Advancing Digitalization in the Water Sector

How the adoption of a digital twin allows utilities to make better operational decisions and enhance services.

Overview

As utilities face shrinking workforces, compounded by their growing reliance on digital data, they need to adopt a digital twin environment that connects technologies, processes, and people.

Bentley's digital twin applications for water distribution help water utilities gain visibility of their entire system, understand network performance in real time, and improve operational response. By leveraging real-time and historical data, they can reduce water losses and energy consumption, and ensure they deliver safe and affordable water to customers.

This e-book looks at how the adoption of a digital twin environment allows utilities to make better decisions and enhance services. It also reviews how some utilities have approached their digital twin advancement to achieve operational excellence.

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Advancing Digitalization

in the Water Sector with Digital Twins

From aging infrastructure, improving water quality, and achieving regulatory compliance, water utilities face a barrage of issues when delivering reliable and affordable water. Growing populations, water scarcity, and rising pressure to increase energy efficiency and decrease the carbon footprint further exacerbate efforts to meet customer demand for water. The strain on assets caused by climate change and severe weather events also heightens the need for emergency preparedness and proactive flood and drought resilience measures. But, it does not end there.

Utilities face challenging internal business issues, including how to boost the return on assets, improve capital planning, and reduce operating costs. Additionally, they must determine how to lessen nonrevenue water loss and increase operational efficiency. Many of these challenges can be overcome with people having the right information at the right time throughout the lifecycles of assets and infrastructure – information that provides insight for more informed decisions.

However, utilities often squander time and money trying to extract and sift through information from different operational data silos and supporting IT systems. With the rise of the Industrial Internet of Things (IIoT), coupled with the falling cost of sensors, data connections, and data storage, the amount of raw operational data generated by utilities has grown exponentially.

Collaborative and Connected Digital Twin Environment

Utilities striving for data-driven and more integrated day-to-day system operations are increasingly implementing digital twin solutions as part of their digital strategy. A digital twin, which is a dynamic virtual representation of the physical assets and processes within a water system,

integrates the hydraulic model of the water network, 3D models, associated engineering data of the plant, and pumping stations assets with relevant data sources. Combining operational technologies, primarily Industrial Internet of Things (IIoT) and supervisory control and data acquisition (SCADA), as well as enterprise systems such as ERP, APM, and EAM to AMI and geographic information systems (GIS), a digital twin creates a real-time model that can be used in operations and maintenance. IIoT, coupled with the falling cost of sensors, data connections, and data storage, the amount of raw operational data generated by utilities has grown exponentially.

The integration of isolated, disparate data into a unified system of systems provides a uniquely collaborative and connected digital twin environment. Water utility personnel can use this environment to zero in on data and apply artificial intelligence and advanced analytics to gain actionable insights and support decision-making better than any single software system.

OpenFlows® WaterSight™ makes data and analytics more visible across the enterprise, reducing operational and capital expenditures, as well as nonrevenue water loss. (Image courtesy of DC Water)

Improving awareness of anomalous network events, such as leaks, bursts, and meter failures, supports utility operators and engineers in reducing response time. (Image courtesy of Bentley Systems)

The dynamic integration of operational and engineering data enables utilities to see what is happening in real time or review any moment in time, while also providing a definitive ledger of change of the water systems and assets as they evolve throughout their life.

The result is an information-rich digital infrastructure model that supports engineering, operations, maintenance, and capital planning for smart water distribution networks and wastewater collection systems. With digital twins, utilities can perform what-if analyses and simulations to make informed decisions throughout the lifecycle of a water system – from long-term system vulnerability and capacity planning to immediate performance monitoring and emergency response. This ability enables utilities to better understand the past and current performance of their water systems while helping them predict future performance and simulate the impacts of potential changes in the virtual world before they commit to funding.

Why Use Digital Twins for Water Infrastructure

Infrastructure decisions made today can impact water utility customers and the environment for decades. Utilities need to invest in smarter ways of providing services. They can start by making better decisions in every phase of the infrastructure lifecycle – from master planning, design, and construction to operations and maintenance. Technology and data-driven decisions can help utilities with their strategy.

By investing and deploying smart solutions that enable advanced planning of capital projects driven by monitoring, real-time data, and machine learning, water utilities can make their systems more resilient. Utilities working together with their technology partners have a unique window of opportunity to create a strong digital framework for sustainable water delivery. Now is the time for change. Now is the time to invest in digital transformation.

