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Adam Feffer, PE, is with San Jose Water Company (www.sjwater.com), San Jose, Calif. Dave Baker is with Telog Instruments (www.telog.com), Victor, N.Y. Randy Moore; Travis Wagner, PE, and Brian Gresehover, PE, are with Pure Technologies (www.puretechltd.com), Columbia, Md.

Water and wastewater utilities are drawing on advances in distribution monitoring technologies to improve their distribution systems. Today's remote data monitoring tools efficiently and accurately collect pressure and other data, enabling faster response times. **BY ADAM FEFFER, PE; DAVE BAKER; RANDY MOORE; TRAVIS WAGNER, PE; AND BRIAN GRESEHOVER, PE**

REMOTE DATA

MONITORING IMPROVES DISTRIBUTION SYSTEM EFFICIENCY AND MAINTENANCE

YOU CAN'T MANAGE what you don't monitor, an adage first attributed to William Thomson, Lord Kelvin, applies to practically everything, including water distribution and wastewater collection networks. Water utilities do an excellent job of producing high-quality water at their plants, but they need to maintain quality throughout their distribution systems. Monitoring water distribution and wastewater collection system infrastructure traditionally has been difficult and expensive. Fortunately, technology is making it possible to economically and conveniently monitor remote water distribution and wastewater collection system assets. If you can monitor your system, you can better manage it.

Remote data monitoring systems typically use recording telemetry units (RTUs) that are deployed in the field and connected to various sensors; sensor controllers and/or transmitters; digital outputs of field assets such as water meters, flowmeters, and rain gauges; contact closures or relays that indicate alarm conditions or pump motor on–off activity; and Modbus communication outputs of other field devices. RTUs typically record and store data from the sensors or devices they're connected to on user-defined schedules. The RTU will then push the stored data to a central server using various communication techniques. Such converging technologies are providing utility operators the ability to visualize their systems 24/7.

PHOTOGRAPH AND FIGURES: TELOG INSTRUMENTS

RTUs can be attached to fire hydrants to monitor system pressures and trends as well as minimum, maximum, and average pressure history at any user interval. Data are internally recorded for many months and wirelessly transferred to a user's host computer on a schedule or in response to pressure faults or transients.

OPERATION AND BENEFITS

RTUs usually operate in a data-push mode, rather than the data-pull mode that supervisory control and data acquisition (SCADA) systems typically employ. By using the data-push methodology, the RTUs conserve battery power by keeping their communications systems powered down until it's necessary to push data stored in RTU on-board memory to a central server on a user-defined schedule or when an alarm condition is detected.

SCADA RTU communication systems are usually continuously powered so they can receive incoming calls or control commands from a central server. As a result, SCADA RTUs consume much more power than battery-powered remote data monitoring RTUs. Typical battery life for remote data monitoring RTUs now averages around 3–5 years.

Remote data monitoring systems usually don't provide any remote control to assets in the field; rather, they collect and transmit data from those assets to a central server where the data can be displayed, plotted, analyzed, exported, and shared. Such systems allow users to monitor a variety of system devices and parameters, including water and flowmeters, pressure-relief valves, hydrant pressure and water hammer, water quality indicators, reservoir levels, rainfall, mag meters, pump stations, and storage tank and aquifer levels.

Key benefits of a remote data monitoring system include the following:

