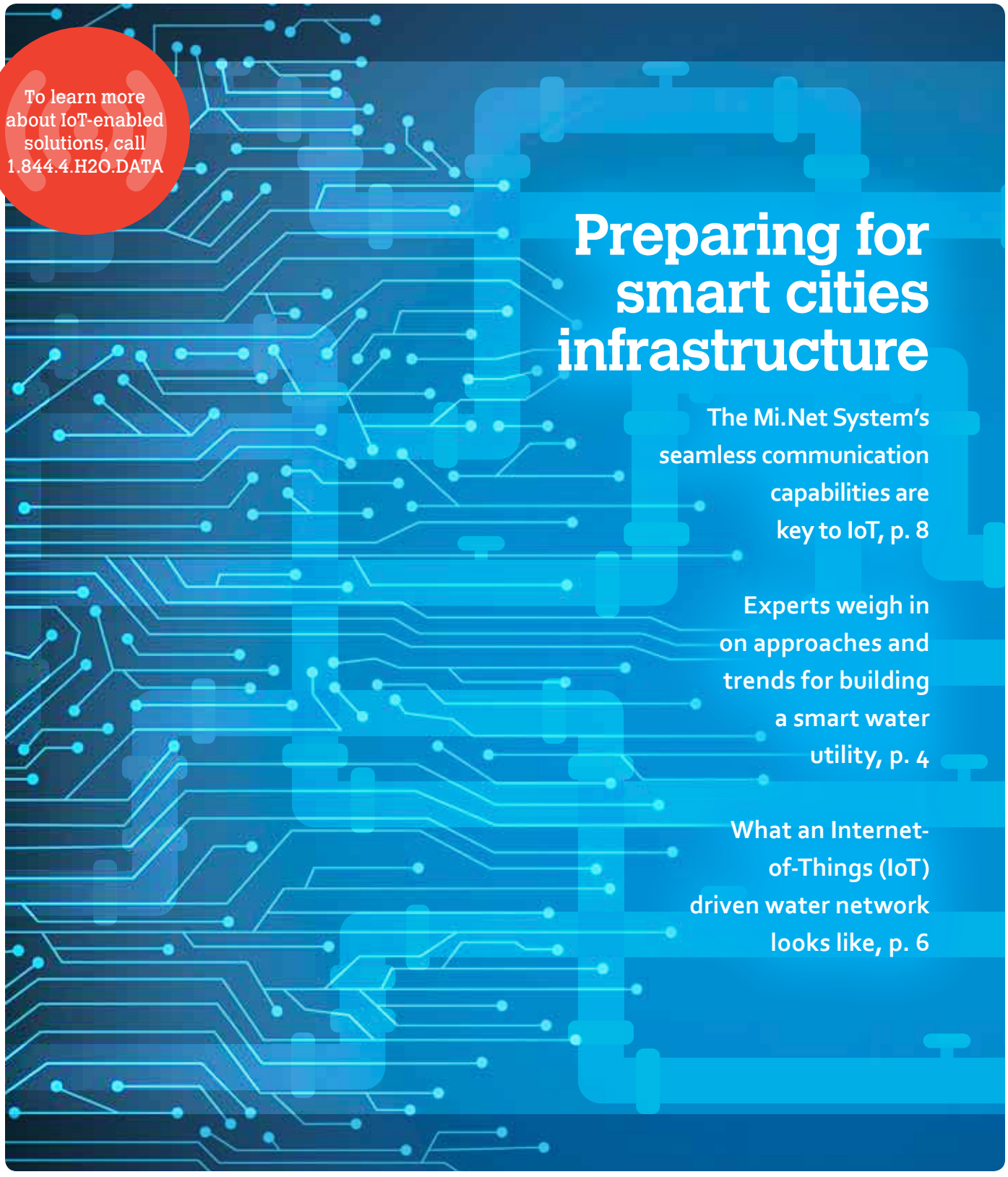
smartwater HANDBOOK

HELPING UTILITIES IMPLEMENT IoT-ENABLED TECHNOLOGIES THAT PROVIDE ACTIONABLE DATA



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Preparing for smart cities infrastructure

Increasing Efficiencies With Data-Driven Solutions

Aging water infrastructure has become a reality for many utilities, bringing additional challenges to those already facing water loss issues, scarce funding, an aging workforce and more. In other industries, "smart" Internet of Things (IoT) technologies are being utilized to streamline processes and increase efficiencies with great success. Such technologies are now becoming available for water utilities.