Five Important Considerations

That Can Help Advance Your Water Utility's Digital Transformation

Water utilities have no shortage of data. In fact, they have many complicated enterprise systems and an increasing amount of operational IIoT data to manage. They face constant pressure to deal with their data effectively. However, some business challenges require in-depth insights that can only come from integrated data. As a result, there is a need for water utilities to adapt new digital solutions to manage day-to-day operations and capital planning decisions.

So, what is the most effective way for utilities to leverage digital solutions to drive intelligent water asset management and capital planning decisions? Here are five important considerations that can help advance your water system's digital strategy.

1

Your digital implementation can start at any point of an asset's lifecycle. From planning to design to construction, including the operation and maintenance phase, there are many ways to leverage digital solutions. For example, by implementing water distribution system data integration and operational analytics, utilities can bring various critical data sources into a single environment. Data integration provides a holistic view and insight into present, historic, and forecast performance for every asset within the system without the need to use different software or tools that do not communicate with each other.

2

Have a strategic vision. A clear vision is key for defining the applications, the people, the processes, and the data analytics that can create efficiencies, solve day-to-day problems, help your team, and improve the level of service. There can be multiple enterprise software systems and databases integrated together to provide operational digital solutions with analytics and key performance indicators. These indicators may include anomaly detection, alert notification, pump, tank and water quality performance information, nonrevenue water audit, and real-time operational event model simulation capabilities. A common mistake is to integrate enterprise data before first identifying and prioritizing the desired near-term and long-term business applications. Having a strategic vision will dramatically save your team time by integrating only the key datasets that align with the strategic plan.

3

Understand internal resources for implementing and managing digital software solutions. It is important to know if you have the right resources to develop, deploy, and manage software solutions in-house. You should also determine if you should maintain and improve your enterprise system data that is managed externally and provided as a software as a service (SaaS). One of the pros of in-house development is that the utility would have in-depth knowledge of its own infrastructure and systems, creating a lot of efficiencies. In most cases, however, the pros for utilizing an external vendor/SaaS far outweigh the pros of in-house options, especially because many utilities lack the resources to manage a unified digital platform and thus require external support and expertise.

4

A digital solution must be flexible. The software should not only provide operational analytics and key performance indicators in the form of dashboards, but should also allow the user to create custom dashboards and additional indicators and data visualization reports. This will give the user flexibility. For example, you can run a hydraulic, real-time model and see the results, but you can also export that data to be used in offline modeling for further investigations and additional scenario analysis.

5

A digital solution must be scalable. Many water utilities already have numerous digital components that operate their water infrastructure, including GIS, hydraulic model, SCADA, IIoT, or work order management systems. What is often not understood is how to integrate all data into a unified digital solution that can help solve everyday utility problems. A digital solution should be scalable without limitations of size or number of sensors. Utilities should be able to start small by testing a pilot area and then continue to build a complete system.

Every water utility has its own digital strategy. The scalability of an effective digital solution allows you to make decisions and define priorities aligned with the organization's core values, but also in accordance with where it stands in its digital process.

DC Water's Digital Twin Strategy

Improving Operational and Financial Resilience through the Implementation of a Water Infrastructure Digital Twin

DC Water distributes drinking water and collects and treats wastewater for more than 670,000 residents and 17.8 million annual visitors in the District of Columbia. They are committed to leveraging technology innovation to deliver affordable, resilient, environmentally friendly, and high-quality services.

In July 2021, DC Water approved a new five-year strategic plan, Blueprint 2.0, to enhance its readiness and resilience. The plan will drive performance by leveraging technology to improve reliability, increase efficiency, reduce costs, drive innovation, and enhance the customer experience. As part of its strategic plan, DC Water sought to implement a real-time, cloud-managed water infrastructure digital twin.

When it comes to the water distribution systems, there are many moving parts. Pumps, tanks, and system and boundary valves, coupled with unpredictable main breaks and power outages, have cascading effects on the delivery of reliable drinking water in a safe and resilient fashion. The decision to pilot a digital twin of the water distribution system was made because of the sheer size of DC Water's network, the dynamic nature of operational unknowns, and, at times, the physical unknowns, and the benefits that they could gain from the implementation.

Seeking a Digital Twin

For its pilot, DC Water selected Bentley's OpenFlows WaterSight to implement a digital twin that would help address these challenges by bringing together information technologies. These include GIS and asset data, and operational technologies such as Maximo work order management, SCADA, and engineering applications like hydraulic simulation

capabilities. The goal was to better mitigate service disruptions, reduce nonrevenue water losses, leverage data to reduce operational and capital expenditures, and improve the overall level of customer service.

