals are rerouted via adjacent wireless devices, which act as transceivers. In this way, connectivity is maintained while achieving greater than 99 percent data transmission reliability.

These battery-operated wireless devices communicate intermittently to save energy, enabling each of them to run for an extended period on one battery. Longevity depends on how often the device "comes to life" (typically once a minute) to deliver a continuous stream of information. Update rates can be faster or slower, depending on the application's requirements. The more frequently the instrument is set to update, the sooner the battery must be replaced, but battery life currently can be extended up to 10 years by using a low-power mode.

Wireless Networks

Wireless technology can affect power plant operations in two broad categories: wireless plant networks for business and operations purposes and field networks for sensor and field device applications.

Wireless Plant Networks (WPN), which are based on IEEE 802.11 standards, use WiFi technology to build networks for plant operations. The mesh-based WPN is designed to provide a secure, high-bandwidth, reliable and scalable way to access fixed and mobile data, not necessarily central to the basic power-generation process. Applications include data connectivity, people or asset tracking, video/perimeter surveillance and voice communication.

Typically, a wireless plant infrastructure is constructed from mesh access points, a wireless local area network (LAN) controller and network management software. A number of access points are distributed throughout the plant to provide umbrella-like wireless coverage. The architecture provides for integration of transmissions within a power plant's existing IT infrastructure, so there is no need for a wireless overlay.

Wireless Field Networks (WFN) based on the WirelessHART

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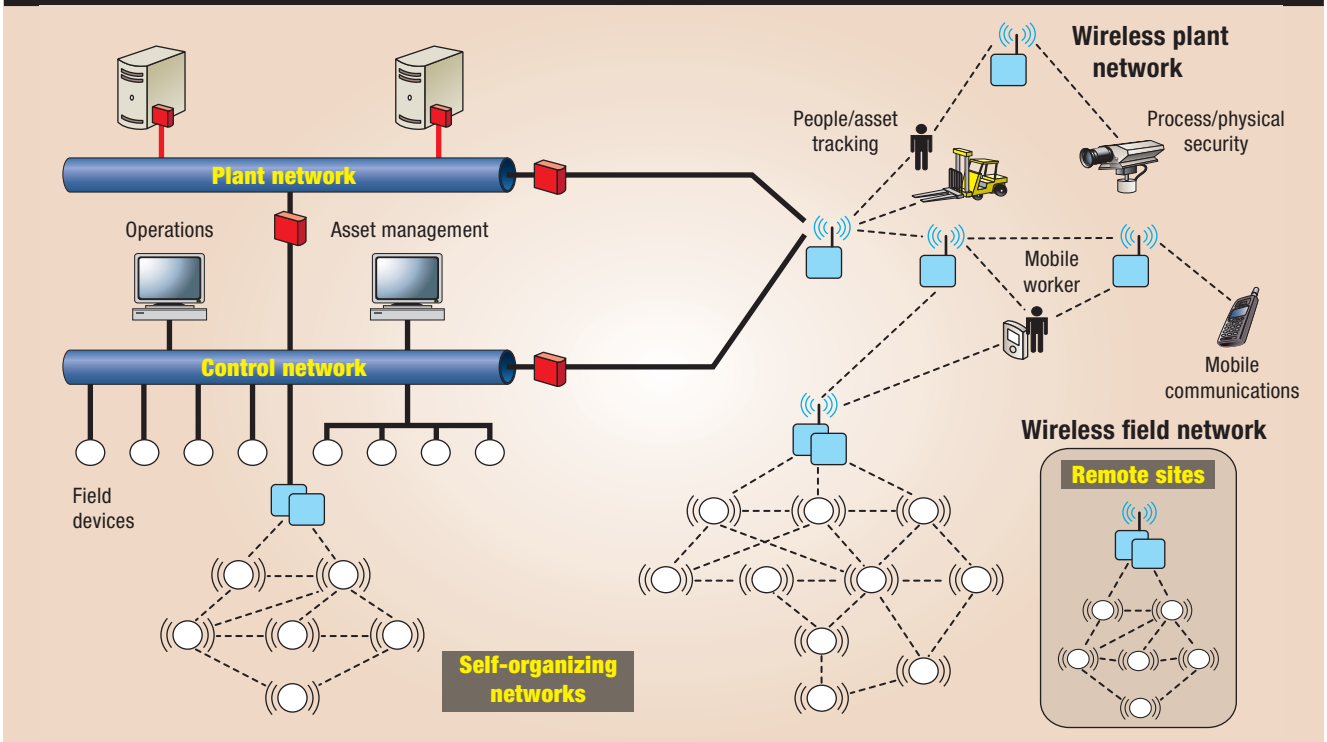
Figure 1 OVERVIEW OF WIRELESS PLANT AND WIRELESS FIELD NETWORK



standard are already in place and delivering measurement data and diagnostics without the need for large investment in a plant-wide infrastructure. These networks focus on measurement and monitoring of remote or inaccessible points such as pressure relief valves and stack gases, temperatures at pre-heaters and pumps or vibration in any number of critical mainstream and auxiliary machines. Obtaining diagnostics information from those same field devices is another highly important use of wireless field networks.