Smart utilities manage their assets through the use of automated devices that enable the collection and analysis of data on usage, flow rates, conditions and more. This enables them to take intelligent action that can reduce costs and ultimately deliver the best service to their customers.

This publication, the Smart Water Handbook, is brought to you by Mueller Water Products, a single-source supplier for utilities bringing leading technologies to the industry on AMI, leak detection, remote shutoff, automated flushing, pressure management and more. Thanks to our partners and industry experts who shared their thoughts and insights on the following pages, we've defined what a smart water utility is and how smart technologies solve common challenges, as well as how utilities of any size can start implementing IoT technologies.

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A PUBLICATION OF MUELLER WATER PRODUCTS

In This Issue

Mueller Water Products

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How IoT and Data Are Helping Utilities

IoT, or "Internet of Things," is a nexus of technologies incorporating sensor-based data gathering and next-generation networking. The smart technology platform harnesses this IoT networking through the deployment of smart devices using advanced wireless technologies for remote monitoring and management of water networks. This allows utilities to tackle problems facing the industry today, such as an aging workforce and the need for real-time water quality monitoring. Below are five common challenges utilities face that can be addressed with data-driven solutions.

Challenge	Data-Driven Solutions
Aging Infrastructure	Traditionally, utilities replaced parts of their water mains or distribution networks without having access to information about the condition of the pipes. In many cases, entire lengths of pipe were in good condition, with only parts of them needing immediate replacement. Gathering actionable data about the water network enables utilities to decide on rehabilitation schedules and the methods used, with focus on intelligent capital and operational expense planning and controls.
Aging/Retiring Workforce	With the average age of water utility operators currently standing at 55, water utilities face the retirement of a large portion of their workforce in the next 10 to 15 years. Along with the loss of skilled personnel will come the loss of system knowledge accumulated over their careers. IoT technologies will play a critical role in helping to avert this, through the capture, centralization and sharing of data that secure collective utility expertise for future generations of water network operators.
Non-Revenue Water Management & Leak Detection	Pressure is put on utilities to reduce water losses from both an environmental and financial standpoint. Robust, simple leak detectors and algorithms enable utilities to differentiate between abnormal consumption (e.g., a running tap or a home pipe break) and leak events in the network. This capability can help prioritize repair needs based on the severity and location of the leak.
Real-Time, Online Water Quality Monitoring	The advancements in online water quality sensors make it possible to monitor chlorine levels, pH and temperature in real time. Integrating such functionality with consumption and use-pattern data enables utilities to improve the operation of the water distribution system, as well as the service offered to their customers.
Interoperability of Smart Network Devices	Meters, sensors, leak detection and communication protocols are often installed from multiple vendors within one distribution network, as utilities are typically reluctant to rely on a single vendor. Solutions such as the LoRa communications platform and device-agnostic data analytics facilitate the integration of existing databases and smart networks with new solutions.

INTERVIEWS AND DATA PROVIDED BY BLUETECH RESEARCH

Industry Leaders Offer Insight on Smart Water Distribution Systems

Don Shields, P.E.
Vice President & Director of Engineering, New Jersey American Water

Is there a common industry definition of a smart water utility?
A smart water utility effectively manages its water resources and efficiently uses them to best deliver on both cost and quality to customers. It also collects and uses data efficiently to make informed decisions, ensuring sustainability of its system. This definition has remained consistent throughout the industry; however, it is evolving with time.

What is an example of how American Water is collecting and using data to optimize operations?
American Water effectively monitors its system to collect and gather information to determine water quality, and for asset management purposes where key aspects of the distribution systems are monitored (e.g., pressure, flow and leaks).

