Improving SCADA Operations Using Wireless Instrumentation

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Summary

Executive summary

The purpose of this paper is to explore the particular ways in which operators can tightly integrate wireless instrumentation networks with SCADA and realize the full benefits of such an integrated solution.

Introduction

Integrating wireless instrumentation with SCADA systems can drive operational efficiency and reduce deployment costs.

The use of wireless instruments in pipelines and gas production operations has been gaining momentum over the past few years. Driven by cost cutting measures and the need to gain more operational visibility to meet regulatory requirements, wireless instruments eliminate expensive trenching and cabling while providing access to hard-to-reach areas using self-contained, battery-powered instruments. However, SCADA engineers and operators are facing the challenge of integrating wireless instrumentation networks with other communication infrastructure available in the field. Managing and debugging dispersed wireless networks presents a new level of complexity to field operators that could deter them from adopting wireless instrumentation despite the exceptional savings.

This paper will look into the particular ways in which operators can tightly integrate wireless instrumentation networks with SCADA and realize the full benefits of such an integrated solution.

The Evolution of Wireless

Since Guglielmo Marconi sent the first telegraph signal across the Atlantic, wireless became part of our everyday lives. However, the last ten years have seen a dramatic change not only in the radio technology but more importantly in how we use it as consumers and oil and gas professionals. Gas producers and pipeline companies have relied for many years on long range wireless technology to transmit and distribute critical operational data using a wide range of technologies, including satellite, VHF, UHF and license-free spread spectrum. As more consumers lined up to acquire the latest Smart Phones with embedded Wi-Fi, Bluetooth and broadband capabilities, the price of radio modules has plummeted over the past three years. This has made it easy on industrial vendors to integrate radio modules into a long list of devices and sensors. As a result, the O&G industry has seen an increase in wireless instrumentation, also broadly known as wireless sensor networks, offered from major process control and SCADA suppliers. Wireless became the holy grail of the industry with editors and pundits predicting double digit annual growth and a $1.2 billion market by 2012.

The business case behind deploying wireless instrumentation is a compelling one. By eliminating cabling and trenching, you can dramatically reduce the cost of deployment by as much as 70%. Since wireless instrumentation is battery powered, they are much easier to deploy in the field relative to their conventional counterparts. Wired systems can take days or weeks to be properly installed. Wireless instruments require only the sensor to be installed in the process, saving hours or days and valuable resources. Other instruments can be added as needed.

Safety and compliance with environmental requirements are major driving factors. In gas production, during the initial flowback period, using wireless pressure sensors reduces the risk to personnel who would otherwise need to be in close proximity to a volatile and toxic well in order to read manual pressure gauges and to report on production readiness. During the flowback period before a wired solution can be installed, wireless pressure sensors put the well analyst in touch with the well enabling remote trending and analysis. EPA regulations in many regions require the use of a Vapour Recovery Unit (VRU) to burn off residual gases from separators and condensate tanks. An easy to install wireless temperature sensor can monitor the VRU and report an alarm condition if the flame goes out.

Wireless Instrumentation is a Different Game

So if the business case is that strong and the return on investment is solid, why are some still reluctant to deploy wireless instrumentation in their facilities? There are three main reasons:

1. Reliability

In industrial applications, reliability is a major concern. Wireless instrumentation must be as reliable as conventional wired units. Even in simple applications like remote monitoring, users come to expect a certain level of reliability and network availability. Wired systems are much easier to diagnose and trace because the medium, the wire, is physically there or could be dug out. Wireless, on the other hand, uses the invisible free space as a medium. Radio signals are subject to free space attenuation, where the signal loses strength at a rate proportional to the square of the distance travelled. Radio signals are subject to reflection as a result of structure, trees, water bodies and buildings. Furthermore, interference from near-by wireless systems such as cell towers adds more challenges.

RF design is getting better in addressing many of these issues. By designing highly sensitive radio receivers, using the transmit power more efficiently and high gain antennas, engineers were able to establish highly reliable RF point-to-multipoint links.

2. Adaptability

Wireless instrumentation networks are required to adapt to the existing environment. It is not practical to move a well head, a compressor, tank or a separator just to create a reliable wireless link. In long range SCADA networks, it would be much easier to locate a 30 foot tower in the field to allow for line-of-sight consideration. It might also be easier to increase the height of the tower to extend the range and avoid obstruction. Wireless instrumentation networks do not have that luxury. It is sometimes difficult to find a location for an access point or base radio that provides reliable communication with the wireless instruments. Relocating the access point or base radio to improve the RF link with one sensor could result in degrading the links with other sensors in the same network.

