ADVANTECH

Enabling an Intelligent Planet

Technical Paper

Solving Communication and Connectivity Challenges for Water System Digitalization

Leveraging cellular technologies for secure, reliable monitoring and data acquisition to improve water quality and better manage water resources.

Introduction

In the United States, most water systems are decades old and these aging systems are starting to show wear and tear and contribute to growing expenses in terms of leaks, inefficient monitoring, unexpected downtime, and increased on-site personnel. Managing and controlling water networks is inherently challenging due to environmental factors, such as weather events and equipment located in remote, sometimes rugged, locations. Additionally, governing bodies must remain vigilant to meet state and federal requirements for water protection, treatment, quality, conservation, security and more, all while continuing to serve the needs of water users.

With growing Industrial Internet of Things (IIoT) technologies, sophisticated water system digitalization improvements are changing equipment and operation monitoring, control, and maintenance. IIoT technologies are becoming easier to deploy and implement for real-time data transmission and system-wide analysis. The growing benefits of digitalization mean system and operation upgrades are a high priority for municipalities and utilities.

Proprietary radio frequency (RF) networks and other meter advanced reading technologies (AMR) have not been delivering value and high return on investment as they once did. "Smart networks" designed with sustainable connectivity solutions, such as cellular (or LTE, "Long Term Evolution"), LoRaWAN, FirstNet-certified wireless broadband, etc., are yielding new ways to reduce costs and optimize operations. Cellular-enabled water meters, for example, offer advantages, such as identification and elimination of leaks and inefficiencies.

Overall, water operations utilizing these types of communication networks are seeing benefits in increased efficiency and revenue, reduced equipment downtime and maintenance, improved supply management, decreased

energy usage and more.

To reap the benefits of digital transformation, and capture and analyze real-time data in a cyber-secure environment, it is vital to implement dependable hardware and software solutions with a reliable communication network. Additionally, end-users must address various cost and technical requirements for specific water and wastewater applications, such as power, system longevity, scale, environment, storm mitigation, and security.

Cellular Networks for Future-Proofed Applications

Many industrial operations benefit from remote site information sent to local systems. For example, knowing if a remote pump is running at peak performance, if a tank is empty, or simply the temperature in a remote facility can either eliminate truck rolls for on-site personnel or trigger a workflow notification for necessary maintenance. Leading network solutions to acquire data from remote sites include the

following:

- Creating a connection, either wired or wireless, between locations with fiber, copper, or specialized wireless solutions;
- "Leasing" a connection using a dedicated leased line from a Telco carrier, who likely has some wired infrastructure already in place; or
- Creating an IoT solution to publish data from a remote location utilizing IoT hardware, such as I/O devices that support almost any number and type of inputs or LTE-enabled gateways to use cellular networks

Modern cellular networks allow for broad reach, are available in nearly every populous area, and provide effective two-way remote communications. Additionally, cellular networks can improve applications already utilizing newer technology. For example, water systems where utilities collect readings from low-power RF emitters at a meter still require on-site personnel—technicians still have to go physically to each meter.

LTE networks allow municipalities and technicians to procure meter readings remotely, more frequently, and at a lower cost. Cellular deployments also eliminate the need to own and maintain a communications infrastructure because LTE offers proven, secure, future-proof, and omnipresent networking.

Previous concerns of the longevity of cellular networks are fading. Major telecoms continue focusing on the industrial market and municipalities as the next frontier of growth for communication infrastructure. With billions of dollars of revenue at stake, cellular carriers make longevity a main point of progression.

To deploy LTE technology effectively, end-users need hardware that is carrier-agile, cost-competitive, and with flexible configuration interfaces to fit M2M (machine-to-machine) applications. Carriers continue to invest and rapidly build out LTE infrastructure for long-lasting connectivity, which is ideal for remote monitoring.

Types of Cellular Networks

- **LPWA** = Low Power Wide Area
  - Unlicensed LPWA includes LoRa and Sigfox
- **5G** = Defined by 3GPP (cellular standards body)
  - Includes LTE M and NB-IoT
- **NB-IoT** = Narrow Band IoT
- **Cat-M** = Category M LTE
- **LoRa** = Developed and licensed by private companies; multiple versions
  - Not 5G

When selecting connectivity options, the potential application will drive specific needs. Many digital transformation challenges revolve around implementing appropriate solutions efficiently, rather than implementing technologies just because they are new. For instance, growing 5G technologies are best for the following use case scenarios:

- Critical communications: 5G is ultra-reliable with low latency
- Massive IoT/LPWA: 5G offers reliable coverage that is low power with high connection density
- Enhanced mobile broadband: 5G can provide a better experience for human-centric applications

Use Case: Reverse Osmosis Modernization

Reverse osmosis uses pressure to separate dissolved salts and other ions from water. As pressurized water moves through a semi-permeable membrane, it allows water molecules to pass, but discards dissolved salts and other ions. Recently, a water utility department in the coastal south United States needed to modernize and migrate its reverse osmosis system. The customer was migrating its software from Rockwell Automation FactoryTalk to Inductive Automation Ignition, and required LTE-enabled gateways to send telemetry data through a cellular LoRAWAN networks.

Ignition is an industrial application platform with tools for building human-machine interface (HMI), supervisory control, and data acquisition solutions. Ignition empowers users to connect data, develop automation systems, scale systems, and more.

The utility customer uses reverse-osmosis to produce water for municipality residents—who use approximately 11 million potable gallons every day—which is less expensive than buying from local distributors. To upgrade hardware and easily migrate to Ignition, Advantech supplied industrial-grade panel PCs that were Ignition compatible, cost-effective, and with larger panels than the old equipment.