While most of the data, such as pressure and flow, is collected at short intervals (5 to 15 minutes), leak detection is one area in particular where American Water feels data gathered at 24-hour intervals is sufficient for operators to identify leaks for the intervention teams to manage the issue.

Michael Wolan
Senior Engineering Manager, New Jersey American Water

What is required to increase adoption of smart water technologies?
Currently, there is a range of technologies available in the market; however, to increase adoption, we need to ensure the various systems are interoperable. There are currently a number of data collection systems in the market that work well independently. If these systems do indeed have synergies, this could open up opportunities for integration with each other, and utilities can use this data to track their systems in real time.

Michael Toh
Director, Water Supply (Network) Department, PUB, Singapore's National Water Agency

Describe what smart water distribution looks like to you.
A smart water grid system integrates information and communications technologies (ICT) into the management of the water distribution system. Sensors, meters, digital controls and analytics are used to automate, monitor and control the transmission and distribution of water, ensuring that it is efficiently delivered only when and where it is needed, and with good quality.

The advances in ICT enable us to capture and store enormous pools of data, and to perform powerful analytics and predictive analysis to contribute toward greater efficiency and effectiveness in our water resource management. As our population continues to grow, our water infrastructure must be ready to meet an increasing demand while maintaining good asset condition. There is an increasing need to leverage these innovative technologies in order to ensure our water infrastructure is sustainable and resilient.

What is an example of how PUB is collecting and using data in real time to optimize operations?
Presently, many of our operational processes, such as water leakage checks, quality checks and meter readings, are still done manually. Against the backdrop of a shrinking and increasingly educated labor force, the implementation of the smart water grid also helps us streamline our manpower requirements and redesign our work processes by automating daily tasks.

New ICT solutions are evolving based on utility needs. As an example, we face a challenge in gathering data on our pipelines that have a deep bury depth, are lined, have undulating profiles and are difficult to access due to urban build-out. This makes it difficult to implement condition assessment technologies on a large scale. However, once these challenges are surmounted, this data can be uploaded into an asset management program to improve the identification of high-risk pipelines and prioritize renewal works.

To read the full executive briefings, visit www.smartwaterbook.com

Booky Oren
Chairman and CEO, Booky Oren Global Water Technologies

Can you provide an example of how water utilities are effectively collecting and using data?
There are many with whom I am familiar, but no one utility has the perfect answer, so smart water systems continue to be an evolving "process." Even a highly advanced water utility continues to put a lot of effort into improving the way it is monitoring the system.

Another dimension to this question is why a utility needs a smart water system in the first place. Historically, water was managed based on assumption of use, and this is acceptable without any budget constraint and regulations. However, budget constraints and regulations are a reality. We are thus moving away from an era in which we manage our infrastructure by assumption, to an era based on data and prioritization. The data obtained through smart water systems gives us the ability to prioritize, to improve efficiency and to give better service to our clients by reducing operational expense and preventing the need for an increase in water tariffs.

Which regions in the world would you say are more progressive in terms of building smart distribution systems?
The most progressive would be North America due to their wide adoption of AMR/AMI solutions—the basic platform for data is thus already there and one can simply change from AMR to AMI. There is also a lot of motivation from the EPA in the U.S., which incentivizes adoption of smart distribution systems. Furthermore, the largest market for smart distribution systems is also in the U.S. with its 350 million people. There might be a big market for these systems in China or another location in the future, but the U.S. is still the most advanced market in the world and thus companies approach this market first.

Marc Bracken, P.E.
Vice President & General Manager, Echologics

Do the core technologies required to build a smart water distribution system exist today?
Five years ago, the technology did not exist. The industry required low-power electronics with high onboard memory and industrial IoT communication technologies. We started using mesh network radio and achieved an 85% communication efficiency, but there was still room for improvement. Last year, many technologies came to the market, an example being LoRa from Semtech—a long-range, low-power application that has plenty of bandwidth and can send data up to 5 miles on a public network. Previously, we were only getting around a 1,500-foot range from spread-spectrum radios. Sending data on a public network, rather than a proprietary communication network, prevents utilities [from] having to be stuck with one technology supplier and thus pushes suppliers to stay on the cutting edge to retain a utility. The cost of using these open communication networks will also go down as more companies use it; for example, smart waste collection where similar technology indicates when garbage bins are ready to be emptied.

