7 Technological Advancements Shaping Water Operations

New technologies and challenges are pushing utilities to create smart networks.

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TRIMBLE

The water industry is on the cusp of a major transformation driven by a combination of industry needs and emerging technology. Challenges associated with aging infrastructure, budgetary constraints, weather and more are driving utilities to do more with less.

A key element in enabling a water utility to become more efficient is building an understanding of how the network is performing and the network assets' condition. Situational awareness through network monitoring is key to understanding how the network is operating, including problems and possible remedies.

Utilities have deployed supervisory control and data acquisition (SCADA) systems to monitor and remotely control network assets. However, SCADA systems are complex, expensive and require continuous power. Their deployment often has been limited to key plant locations such as treatment works, pump stations and reservoirs. This leaves a blind spot for utilities throughout the distribution and collection networks that can be filled with battery-powered remote monitoring for pressure, flow, level, pump runtimes and other parameters.

These can be cost-effective solutions; however, with current remote monitoring data loggers, there is a trade-off between battery life and reporting interval. The power requirements of current cellular technology means shorter interval reporting, causing more regular battery changes and, in turn, increasing the monitors' operating cost.

IoT Networks

The enabling technology for the emerging Internet of Things (IoT) is Low Power Wide Area Networks (LPWAN), which is a family of new communications technologies that allow devices to communicate small volumes of data over a long distance with low power. For this reason, they are perfect for battery-operated sensors because they facilitate small bursts of measurements sent frequently, while the low power profile ensures that sensors can retain a long battery life. This is a significant advantage over current cellular network technology for machine-to-machine communications.

Network technologies that fall under the LPWAN umbrella include LoRa and SigFox, both of which operate in unlicensed radio spectrum, and NB-IOT, which is a cellular technology that uses a small part of the current cellular spectrum.

Long Range Wide Area Network (LoRaWAN) is an LPWAN specification from the nonprofit IoT group LoRa Alliance for battery-operated devices that provides secure, bidirectional communications between remote sensors and centralized network servers.

LoRa has gained significant acceptance in the industry with multiple network providers offering public networks across North America, Europe and Asia. Availability of these public networks means that utilities do not need to operate their own networks and can use existing networks in a similar manner to current cellular service.

DEVELOPMENTS IN MONITORING TECHNOLOGY

Advancements in technology will enable a rapid change in how water utilities conduct their operations. These technology drivers include:

1. **IoT:** LPWAN technologies such as LoRa, SIGFOX and NB-IOT are being adopted with smart sensor solutions available for the water industry. These new smart sensors are much lower cost to deploy than sensors using cellular technology. Their battery life is much greater than cellular-based sensors and recorders, even with shorter reporting intervals, meaning that utilities can get near-real-time data while having much lower maintenance costs. With the lower cost to deploy and operate these sensors, utilities will deploy them on an unprecedented scale and gain a near-real-time view of network performance.
2. **Sensor technology:** Another key technology driver is in the area of sensors, where the cost is dropping and new types of sensors are being brought to market that enable monitoring of parameters such as water quality at line pressure. These new sensors enable a visibility of the network's state and quality not previously possible and ensures that the number of monitoring points and parameters at each point will increase dramatically.
3. **Network protocols:** New sensors and network technologies will introduce new protocols for integration of sensors to master stations. These protocols will reflect the needs of the emerging sensors, which will send very small bursts of data in short intervals and integrate data from third parties such as weather agencies. This does not mean that supervisory control and data acquisition (SCADA) will be replaced because current SCADA technology will remain and evolve, particularly for control of critical plant assets.
4. **Big data:** The scale of future water telemetry networks and volume of data captured will raise a challenge for the systems that must store, process and analyze this data in order to extract meaningful, actionable information. Storage and analysis tools collectively referred to as big data will be critical to distill the information from the sea of data. Elastic cloud-computing techniques will allow rapid execution of analysis functions on this data that would not be possible with current on-premise server technology.
5. **Real-time modeling:** Utilities have relied on hydraulic models to aid in planning and operational decisions. Availability of both near-real-time data from the network and powerful cloud-computing resources will allow near-real-time execution of such models to aid operations staff to predict and respond to unfolding events and take preventive actions.
6. **Domain-focused applications:** The degree to which the future water network will be monitored means that all stakeholders in the utility will need access to that information to aid them in their work. Information derived from telemetry will no longer be the preserve of an individual department, but rather each department (e.g. operations, engineering, customer service) will have focused, near-real-time decision support applications that allow them to take optimal and informed actions.
7. **Self-healing systems:** These mentioned trends will enable utilities to deploy systems that move from reactive monitoring to adding more real-time control and optimization at key points in the network. This will be similar to "self-healing" concepts in electric and communications networks, whereby the system can automatically predict events and take preemptive action—for example, automatic pumping to storage tanks during extreme rainfall.

In some regions, cellular operators are rolling out LoRa networks as an IoT specific complement to their cellular offering. Other cellular operators are pursuing NB-IOT, which has completed standardization and is intended to be the cellular solution for LPWAN requirements. These LPWAN networks will be the driver for more economic, near-real-time monitoring solutions, which will enable water utilities to execute on smart water strategies.