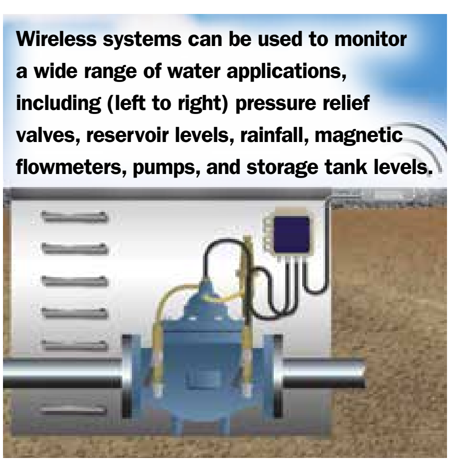
- Access to remote real-time and historical data.
- A common data platform for all parameters. All data reside in one common database, allowing users to easily analyze and compare different data.
- Alarm notification and management. Alarms can be sent as text messages to mobile devices or as email messages sent via the Web.
- Choice of communication technologies, including cellular, radio, satellite, landline telephone, or direct-connect Ethernet options.
- Choice of RTU power options, including battery, solar, alternating current, etc.
- System scalability.
- Automated operation. Data are collected, stored, and transmitted automatically, eliminating the need for field personnel to travel to remote sites to manually download and collect data.
- Open database for third-party sharing. Common database platforms allow users to easily share data from one data management system to another.
- Low procurement, installation, and lifetime operating cost of ownership. Typical remote monitoring system installations are one-third to one-fifth the cost of traditional SCADA RTU installations.

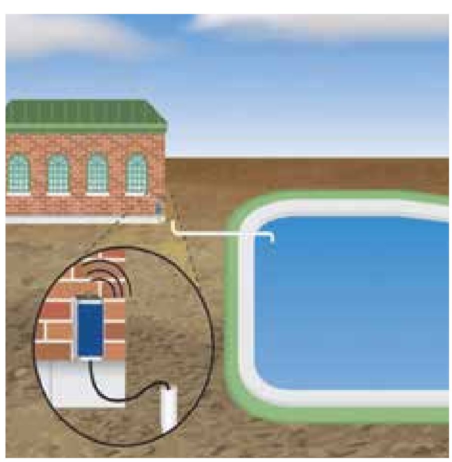
RTUs used in remote data monitoring systems are typically robust and dependable, as they're built for harsh environments. Nearly all systems have full alarm and alert capabilities, plus they allow utility personnel to be proactive rather than reactive to situations by allowing users to easily comprehend historical trend data and powerful analytics that can help foresee and predict operational anomalies, equipment degradation or malfunction, and other trouble spots that may be lurking within a water distribution system.

DATA TRANSMISSION

Of all of the data transmission methodologies available, cellular wireless technology is the most common form of remote communication. Cellular network coverage is vast, estimated to blanket nearly 100 percent of water distribution networks. Also, cellular data costs are low and continue to drop; data reliability via cellular transmission is excellent; low-power, low-cost cellular data modems have emerged; and network security exists at multiple levels.

Much can be done with RTU-collected data, including, but not limited to, displaying or printing in graphical or spreadsheet presentations; exporting in a variety of formats to third-party applications, e.g., SCADA, modeling, and asset management systems; processing by an analytics application to produce user alerts; and sharing via website access via the user's intranet or the Internet.





Wireless systems can be used to monitor a wide range of water applications, including (left to right) pressure relief valves, reservoir levels, rainfall, magnetic flowmeters, pumps, and storage tank levels.

Remote data monitoring systems are cost-effective and scalable, enhance existing SCADA systems, and save valuable time by allowing field personnel to concentrate on operation and maintenance activities instead of collecting data from remote monitoring sites.

DATA USE

In many organizations, data are some of the most prevalent and underused resources. For water and wastewater utilities, several existing data sources can be combined with distributed sensor technologies to provide a robust decision-support framework that will lead toward optimized distribution and collection systems.