A utility is thus waiting for technology that proves it can solve issues. If smart water technologies can, for example, avoid false positives in leak detection and thus prevent money being spent on checking these, the adoption of such technologies will increase.

Why should utilities invest in "outside the plant gate" data acquisition?
Traditional SCADA monitoring capabilities within a treatment plant almost disappear as soon as the water leaves it, leaving most utilities operating with little to no information about the water moving through their distribution system. IoT-based solutions enable utilities to more efficiently manage operations and optimize capital investments. Having the ability to be proactive versus reactive is the key difference between smart technology and a traditional approach.

INTERVIEWS AND DATA PROVIDED BY BLUETECH RESEARCH

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IoT-Driven Water Networks

Visibility, Control and Optimization of Utility Operations

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Disinfectant Residuals
- Maintain consistent water quality
- Reduce customer complaints
- Comply with U.S. EPA requirements
- Lower operational costs

Temperature
- Preserve dissolved oxygen
- Maintain water quality
- Improve public health

Pressure
- Reduce non-revenue water
- Minimize water main breaks
- Better manage pumps to reduce energy needs

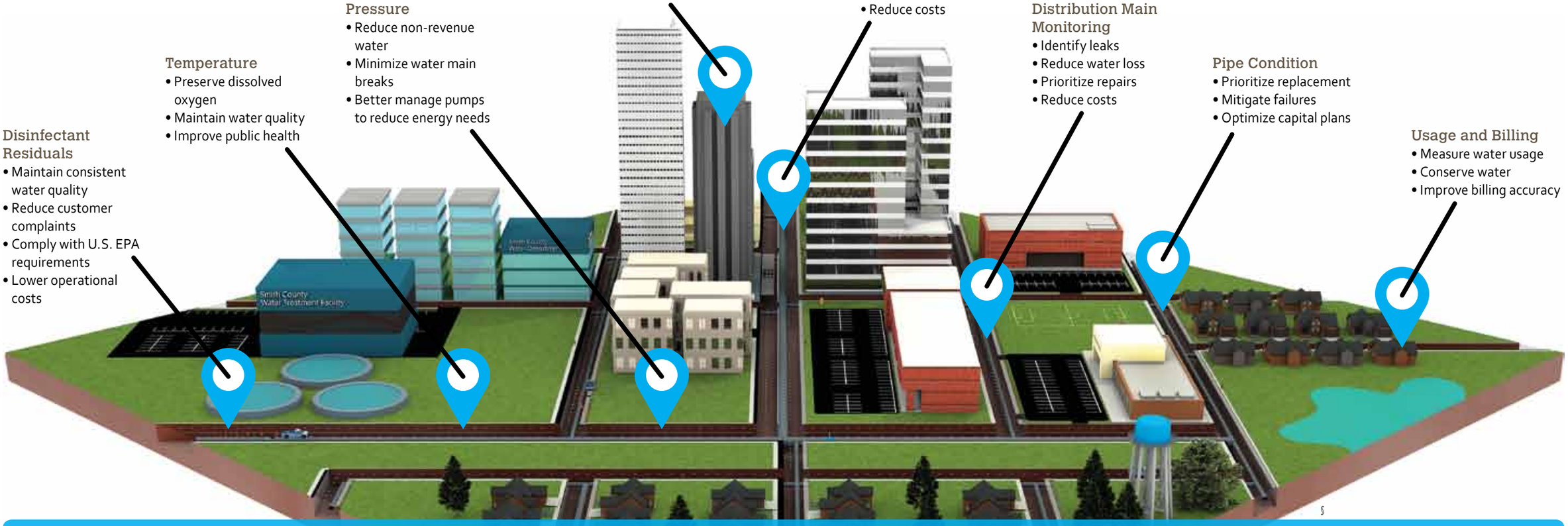
Remote Meter Disconnect
- Minimize crew dispatches
- Manage delinquent accounts
- Property damage avoidance
- Seasonal water disconnects

