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Advances in wireless remote monitoring

Wireless monitoring is helping users solve problems by integrating new and existing technologies across a common infrastructure to get data into the hands of those who need it—securely.

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The use of industrial wireless sensor networks has been growing rapidly in the process industries during the past decade. During this time, many stories have been told of successful implementations in process, reliability, and energy application areas as well as in health, safety, security, and environmental monitoring applications. Many users across these application areas have found that wireless monitoring technologies provide new ways to improve the performance and reliability of their operations.

Measure things that couldn't be measured before

The cost of wireless sensing networks is significantly less than wired infrastructure due to reduced cost of wiring, cable trays, input/output (I/O) equipment, and associated design, installation, and maintenance labor. This reduced cost makes it possible to implement new applications that previously weren't financially justified. For example, tank farm automation projects are now possible because of cost savings of up to 70% from reduced infrastructure, design, and labor required for installation and commissioning (see Figure 1). Wireless level, temperature, and pressure measurements can be installed to monitor the materials stored in these tanks, improving the capability of operations.

Wireless sensing technologies make it possible to measure processes that could not be measured before. New sensors, combined with analytics software are being applied to applications, such as process emissions, steam trap health, relief valve status, and equipment corrosion monitoring. Previously, these applications required manual inspection using handheld equipment or other manual techniques. With manual inspection, identifying the source of process gases that are being sent to a flare can be very difficult. Now, wireless acoustic monitoring allows companies to identify the source and quantity of material being sent to flares (see Figure 2).

An electricity and natural gas utility company implemented

a wireless network to enable remote monitoring of outlet gas pressures from four district regulators. The company required quick installation and the cost of installing wires was prohibitive. By attaching WirelessHART interface adapters to existing pressure transmitters, it was able to replace paper chart recorders with digital information displayed on screens in the control room and logged in the historical database. The entire installation was completed, tested, and tuned in three days.

WirelessHART networks also can enable access to smart field device diagnostics that are stranded by legacy systems. Most legacy control systems don't have I/O hardware that is capable of HART digital communications with smart field devices. Rich diagnostics and sensor data is trapped in these smart devices with no way for monitoring systems to connect to them. Previously, end users have dealt with this by wiring multiplexers, but this approach is complex and costly to implement. Instead, WirelessHART networks enable access to diagnostic information through the use of wireless transmitters installed on smart devices (see Figure 3). For example, control valve diagnostic information can be accessed remotely by technicians for online diagnostics and troubleshooting.

Integrate data across information silos

Wireless data shouldn't stand by itself. Integrating wired and wireless data into analytics and visualization applications increases users' ability to do more with the data. Wireless data can be integrated into control systems, data historians, and software applications where data from other sources also are available. Before adding wireless measurements, engineers should take inventory of sensor data that is already installed and add new points to complement existing measurements.