Since WirelessHART devices function in the same way as traditional wired instruments, they measure exactly the same pressures, temperatures, flows, tank levels or amounts of vibration. The only difference is a small visible antenna. Instrument technicians already familiar with smart field devices have no difficulty understanding wireless instrumentation or working with wireless field networks.

When planning wireless field networks, there is no need for preliminary radio frequency (RF) site surveys or assumptions as to what the RF characteristics are going to be like at any one time. With WirelessHART self-organizing networks, it doesn't make any difference because of the ability of the communications mechanisms used to continuously jump between the 16 frequencies in the 2.4 GHz band to avoid (or "blacklist") those that are interfering. Less communications infrastructure is required because these networks operate well in dense plant environments. Adding or moving devices is also relatively easy. So long as a device is within range of at least two others on a network, it can communicate. Generally, a network of up to 99 devices can be served by a single gateway. An available software tool helps lay out and validate communications networks against best practices.

Security is a high priority with wireless systems. WirelessHART uses a multi-layer approach, employing a variety of techniques including frequency-hopping/anti-jamming measures, encryption, authentication, verification and key management.

These elements should be used on both sides of the gateway that interfaces the wireless field network with your plant's wired control network. Because communication from the gateway to the control room probably uses transmission control protocol/internet protocol (TCP/IP) messaging, the addition of a firewall or other industry standard technique is recommended.

The wireless infrastructure allows cost-effective integration between the field data and a plant's automation or asset management systems. When adding a wireless network to an existing control system, the host system's interface requirements typically dictate what type of gateway interface will be needed. Connectivity can also be fostered with programmable logic controllers and process historians, as well as other legacy control systems.

Innovative Applications

Putting wireless technology to effective use in power plants generally requires finding ways to use one or more of the benefits, including easy, low-cost installation in remote locations, more and better data from inaccessible points, faster response to equipment problems, improved worker safety, environmental compliance, reduced maintenance costs and flexibility in response to change. A number of current applications do just that.

Milford Power in Milford, Conn., applied a self-organizing field network to monitor water pumping and circulation equipment in 11 remote buildings against damage due to freezing temperatures. Although the remote stations are heated, newly installed temperature transmitters inform plant operators in case a heater fails so they can take action to prevent damage that could cost as much as $20,000 for a pump repair or replacement. The company saved $75,000 installing wireless devices, avoiding the construction of trays over roads or running conduit under existing structures, while the self-organizing network was completed in a short time frame.

Self-organizing wireless mesh networks are contributing to improve reliability at two power stations operated by PPL Corp. The

Smart Wireless concept provides continuous performance data on critical boiler feed pumps at the Montour power station and also on feedwater and air heaters at the Brunner Island Unit 1. Needed temperature and pressure measurements in the past were unavailable to populate software designed to analyze thermal performance and determine optimum maintenance schedules. An on-site demonstration proved the ability of a self-organizing network to transmit reliably despite the dense power plant infrastructure. Multiple installations followed.

Another power producer wanted to install new instruments to reduce downtime and improve plant performance, but a wired system was considered too expensive. The solution was nearly 120 wireless pressure and temperature transmitters along with wireless gateways in each of the company's five units. The data obtained from the field devices are integrated into the plant's existing distributed control system, resulting in a number of improvements. For example, predictive diagnostics have enabled maintenance personnel to reduce downtime by fixing equipment before it breaks down. In addition, having more information has increased operator efficiency and maintenance costs have gone down by eliminating operator rounds.

Other wireless network applications involve monitoring valve operation, effluent streams and the condition of rotating equipment. Wireless valve monitoring makes sense for power producers because so many operations have "blind valves," either manual or semi-automated, that provide no feedback at all. In most cases, cost and/or location dictated against wiring large numbers of valves. Yet valve position information is important since incorrectly positioned valves represent a significant cause of safety-related incidents.

Continuous wireless vibration monitoring of rotating equipment is a great improvement over the periodic "route checks" that have been the principal means of gathering vibration data. New wireless vibration monitors make it possible to keep a continuous watch on a range of remotely operating motors, pumps, induction fans and so on, which were not previously instrumented due to the cost of installation. This is expected to become a prime application for wireless in the power industry.

Looking Ahead

The first step in getting started with wireless is simply to consider "want-to-have" measurements that are too expensive to wire-up but that might be economically feasible with wireless. The inherently low cost of installing wireless devices makes it possible to obtain needed information from more of these points.

Getting started may involve a few wireless devices and a gateway. Once that initial investment is made, more measurement/monitoring points can be added for little more than the cost of the instruments themselves.

Most major instrument suppliers are supporters of the WirelessHART standard and can be of service to power producers in initiating wireless applications. In the final analysis, the use of wireless technology in key locations improves safety and plant performance, while at the same time costs for operations and maintenance are lower, making getting started in wireless a sensible and worthwhile endeavor. pe

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