Transmission Main Monitoring
- Identify leaks
- Mitigate failures
- Proactive repairs
- Reduce costs

Distribution Main Monitoring
- Identify leaks
- Reduce water loss
- Prioritize repairs
- Reduce costs

Pipe Condition
- Prioritize replacement
- Mitigate failures
- Optimize capital plans

Usage and Billing
- Measure water usage
- Conserve water
- Improve billing accuracy



Flexible Backhaul Approaches

Mueller Water Products' companies offer flexible backhaul options for utilities, giving them the opportunity to migrate their data as they grow into full IoT-enabled smart cities. In several cases, this flexibility allows water utilities to implement new technology at their own pace, enabling them to expand over time. Mueller's offerings can transmit and collect data via a radio, cellular or the LoRa-based Mi.Net® network. By offering these backhaul options, Mueller is able to accommodate utilities of all sizes at any point in their transition to smart cities technologies.

Radio Frequency

Radio frequency (RF) is the most basic of the backhaul options, ideal for smaller utilities with fewer end points and less extensive networks. Data travels from one point to another via the RF spectrum, and the data is secure.

Cellular

For utilities interested in implementing IoT-based leak detection and pressure management solutions, cellular backhaul is a good option. As specific telecom carriers host cellular networks, there is no need for a utility to create its own fixed radio network. This enables utilities to quickly deploy technologies into the water network.

LoRa

Utilities seeking an option with the most IoT capabilities should examine migrating to a LoRa-based network. Short for "low power, long range," LoRa is an RF modulation technique that offers high-power transmissions and increased range over traditional systems. This option reduces the noise that can cause interference in basic RF transmissions, allowing for longer-range data retrieval. LoRa is an open-systems, interoperable network, which allows utilities to connect to any IoT-enabled devices.

Mi.Net® System Prepares Utilities for Full Smart Cities Infrastructure

Regardless of size, utilities all face similar challenges, with time, money and manpower often in short supply. Fortunately, new-generation technologies that allow for seamless communication between devices are making it easier for utility workers to collect data in near-real time without leaving their offices. This enhanced Internet of Things (IoT) technology approach helps provide a comprehensive overview of an entire water distribution system by allowing multiple devices to work in tandem, collecting actionable data to help proactively address concerns.

Complete Data Solution

For more than 150 years, Mueller Systems, LLC and its affiliates have been providing water infrastructure solutions, including metering, to water utilities. The Mi.Net system is a LoRa-based network technology that allows long-range, fully two-way communications for smart cities applications. Utilities can gather hourly usage data from every meter in the network. The system includes Mueller Systems' 420 RDM (Remote Disconnect Meters) and integrates seamlessly with the EchoShore®-DX leak detection platform; it also can be combined with other IoT devices as needed by the utility.

Data from equipment installed throughout the distribution system communicates across the Mi.Net network and can alert a utility of leaks, bursts, or other emergent conditions. With all this data at its fingertips, the utility is able to be proactive, instead of reactive. As an example, the ability to direct time and resources to the location of the leak is crucial. Instead of waiting to see a leak or for a customer to complain about a large bill, utilities are notified of leaks sooner rather than later and can take action immediately.