With a digital twin, DC Water could more easily replicate the data from its enterprise systems in a managed cloud application database. There, they could organize and scrub the data in near real time and then configure operational applications, such as use cases, to address key operational challenges for water utilities. For example, a digital twin can help utilities understand pump and tank operational performance, automate nonrevenue water audits by month or by pressure zone, or analyze and mitigate operational events, such as pump shutdowns or pipe breaks, using a browser-based SCADA integrated hydraulic model.

Deploying Digitalization Across the District

DC Water began by looking at how the sensors are sending the data and looking for anomalies. They also observed the

Image courtesy of DC Water.

pump combination, especially when multiple pumps were running together. The team was interested in a hydraulic model conducted at a regular interval by feeding the SCADA near real-time data, seeing how the system behaves or produces the result when both of those are combined. They also wanted to know how the application would help them be better prepared in an emergency.

The implementation team worked to make the data available for cloud applications so they could perform live simulations and other SCADA-related activities. One of the key benefits of the water infrastructure digital twin is that the data output can be viewed in a browser-based application, making it accessible on any device by any authorized user.

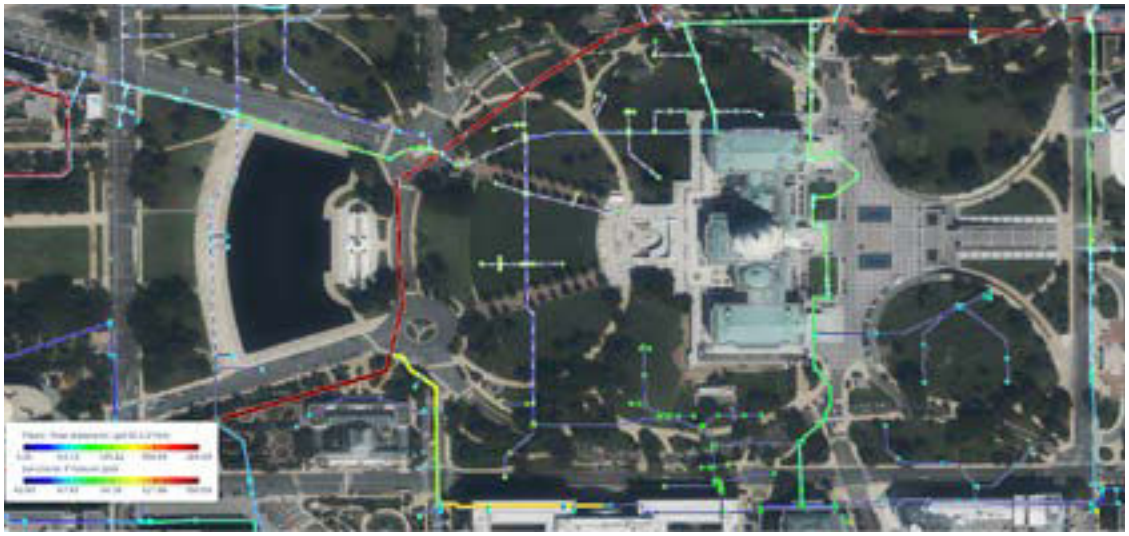
Lessons Learned

By using a water digital twin, DC Water learned the importance of setting both immediate and long-term objectives. Their immediate goals included integrating and establishing the connectivity among all data sources and functions like monitoring pump efficiency. The web-based accessibility of the hydraulic model will allow staff in operations to observe system performance in real time, which is key as they typically do not have access to the actual hydraulic modeling tool. The water digital twin will allow them to view readily generated results or even simulate what-if scenarios to make informed decisions. Long-term objectives include tracking water consumption, or comparing production

versus consumption, which involves the integration of all AMR sources, AMR data, and complete access to all the pump productions and production sources.

The benefits of a water infrastructure digital twin are numerous for DC Water. The team will now be able to leverage all the data across all the enterprise applications and a common environment, where the data and analytics of the operational applications are more visible across the enterprise. The team has the potential to reduce both operational and capital expenditures and nonrevenue water losses. Perhaps most importantly, a digital twin helps them leverage and optimize investments in their enterprise software and tools to improve the customer's overall level of service, whether that is improving water quality, operating pressures, or operational response.

As a forward-looking utility that considers implementing a digital twin as an essential business priority, DC Water knows that while data is crucial to the implementation, collaboration among stakeholders is key to their success.



