

Improving SCADA Operations in Water and Wastewater Using Wireless Instrumentation

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Water and wastewater operations are prime candidates for wireless instrumentation. Plants are spread out over hundreds of acres, and remote pumping stations can be miles away from the central SCADA system. Running hard cables or using dial-up phone lines to bring in remote I/O can be expensive and unreliable. Using wireless to connect remote monitoring systems with centralized SCADA systems and control rooms makes a great deal of sense. But, as we will see here, not everyone is convinced.

Introduction

The last ten years have seen a dramatic change not only in the radio technology but more importantly in how we use it as instrument and control engineers. As more consumers line up to acquire the latest Smart Phones with embedded Wi-Fi, Bluetooth and broadband capabilities, the price of radio modules have plummeted. This has made it easy on industrial vendors to integrate radio modules into a long list of devices and sensors.

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, whereas 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.

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:

Reliability: In water applications, reliability is a major concern. Wireless instrumentation must be as reliable as conventional wired units. Even in simple applications like remote pump monitoring, users come to expect a certain level of reliability and network availability.

For example, the controls and communications for a wastewater pump station, often located far from the central control room, have to be reliable. If something goes wrong, maintenance people have to be dispatched immediately. South East Water Company in Melbourne, Australia, had that problem. Their dual

submersible pump control (Figure 1) required the local controller to cycle between two pumps, ensuring that both pumps were used approximately equally.

The local controller also had to report critical system data, such as flow totals and pump running times to the central SCADA system. Grundy's Electrics, a systems integrator in Melbourne, installed Control Microsystems SCADAPack controllers, local display panels, and DNP3 optimized radios at each pump station.

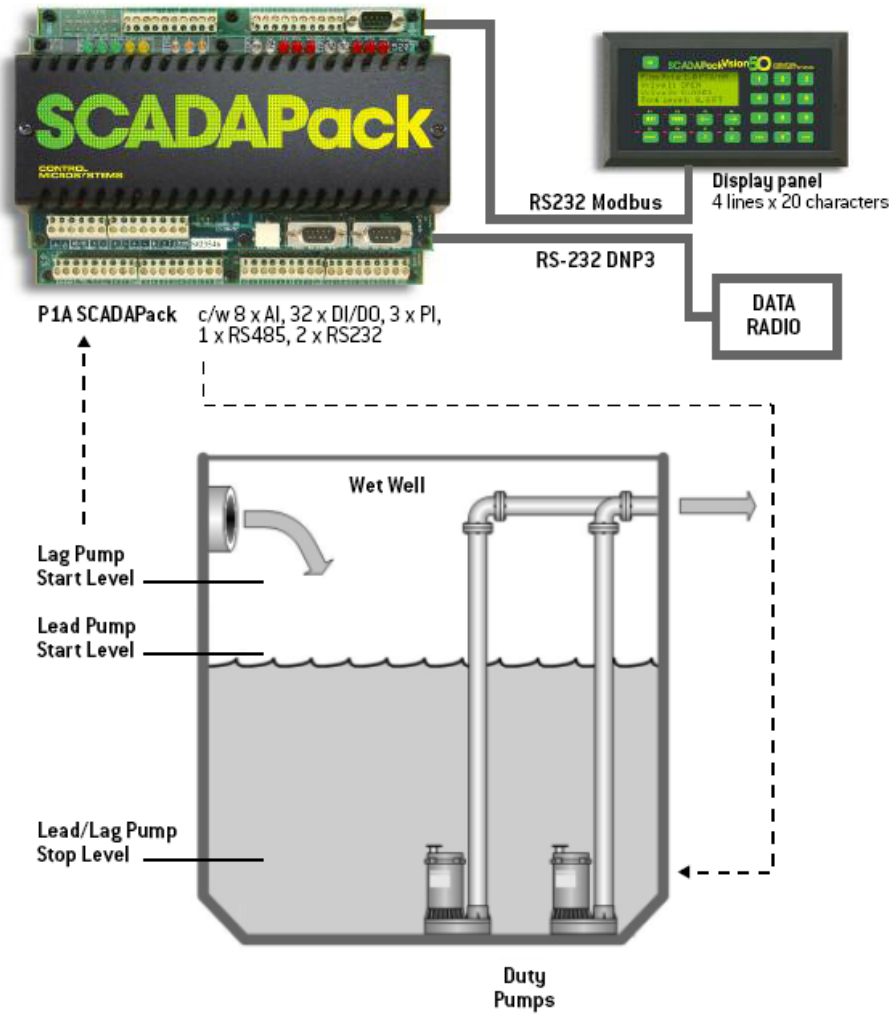


Figure 1: Remote wastewater pump stations must have reliable controls and communications. South East Water Company in Melbourne, Australia, uses SCADAPack controllers and wireless communications.

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, and using the transmit power more efficiently with high gain antennas, engineers can establish highly reliable RF point-to-multipoint links.

The City of Houston in the U.S. wanted to monitor flow rates and levels in its storm drain system, which protects downtown Houston from flooding. To avoid RF interference, Houston installed 900MHz frequency-shifting transmitters at the monitoring stations. These not only solved the interference problem, but the stations were able to communicate to the SCADA system despite large buildings, deep gullies and foliage.