Adopting Technology

While the IoT's technology advancements may be revolutionary, its adoption in the water industry will be evolutionary and iterative.

Water utilities will initially focus on key assets in their distribution and collection systems such as pumping and lift stations. This allows visibility into the performance of these assets with a modest capital investment that can be retrofitted to existing equipment such as pumps, valves and meters, turning these into smart assets.

Near-real-time information on asset performance allows operational staff to make informed decisions about the current network state. For example, when a pump is deviating from its expected duty cycle, an alarm can be raised to a dispatcher. Adding other sensors such as a level monitor in the wet well can provide the dispatcher with more information to determine the best response.

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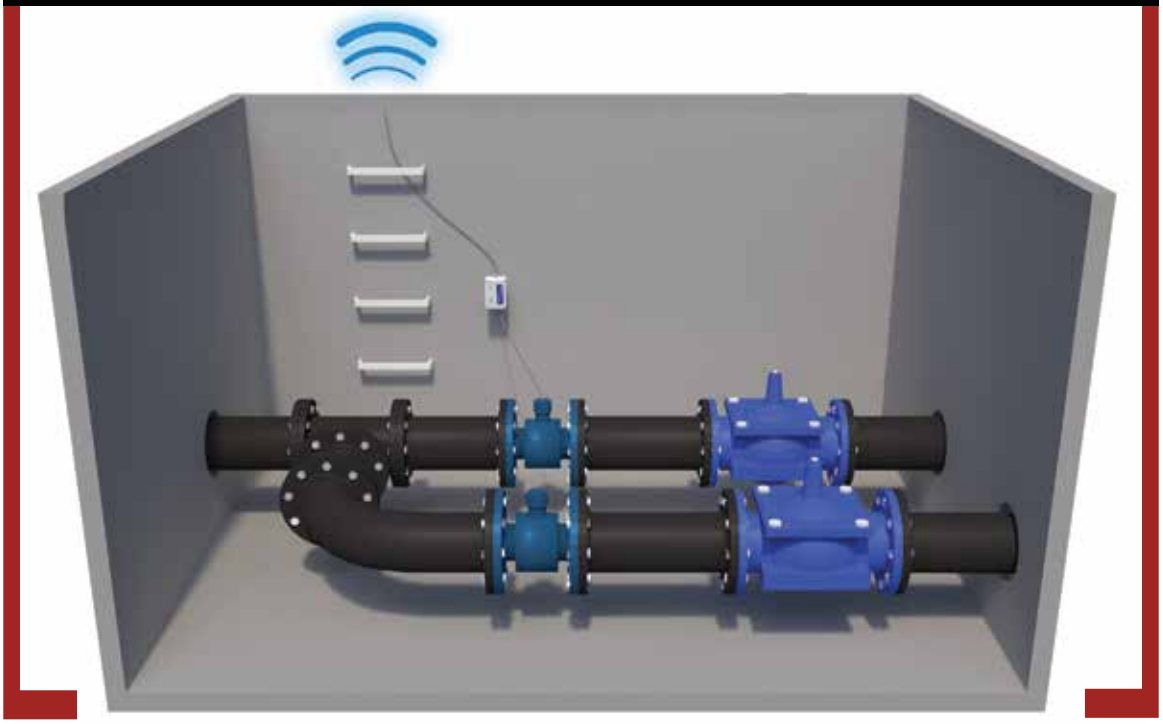
Figure 1. Wireless remote monitoring of a pump station with an IoT sensor *(Graphics courtesy of Trimble)*



As the work progresses to address the issue, near-real-time information allows both dispatch and field staff to understand the impact of the work and ensure that issues are resolved before staff leaves the remote site.

With the new generation of battery-operated IoT sensors, water utilities can readily incorporate monitoring throughout the network. The sensors' lower capital costs, coupled with the long battery life and low maintenance requirements, mean that the total cost of ownership (TCO) is much lower than previous solutions and enables utilities to roll out monitoring throughout their distribution and collection systems as part of a smart network strategy.

Cloud-based analytics operating on this monitored data can extract key information and performance indicators, turning raw data into actionable events. Sophisticated graphical and spatial visualizations ensure that personnel can quickly assess the situation and field staff have access to key performance data in the field.

Creating Smart Networks

Remote monitoring systems are a foundational element on a journey that many water utilities will undertake in the next decade. This journey starts with getting sufficient data to make optimal decisions. Making all machine data and other pertinent telemetry data available within a single platform is critical to the eventual realization of an optimized network.

This journey will follow a number of stages:

- Rolling out instrumentation through the network and gathering the data back to the cloud, where it can be stored and managed.
- Organizing data into reports, dashboards and visualizations, thereby understanding what is happening on the network and responding to alarms and other events.
- Optimizing operations that integrate network data into systems for better decision making.
- Adding analytics to understand correlations in data and develop models to predict what will happen on the network and react before it happens to optimize operations and significantly reduce operation cost.
- With the addition of machine learning and artificial intelligence, the operational decisions and changes required for the network's optimal operation at minimal cost will be advised by the system.

These developments represent an exciting time for the industry as it works to find creative and effective ways to implement new technologies to achieve much-needed changes and growth. ■

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