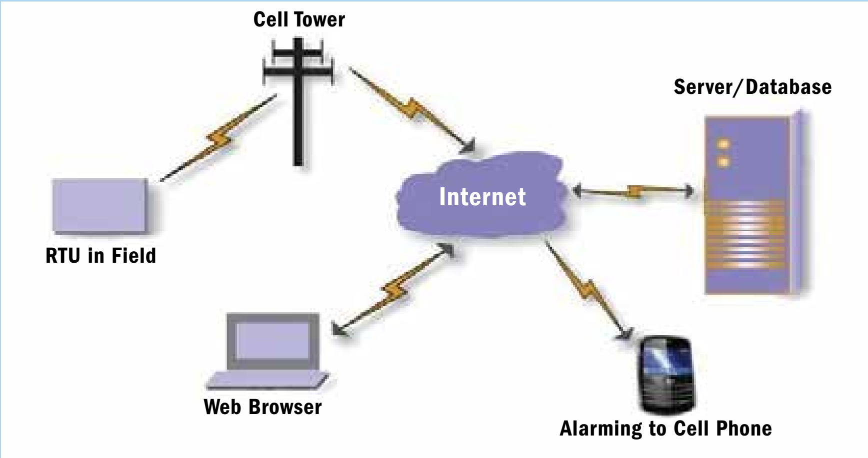
Examples of existing data sources include SCADA systems, customer billing records, pressure monitors and pressure-relief valves, maintenance and management records, energy use and billing records, water quality tests, and hydraulic models. Using even a few of these readily available data sources can provide a utility with the ability to compare expected versus actual system behavior, track efficiencies, and better focus resources where needed instead of where expected.

One example is to compare historical and current customer billing records with expected residential or commercial usage values on an ongoing basis. This process can be the first step in determining if meters have problems that create billing errors. Maintenance crews can then evaluate specific metering locations to test for hardware issues.

Utilities can also use existing pressure data from SCADA systems, hydraulic models, and other data sources to determine whether pressure-reduction strategies can potentially decrease leaks or breaks within a distribution system (see Monitoring for Pressure, page 14). Higher system pressures have a direct correlation to water main leaks and breaks. Pressure data can also be combined with energy use/billing records to determine if pump efficiencies can be improved, as many facilities have been found to operate outside of their optimal pressure and flow ranges because of various factors. Such an analysis has the potential to save utilities energy while extending pump life by operating as designed.

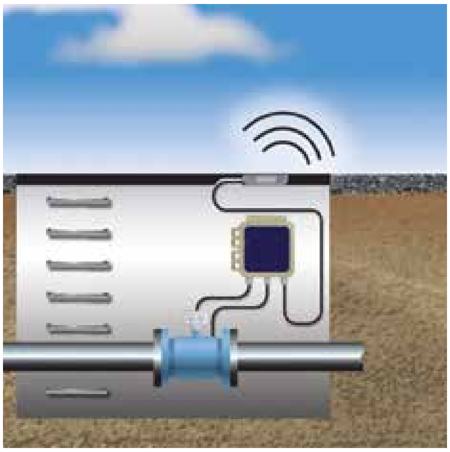
Cellular Wireless Technology

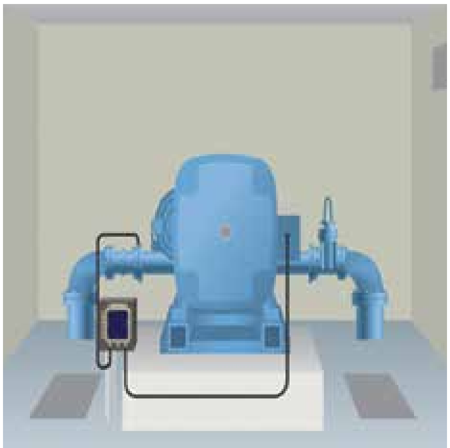
Cellular wireless technology is the most common form of remote communication, blanketing nearly 100 percent of water distribution networks.



TAKING ADVANTAGE OF ADVANCED SENSORS

Although existing data can provide a significant benefit through analytics, adding advanced sensors in the system will increase optimization potential even further. For example, transient pressure monitors at pumping facilities or at specific locations throughout the system allow for a more detailed understanding of system operation. Transient pressure monitors record and report pressure events at a much higher rate than typical hardware (sometimes more than 1,000 readings per second). This is important, because the pressure wave from





BEST PRACTICES

MONITORING FOR PRESSURE

Many utilities think of distributed wireless pressure monitoring as a luxury rather than a necessity. Here are three good reasons to monitor pressure in your distribution system:

1. It's the law (in California). California Public Utilities Commission (CPUC) General Order 103 specifies in its "minimum standards for design and construction" that distribution system pressures should be between 40 psi and 125 psi under normal conditions and between 30 psi and 150 psi under peak and minimum demand conditions. Survey reports submitted to the CPUC must contain at least 24 hours of continuous hourly data, and data must be collected from two representative points in each pressure zone.
2. It's recommended by AWWA. The AWWA Partnership for Safe Water Distribution System Optimization Program has identified three critical aspects of utility performance for utilities to be considered optimized: main break rate per hundred miles of pipe, disinfectant residual stability, and pressure monitoring.
3. Many opportunities for operational improvements emerge when continuous representative operational data are available. Such potential improvements include early notification for large leaks, detecting operational anomalies like large valves in the wrong position, better corroborating data for customer service when responding to low-pressure complaints, and potential energy savings by modifying set points to reduce pressure where possible.

Many utilities monitor for pressure in their distribution system. The problem is that constraints on monitoring installations have largely confined pressure data collection to facilities like tanks and pumps. Many utilities have pressure sensors at the base of tanks, but the closest service may be down a hill hundreds of feet below. Or they may monitor at the discharge of a booster pump when the closest service is in a pressure zone up a hill a mile away. Pressure data from these locations may be useful but not necessarily representative of what customers are receiving.

For optimized pressure monitoring, take data from "critical locations," or at least two sites per zone that represent a high and a low point that customers actually see. Think of these locations as the 90th and 10th percentile of customer pressures in a zone. Up until a few years ago, getting this type of data wasn't practical. Gaining access to a piece of property, then running power and communication lines to that property, was too complex and expensive to be worth it. However, with the advent of affordable cellular communication, new batteries powerful enough to last on-site for five years, and monitoring hardware small enough to sit in a small vault, distributed wireless pressure monitoring is now a feasible option for utilities everywhere.

For example, California's San Jose Water Company (SJWC) spent the last year conducting a pilot project from pressure monitoring. The pilot project was confined to 10 of SJWC's 97 distinct pressure zones. SJWC installed two sensors per zone and set up the sensors to take data every 15 min and transmit data every 24 hours. The data is also transmitted if pressure readings ever exceed onboard high and low thresholds.

SJWC targeted hydrant laterals for installation to minimize interference from customer usage and because most installations could be done in park strips, thereby avoiding traffic disruptions and repaving costs. The sensors installed are roughly 5-in. cubes and have capacity to measure pressure up to 300 psi. All installations were done with ¾-in. copper sensing lines and composite traffic-rated vault lids to improve wireless transmissions in and out of the vaults.

a transient event (water hammer) travels through a pipe at thousands of feet per second. By collecting and analyzing transient data, utility benefits can range from extending pipeline asset life to improving water quality.

Also becoming more prevalent within the industry is the use of temporary or permanent leak monitoring tools. Such tools help users identify high water loss areas within a distribution system and even alert utilities if a potential water main break has occurred. These sensors provide a better understanding of system "health" and greatly benefit a nonrevenue water program when properly implemented.

Another noteworthy advanced sensor application is water quality monitoring. Because regulations often increase the need to better understand water quality within a distribution system, continual improvements to sensor hardware may aid utilities in proactively operating and maintaining their systems.

Water utilities already have a lot of data that can be collected, analyzed, and used to make better decisions. However, many sensor advances allow utilities to cover a distribution system with "standard" as well as more advanced sensor technology. An integration and management strategy/system must be in place to handle and analyze such a massive amount of data, but investing in these services and hardware has helped utilities provide safer drinking water to their customers while optimizing system operation.

Remote data monitoring systems are cost-effective and scalable, enhance existing SCADA systems, and save valuable time by allowing field personnel to concentrate on operation and maintenance activities instead of collecting data from remote monitoring sites. Moreover, the data may be easily managed, analyzed, and presented, as numerous remote data monitoring system software packages are available.