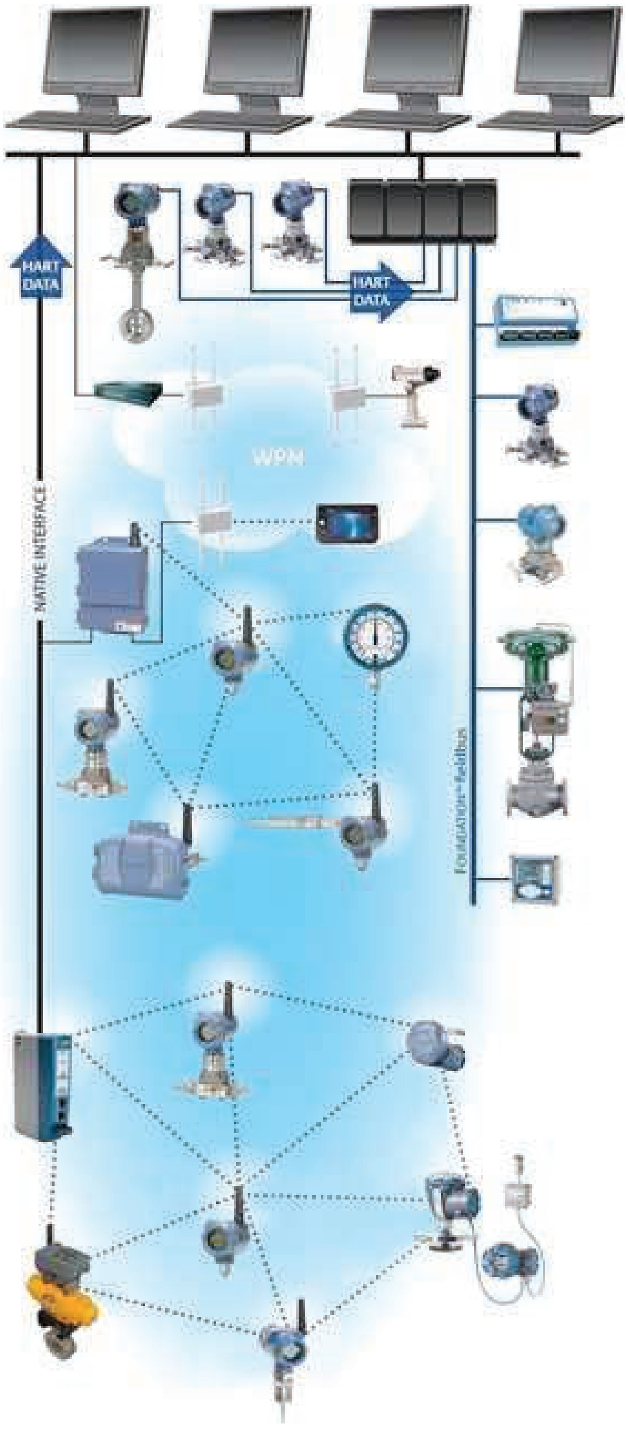
When the data is integrated, flexible analytics and visualization platforms enable experts to derive insights and actionable information. Subject matter experts have a more holistic view of data and can make recommendations based on their education and experience. Purpose-built software tools can be used to apply physics principles or empirical models to deepen the level of analysis.

For example, software with first-principle thermodynamic models can be integrated with a data historian to detect equipment performance degradation as an early indication of mechanical problems. An existing heat exchanger might have flow and process temperature measurements that are used by for temperature control, but would require additional temperature and pressure sensors to be installed for performance monitoring. Existing measurements can be combined with new wireless measurements, where mechanical gauges are replaced with wireless transmitters. By expanding the data set to include all of the available measurements, the thermodynamic models can be used by experts to more accurately detect problems and proactively recommend actions to be taken.

Land and expand

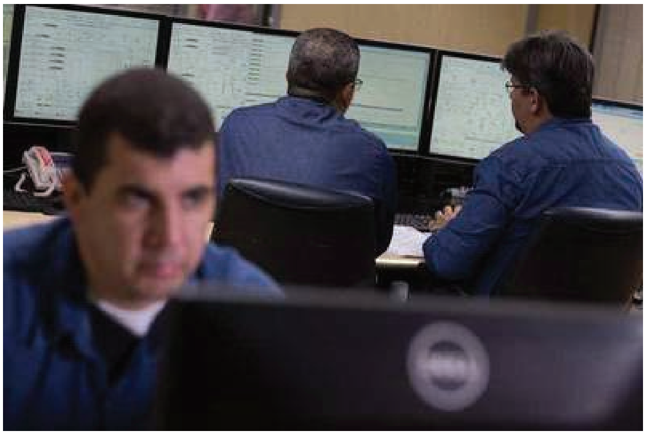
Often, when end users want to get started with wireless monitoring, they are not sure where to start. One approach is to design an all-reaching wireless sensing infrastructure that can enable any monitoring application that one might need—reliability, energy, safety, environmental, and so on. One may design a network of wireless gateways with optimal placement for blanket coverage of operational areas and then layer on applications where needed. This is a great approach if you have the capital available and can justify the investment. Just be sure to choose a standards-based technology that will support a wide variety of measurements and solutions that you can integrate into the same infrastructure.

However, this scenario is not very common. Many operating facilities are capital constrained, and there is a long list of investment opportunities competing for a fixed amount of funding. This scenario makes it difficult to allocate a large amount of capital funds for a facility-wide wireless infrastructure. A more practical approach is to identify the most important problem to solve with a clear return on investment



that is easy to quantify. Build the business case for this investment and install a standards-based wireless infrastructure that enables this specific problem to be solved.