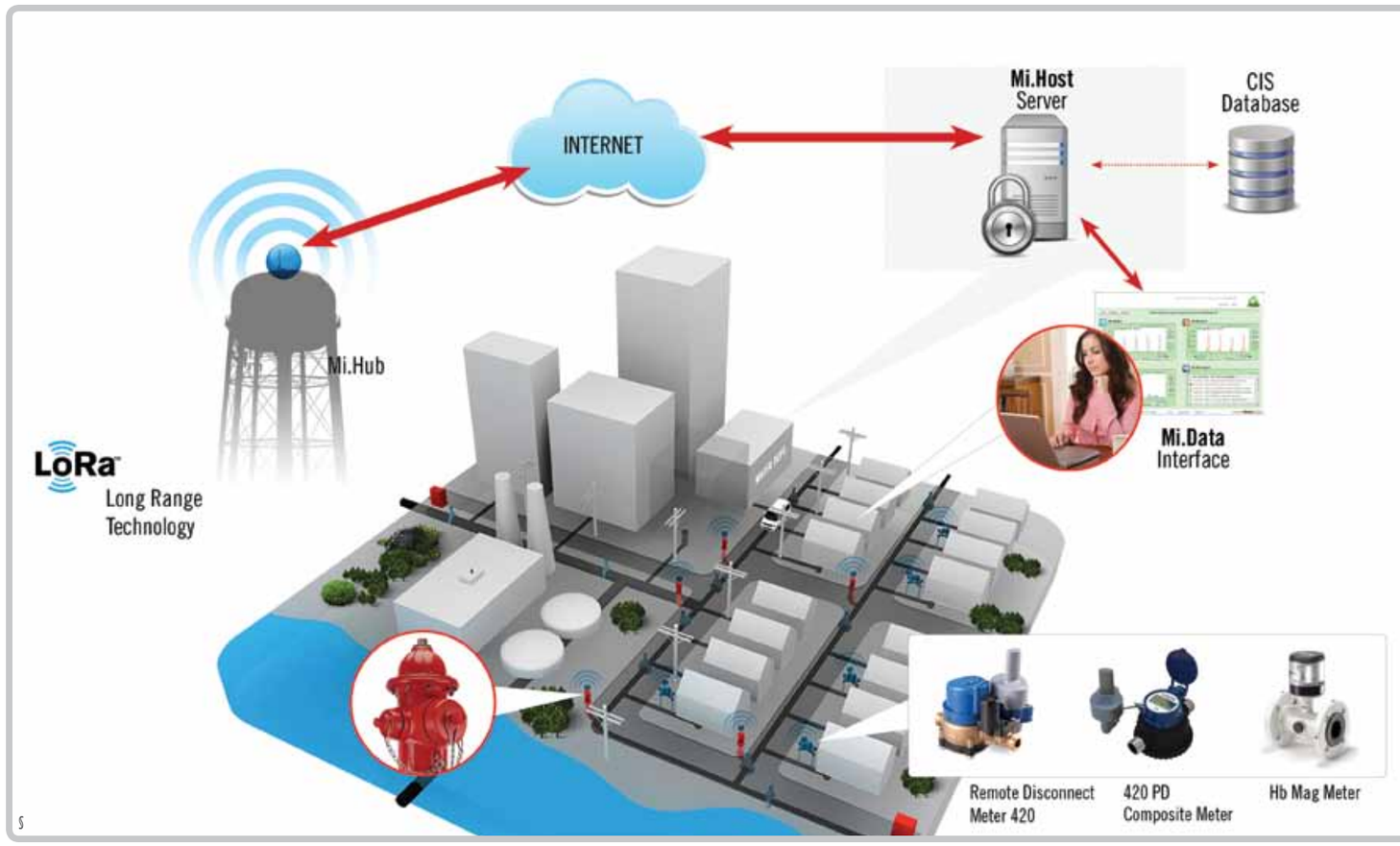
IoT-Ready

The unique differentiator of the Mi.Net system is its ability to enable IoT smart cities infrastructure. While traditional AMI networks are closed systems on proprietary networks that only allow communication between certain types or brands of equipment, the LoRa platform is an open architecture standard designed specifically for IoT applications. On this network, a utility can install any IoT device regardless of manufacturer or equipment type. This open network operates seamlessly on the open ISM band. IoT systems require open standards and open, unlicensed frequencies.

Implementing the Technology

Utilities have a number of options for implementation. Most utilities desire a full change out of devices, but switching out thousands or even tens of thousands of meters at one time can be a challenge. The Mi.Net system's network gives a utility the option to begin with a mobile system and eventually upgrade to a fixed network. Utilities can also choose which meters to connect to the network based on population or location. When fully implemented, the utility receives the full impact of the system.

The Mi.Net system is ideal for utilities of any size. Whether connecting a network of 1,000 meters or 500,000 meters, the result is the same: an IoT-based data solution that helps make a utility smarter.