The Advantech PPC-3211SW is an all-in-one light panel PC with a wide format, 21.5-inch industrial-grade LCD. With a high durability design, the PPC-3211SW has a true-flat touchscreen with an IP65-rated front panel and die cast aluminum alloy enclosure, making it ideal for water system operations.

For utilizing cellular networks, the utility also implemented Advantech's ICR-3241W, LTE Cat.4 VPN gateways. The ICR-3241W is ideal for connecting IP or serial devices to cellular networks. With LTE Cat.4 upload speeds of up to

50 Mbps and download speeds of up to 150 Mbps, the ICR-3241W router provides ample bandwidth for high-data and critical applications.

Municipalities Embracing Digital Transformation for Water Management

The same water utility customer continues to add IoT technologies for real-time monitoring and management in additional applications. Water technicians found it challenging to complete on-site tank monitoring with existing panel PCs.

With outdoor tank locations, all panel PCs, sensors, and associated monitoring equipment are also outdoors. Not only must the equipment be able to function in rugged, open-air environments, technicians were having trouble viewing existing panel screens due to high sunlight.

Advantech's sunlight readable panel PCs displays are optically bonded with material that fills the gap between the glass cover and the LCD panel, providing a reflection rate of <0.2%. The Advantech TPC-1251T has an industrial 12.1-inch XGA TFT LCD display providing intensity and brilliance for outdoor application requirements.

With the modernized thin client panel PCs, technicians are able to check metrics more quickly, but the second part of the solution involves remote monitoring data for critical errors.

Technicians cannot be on-site at field tanks 24/7, so a system of real-time monitoring and alerts also is key. For remote location data, cellular-enabled IoT gateways were also included. Similar to other applications, the customer implemented the ICR-3241W LTE Cat.4 VPN gateway at tank locations. A specific feature of the ICR-3241W makes it ideal for critical communications – FirstNet-certified connectivity.

FirstNet, built by AT&T, is the first high-speed nationwide wireless broadband network dedicated to public safety. Only FirstNet-certified devices may access the network, making it highly secure and less prone to network congestion.

The inter-operable communications platform allows utilities to receive information and condition alerts more quickly. They are able to work faster and in turn, are better equipped to make improved working decisions.

Upgrading Water Lift and Pump Stations

Managing and monitoring lift/pump and water treatment systems remotely, in real-time, is crucial to optimizing and protecting water supplies. Lift stations are a critical piece of wastewater treatment infrastructure, and effectively transport sewage over uneven terrain to primary treatment plants. Pumping installations normally consist of one to three pumps and its associated control

TPC-1251T LCD Thin Client Terminal

- Industrial 12.1" XGA TFT LCD display
- Intel® Atom™ processor
- 5-wire resistive touch screen
- IP66-rated, true-flat design

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panels. Lift stations include a storage tank along with floats or sensors for controlling the pumps and maintaining safe levels of storm water or sewage. Any failure of these components means undesirable consequences, such as low water pressure in hydrants or hazardous sewer backups.

Lift station remote locations make real-time management and monitoring a challenge. Data from condition-based monitoring and analysis offers customization for specific local level applications. With Advantech's powerful and cost-effective IIoT edge gateways—including machine-learning algorithms—end users can enable efficient management of remote lift stations.

In addition to liquid levels and pump status, systems with industrial sensors can monitor additional parameters, including pH levels, flow, and more. Maintenance personnel now have the ability to remotely update, troubleshoot, and capture diagnostics from intelligent station controls without setting foot in field locations. Cloud-based services that manage the connectivity also reduce the need for expensive infrastructure for integration into existing networks.

The Advantech ADAM-6700 series offers compact, intelligent gateways capable of performing multiple tasks at the edge for integrated water systems. Unlike competitors, the ADAM-6700 series is equipped with a range of I/O for comprehensive data acquisition functionality and built-in Node-RED programming. Implementing the ADAM-6700 is also non-invasive and stress-free. For example, to monitor pump electricity currents, end users can clamp current sensors to pump power wires after installing an Advantech gateway and the ADAM series module. Utilities can then measure the current each pump is drawing in real time.

ADAM-6717
Intelligent I/O Gateway

- Linux Open Platform
- 8ch analog input (current or voltage) / 5ch digital input / 4ch digital output
- Program by Linux C API, Node-RED
- Cloud/Database access, edge data analysis and logic control, data visualization dashboard

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Need to add Wi-Fi or LTE?

ADAM-6700E USB to MiniPCIe Adaptor

- Wall-mount and DIN-rail
- Connects to ADAM-6700 series via USB cable

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Conclusion

Modern data acquisition and remote monitoring and control solutions via LTE networks are bringing water systems, treatment plants, and more into the age of IIoT. The Internet of Things allows municipalities to access and connect to various control systems, sensors, and—ultimately—real-time data, anytime and anywhere.

The capacity to monitor water parameters continuously, or semi-continuously, offers exciting possibilities to engineers, technicians, and administrators needing to improve water resource management. Water/wastewater plants and systems should have regular equipment and performance evaluations to ensure operating facilities and systems are running well.

Outdated, inefficient equipment or non-user-friendly systems result in high labor, high operating costs, and negatively water quality operations. Leveraging technology for real-time data and maximizing that information by applying big data analysis principles is the digital water system of the future.

Further Reading + Watching

- **VIDEO: What you need to know about digital water**
- **VIDEO: Emerging Trends for Water Pump Stations & Control**
- **Solution: How industrial devices keep water flowing in seaside water district**
- **Solution: Cloud-enabled remote equipment monitoring for water management**

For more information on water/wastewater solutions, contact our team at ANA.Water@advantech.com.

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