Plan the wireless network with an eye on the future and create a design that can be expanded into other areas. Networks such as a wireless mesh network can be expanded easily by adding new measurements online while increasing the reliability and performance of the overall network. By proving the return on investment of a specific issue and designing a network with expansion capabilities, one can install the infrastructure that will support additional wireless monitoring solutions to be added at a later time.



Leverage expertise wherever it's available

Regardless of the size of the facility, you are not going to be able to staff deep subject matter expertise for every domain. Experts aren't always available to be physically located where you need them, when you need them. Rather than bearing the cost and time required to bring an expert to the site, wireless monitoring enables data to be collected and sent to the experts-wherever they are located. This enables more effective use of experts' time, and can make it more economical to retain these domain experts.

Because remote experts cannot be close to the equipment, they cannot see, smell, touch, or hear what is going on. For this reason, more sensor-based measurements are required. Wireless measurements make it possible to collect enough data so that they can make informed decisions without being physically located at the equipment. For example, mechanical pressure and temperature gauges can be replaced with wireless measurements so the measurements can be monitored remotely.

Bigger companies can leverage expertise across multiple sites, and sometimes they will invest in centralized centers of excellence where experts can be co-located for collaboration. This kind of approach is becoming more common in oil and gas, power generation, and mining industries.

Even in these centers of excellence, it doesn't make sense to develop deep subject matter expertise in all areas. Instead, companies will choose to focus expertise on process monitoring and critical equipment and outsource or partner with external service providers for monitoring in other areas. For example, a power generation center of excellence might have chemical engineers focused on performance monitoring and optimization for turbines and boilers across a fleet of power plants, and outsource monitoring of less critical machinery and valves to a service provider. Experts from a machinery or valve monitoring service provider can analyze the equipment data to detect early indicators of mechanical failures, diagnose the problem, and recommend actions to be taken to slow down failure propagation and to plan maintenance and repair. Whether onsite at a center of excellence or an external service provider, these experts depend on the measurements coming in from the field. Using wireless networks to deliver deeper visibility into the plant enables experts to more effectively contribute to plant performance and reliability.

Reduce security risks

There are several basic options for deploying wireless sensing networks in industrial facilities. One option is to integrate wireless measurements into your control system. This can be done with wireless networks embedded in the I/O subsystem by the control system vendor, or external wireless networks that can be integrated into the control system via protocols, such as Modbus, OPC, and EtherNet/IP. This approach is useful when measurements are needed for operators to better control the process. Because the networks are integrated into the control system, they benefit from the same security safeguards used to protect the overall control system. To protect the wireless network, choose a technology that has robust security, including channel-hopping virtual local area networks, encrypted communications, message authentication, white listing, and other security controls.

Another option is to install wireless sensor networks that are separate and independent from the control system. This approach can simplify the security requirements for the monitoring network because it is being implemented in a way that does not introduce connectivity to the control system. Many applications don't require control system integration because the data isn't used by operators for control of the process. Instead, wireless sensor data can be integrated into software running on the IT networks where engineers and specialists can more easily access the information. Then, information can be tied to data historians or stand-alone application software focused on solutions such as energy management, environmental monitoring, and regulatory compliance reporting.

For more specialized applications, it is becoming common for vendors to offer connected services based on wireless sensing networks. In this case, the wireless monitoring networks are owned and operated by the service provider and the user pays only a monthly service subscription fee. Vendors provide services based on drop-in monitoring networks that are owned, installed, and operated by the service provider (see Figure 4). These are connected securely through the user's existing IT network, or installed with Internet connectivity via a cellular router. Appropriate security measures are applied by the vendor, including firewalls, data encryption, and even physical security to prevent tampering.

Stand-alone wireless networks that are used for only measurements, such as acoustics, vibration, and temperature, must be secured for availability, integrity, and confidentiality. However, if these monitoring networks connect to critical control equipment, such as control valves, gas analyzers, or flowmeters, the security needs will be much higher. Even in this case, security technologies, such as data diodes can be used to ensure separation of the monitoring network from external threats.

Untethering data

In this time of digital transformation, the companies that use technology in new ways are the ones that gain a competitive advantage. Merely adding measurement points through wireless monitoring won't reset users' expectations to achieve new business goals. When users begin strategically using wireless technology to complement their wired infrastructure to address previously unsolvable issues, they can start to advance the performance and reliability of their entire operation.

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