What is LoRa?

The Mi.Net system employs LoRa technology. LoRa, short for "low power, long range," is an RF modulation technique that offers high-power transmissions and increased range over traditional systems with lower battery usage. The technology offers a meter reading distance of beyond 2 miles, with a battery life of greater than 20 years. The secret behind this technology is a modulation scheme that reduces the RF noise that is inherent in any radio environment. By eliminating the noise, the reading distance increases, offering enhanced performance. Additionally, LoRa is an open-systems, interoperable network, which means utilities can connect to any IoT-enabled equipment regardless of manufacturer.

Flexibility to Use Best-in-Class Technologies

The Mi.Net technology enables more than just remote meter reading. When matched with the capabilities of the 420 RDM and paired with the EchoShore-DX leak detection platform, it provides a full leak detection solution. When the EchoShore-DX acoustical technology detects a leak in a distribution system, the data generated is sent through the system and flagged. The acoustic units are then able to correlate the data to determine the location of the leak. Once the leak is confirmed, service can be shut off via the 420 Remote Disconnect Meter. This actionable data is vital in mitigating water loss in a distribution system, leading to cost savings for both the utility and the customer.

EchoShore®-DX Technology Automates Leak Detection for Smart Utilities

The automation of data collection and reporting is a key component to developing smart cities. Monitoring smart water infrastructure gives utilities the ability to not only identify leaking pipes before they cause issues, but also create significant operational efficiencies through optimized capital investments. Through early detection of leaks, utilities can better manage their water main assets and help avoid catastrophic consequences.

Continuous Remote Monitoring

The EchoShore-DX leak detection platform from Echologics provides daily monitoring of a water distribution system. It looks for existing or emerging leaks using acoustical sensor nodes that are fitted onto a standard fire hydrant pumper nozzle cap. The nodes are intelligent with the ability to discern the presence of small leaks in their zones of deployment. They can also communicate with each other, as well as a central collection hub. Each node establishes an accurate acoustical baseline for its respective monitoring zone, ensuring detection of leaks that may develop in the future. With EchoShore-DX technology, data is collected via radio frequency (collector) or cellular networks, allowing for near real-time data analysis. The user interface (UI) is highly intuitive to use, providing high-level reports at the start of each day. The location and other relevant details of potential leaks are easily identified. The UI provides two-way communications, enabling simplified verification of points of interest by field personnel.

Maximizing the Benefits

A key benefit of the EchoShore-DX technology is its interoperability with other Mueller Water Products, Inc. smart infrastructure systems. The data points collected and analyzed via EchoShore-DX nodes are managed through the same UI as Mi.Net® network technology, e.g., 420 Remote Disconnect Meters from Mueller Systems, LLC, and remote pressure monitors from Mueller Co. LLC. By combining these smart components, utilities can create a more complete Supervisory Control and Data Acquisition (SCADA) system for their water distribution systems.

In addition to maximizing non-revenue water loss from non-surfacing leaks and reducing pipe repair costs, traditional resources used to hunt for leaks are no longer required. Field crews can be directed toward the highest priority leaks. The data provided by the system enables a utility to not only identify a leak, but also to monitor its progression and prioritize repair criticality.

EchoShore-DX nodes enable a utility to find leaks early and prioritize repairs.

Data Backhaul Flexibility

The EchoShore-DX system is scalable and migratable, an ideal way to start a new technology deployment, typically in an area of concern. Targeted deployments can be done with cellular networks, so smaller utilities without full AMI capabilities can still experience the data benefits of EchoShore-DX technology. As the EchoShore-DX system is deployed to cover larger sections of a network, it can seamlessly transition to the radio frequency or LoRa network, giving each utility the flexibility and time to grow its use and management of data.

Remote Meter Connect/Disconnect Technology Delivers Operational Savings

A utility's data truly becomes useful when it provides an impetus to take action within the water distribution system. In a smart water utility network, DMA zones are remotely monitored and controlled, leading to more efficient personnel responses and greater awareness of activity occurring within the water delivery infrastructure. With devices such as the 420 RDM (Remote Disconnect Meter) from Mueller Systems, LLC, water utilities can better serve their customers with the data obtained from their Mi.Net® advanced network infrastructure. There are numerous use cases for utilities to better serve their customers by directly controlling valves at each customer site.