Adaptability can be addressed by using lower frequency bands, such as the license-free 900 MHz, which tend to provide better coverage, longer range and better propagation characteristics allowing the signal to penetrate obstacles. Also, high gain external antennas that can be mounted as high as possible on a structure allow access to hard-to-reach sensors which could be located at the bottom of a tank. Improved receive sensitivity of radio modules also plays a crucial role in ensuring network adaptability to various industrial environments.

3. Integration

Most gas production, processing plants and pipeline facilities have some level of wireless capability in place. Long range proprietary SCADA networks, backhaul point-to-point networks and local wireless area networks are some of the common systems deployed. Each of these networks is being used for a specific purpose such as control data transmission, high bandwidth communication and video surveillance. Engineers and operators are facing the challenge of integrating wireless instrumentation networks with other communication infrastructure available in the field. Managing and debugging dispersed wireless networks presents a new level of complexity to field operators that could deter them from adopting wireless instrumentation despite the exceptional savings.

The wireless networks integration dilemma is more apparent in SCADA systems. Since wireless instrumentation networks are supposed to tie into the same SCADA infrastructure available at site in order to relay valuable operating data to the SCADA host, having the ability to manage the complete infrastructure as one network becomes essential.

Moreover, having the ability to access hard-to-reach areas and gather new data points that were not economically viable before, gives the operator better visibility into the process and plant operations. However, this data has to end up somewhere in the system in order to be monitored, analyzed and leveraged. SCADA systems are normally designed to handle a certain number of data points or tags. Scaling up the system to handle additional data points and integrate them in trends and reports could be costly.

Despite the abundance of tools to capture, process and analyze data in the process control market, ensuring data integration is still a major problem. Some SCADA systems even have a separate historian module that must be purchased as an add-on to handle the flood of data as a result of adding wireless instrumentation networks.

Addressing the Wireless and Data Integration Challenges

A new breed of advanced wireless instrumentation base station radios or gateways is now emerging in the marketplace to address this need. This new generation of gateways integrate both a wireless instrumentation base radio and a long range industrial radio in the same device. The wireless instrumentation base radio has a Modbus data port, allowing an external Modbus Master to poll information from the base radio about its own status as well as the status and process values of its field units. It also has a diagnostics port, allowing the connection of the network management software for sensor configuration and diagnostics. Both of these data streams are sent simultaneously through an advanced long range serial or Ethernet radio network. This is how it works in practice:

- The wireless instrumentation base radio and all field units must have the RF Channel and Baud Rate set identically.
- Each field unit must then have its RF ID set to a unique value. This value will be used later for Modbus polling of the data.
- The base radio's Modbus serial port baud rate must be set to match that of the long range radio.
- The base radio's Device ID must be set. This value will be required later for Modbus polling of the system.

The integrated long range remote radio is configured as a remote device relaying information to a Master radio at the main SCADA center. The available two serial ports on the radio are configured to tunnel Modbus polling and diagnostic data simultaneously to the wireless instrumentation base radio. This allows operators to manage and diagnose the wireless instrumentation network through the existing long range SCADA infrastructure. Live data and status information for all field units are displayed in a separate view or integrated in the SCADA host.

On the data integration front, modern SCADA host software offers a fully integrated environment that includes an integrated and scalable historian to handle more additional data without going through expensive and sometimes lengthy upgrades. Developing the SCADA screens based on templates allow engineers to add data points easily and rapidly in their systems.

Conclusion

As the adoption of wireless instrumentation networks increases, users will be faced with a number of challenges to ensure the reliability, adaptability and tight integration with their existing infrastructure. New RF and antenna designs help to address reliability and adaptability challenges. This leaves wireless and data integration with the existing SCADA infrastructure as one of the critical challenges to be resolved. Luckily, hybrid gateways, where sensor network base radio and long range radio are integrated, allow users to view, manage and diagnose their dispersed wireless systems from a single point. Similarly, advanced SCADA host software, with an integrated historian and rapid development environment using templates, can facilitate the integration of new data points generated by a growing network of wireless sensors.

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