Water plants that rely on dial-up phone modems have problems with both reliability and cost. It is very difficult to provide redundant phone systems, and the dedicated phone lines are expensive. The City of Ottawa, Canada, wanted to monitor 100 pump sites at its ROPEC wastewater facility, but didn't want to install any more phone lines. Instead, it uses SCADAPack controllers with redundant capabilities, and a wireless LAN. The higher cost of the wireless LAN equipment was quickly offset by eliminating ongoing phone line charges.

Adaptability: Wireless instrumentation networks are required to adapt to the existing environment. It is not practical to move a pump station, weir, lagoon, tank or separator just to create a reliable wireless link. 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.

For example, the Beypazari water system in Turkey (Figure 2) is spread out over 270 square miles of mountainous terrain. They had problems with the distant locations of their alarm systems, so maintenance staff had to visit each pumping station three times a day to check on system operation. Because of the high cliffs, a wireless system appeared to be impractical.

Bey pazari installed Control Microsystems SCADAPack controllers at each of the nine remote sites. Wireless radios at each site and two wireless data concentrators—one on a hill overlooking the town—transmit critical data to the central SCADA/HIM system. The communication network is a mixture of 2.4 GHz radio modems and conventional UHF radio and line modems that are ideally suited to the mountainous locale in which they operate.

Also, GSM (a digital mobile telephone standard) was implemented at the central location to provide Short Message Service (SMS) that sends alarms to operator cell phones.



Figure 2: Mountainous terrain is not the problem it once was for wireless. In Turkey, a combination of 2.4 GHz radio modems, conventional UHF radio, and GSM cellular let remote pumping stations communicate with the central SCADA system.

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

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.

The water distribution system in the town of Wise, Virginia, U.S., had the same problem as water plants do all over the world: An aging PC-based control system and unreliable dial-up phone lines. They wanted to upgrade their SCADA system and improve their ability to monitor remote stations.

They started by connecting wired SCADAPack controllers to an Iconics-based HMI in a single plant, and then added wireless controllers in the treatment plant and remote tanks and pumping stations (Figure 3). Then, they added data logging capabilities with SCADALog software from Control Microsystems. The system was installed and operational in three months.

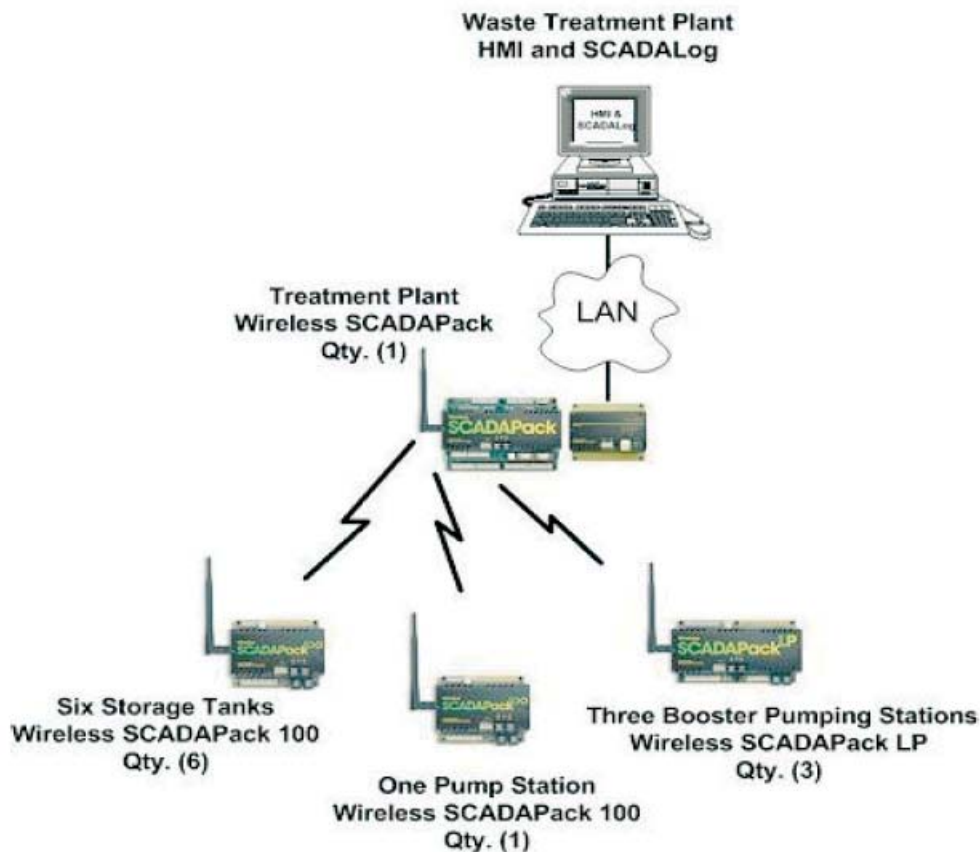


Figure 3: The wireless system in Wise, Virginia, brings data from remote locations to a central treatment plant, and then passes it via a wired connection to the main HMI/SCADA system.

(Note: Illustration at http://www.controlmicrosystems.com/media/page-body-files/application-notes/AN_16_Town_of_Wise_Water_System_V002.pdf)

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. This new generation of gateways integrates both a wireless instrumentation base radio and a long range industrial radio in the same device.

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 increase, 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.

About the Author

Hany Fouda is the VP of Marketing at Control Microsystems and is responsible for developing and executing global marketing strategies across the brand portfolio to further drive growth.