Managing Disconnects and Reconnects

The 420 RDM contains a remote disconnect valve, which is integral to the ⅝-inch residential meter. Utilities can use this feature to directly manage their water services from the utility office. The unique quality of the 420 RDM is the integral valve that allows the utility to upgrade to remote disconnect by simply installing the meter into the existing standard 7.5-inch service. The RDM works seamlessly with Mueller Systems, LLC's Mi.Net advanced IoT network technology and receives prompts from the Mi.Net user interface when action is needed.

When the utility customer service department notes a condition requiring valve activation, the system works as easily as clicking a mouse to disconnect or reconnect the water service as needed.

Adding 420 RDMs to any smart water network offers numerous benefits for water utilities. When reports come in via the Mi.Net system that indicate an unexpected excess flows at certain properties or areas, service representatives at the utility can follow up with owners to determine the source. This can be valuable in a number of scenarios, such as when vacationing homeowners are unaware a pipe has burst; shutting off their valves can save precious water resources costs as well as minimize property damage.

Improve Operational Efficiency and Safety

Another key benefit is the ability for utilities to cut down on labor and operational costs, as fewer trucks are needed to manually shut off or turn on water service in the field. With less crews and fewer vehicles making routine disconnects and reconnects, those resources can be redirected elsewhere where maintenance or other work is needed. This ultimately keeps employees out of any situation where they may encounter safety risks, including unknown states of plumbing, angry customers, or dangerous neighborhoods. Protecting employee safety is always the foremost concern of the utility.

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In conjunction with Mi.Net, the 420 RDM allows utilities to remotely manage their water services.

Ease of Deployment

It is very easy for utilities to realize the efficiencies and real cost savings of the 420 RDM. The most attractive business case option is for installing the 420 RDM into the Mi.Net IoT network infrastructure. The 420 RDM is easily installed into any existing or future Mi.Net network. The utility can choose to install the RDM in strategic areas with as few, or as many, RDMs as needed. Of course, the most compelling business case for the RDMs is to install them throughout the system. In many cases, the payback period for an AMI installation can be cut in half by purchasing the 420 RDM for all installations.

For those utilities who want the benefit of smart utility infrastructure, but are not quite ready to make the jump, Mueller also offers the RDM Mobile option. This option allows for the utility to remotely connect/disconnect the 420 RDM from the street without having to gain access to the meter box in order to make the connection/disconnection.

AUTOMATED FLUSHING SYSTEMS PROVIDE HIGHER WATER QUALITY CONSISTENCY

Water distribution systems with areas of stagnation or insufficient demand must maintain minimum disinfectant residuals in their water lines in order to maintain quality. Periodic flushing of the pipelines is a common solution to controlling residuals within the distribution system, but the traditional method has been to deploy work crews to manually flush water at end points. For smart cities, automatic flushing systems provide the opportunity for utilities to automate and program their flushing schedules, lowering labor and operational costs as well as improving consistency of water quality.

Mueller Co.'s Hydro-Guard® line of solutions flush distribution systems when water demands are low, or when residual levels are below pre-determined levels. Several water quality conditions can be monitored, including chlorine, pH, temperature, turbidity and flow rate. With more monitoring at dead end points of a water distribution system, utilities can be more proactive in their flushing processes and rely less on documented complaints from customers regarding their quality, improving customer service. Utilities can also reap the benefits of saving time and money by not having to send field crews to disrupt traffic and manually flush fire hydrants, redirecting them elsewhere to more needed jobs. The Hydro-Guard system is also available with pressure sensors, giving water utilities a real-time pressure monitoring solution throughout their distribution system. Using local cellular networks, sensors continually report data and alert the utility when high or low pressure thresholds are exceeded.

Permanent flushing systems from Mueller Co. allow utilities to maintain more consistency in the level of chlorine residual, especially at dead ends in the system.

HYDRO-GUARD®

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