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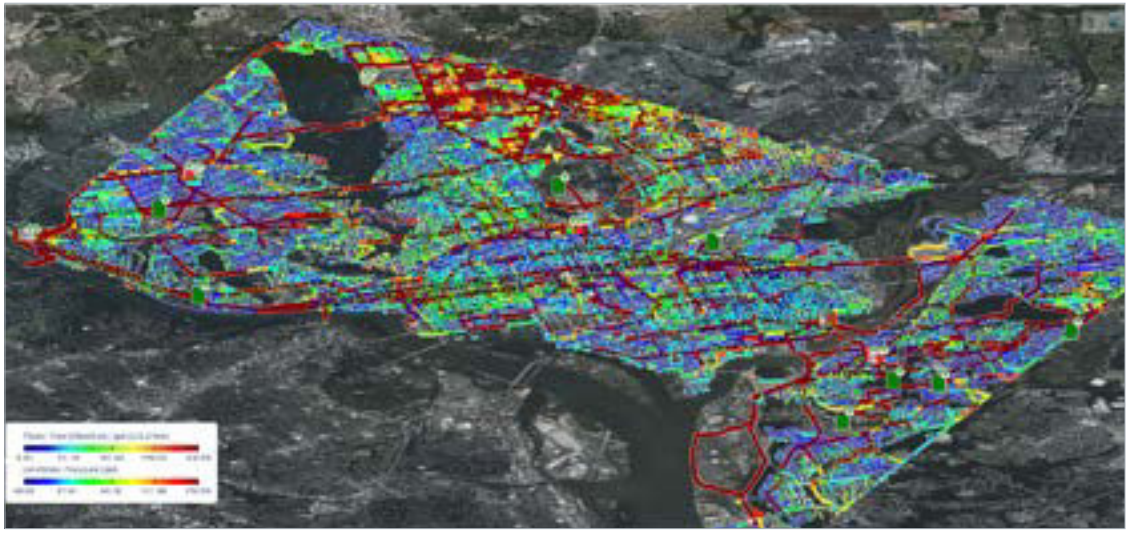

Image courtesy of DC Water.

Brazil's AEGEA Implements Digital Twin at Manaus' São Jorge District

Utility Works to Improve Leak Detection and Optimize Operational Workflows

AEGEA, one of Brazil's largest private water and sanitation companies, serves more than 21 million people in 153 cities across the country. Founded in 2010, the utility manages water infrastructure assets through full or partial common concessions, subconcessions, and public-private partnerships (PPPs). The utility manages public concessions in the entire water cycle, including supply, collection, and sewage treatment, according to the profile and needs of each town.

"We play a fundamental role in supplying vital resources for the quality of life of millions of Brazilians," said Lais Regis Salvino, digital infrastructure engineer at AEGEA. "Our operations are guided by respect for society, the environment, and ethical principles. We are a transforming agent in the lives of people and the cities where we operate."

In 2021, AEGEA turned its attention to improving the quality of water services and asset management decisions in Manaus, the capital and largest city in the state of Amazonas. The utility initiated a pilot project in the district metered area of São Jorge, which serves 10,000 customers, to optimize operational activities and prevent pipe bursts. The pilot project included a 61.4-kilometer network with the goal of monitoring operations of the Manaus water supply system.

Searching for a Solution to Meet Their Needs

Situated in the Amazon Rainforest and isolated from other main cities, Manaus' position and geography created a unique challenge for water providers. As a result, AEGEA needed to find a solution capable of remotely monitoring and analyzing Manaus' water systems. Such a system would also prevent them from having to conduct multiple site visits that lead to increased fuel and labor costs. Moreover, it would enable them to focus on predictive maintenance, which extends the operating life of the infrastructure and, in turn, reduces the resources required to keep it running safely and reliably.

Image courtesy of AEGEA.

Innovative Technology Establishes a Connected Data Environment

Using OpenFlows, they created and curated a digital twin that brought SCADA, GIS, hydraulic modeling, and customer information into a connected data environment. With a digital twin, they could deliver cost-effective operations and maintenance strategies in real time. Because digital twins can be used at different scales, OpenFlows WaterSight utilizes real-time data to create a model that continuously monitors all infrastructure assets, including pipes, pumps, valves, and tanks. The scalable environment provides utilities access to critical system and individual asset performance information to enhance operations, maintenance, and decision-making.

Image courtesy of AEGEA.

"Powered by a single water infrastructure digital twin, the application provides visibility of nonperforming assets or anomalous network conditions, as well as efficient analysis of present, historic, and forecasted performance for all assets," said Regis Salvino. "OpenFlows WaterSight also helps us uncover areas of improvement."

Leverage Hydraulic Models to Simulate Network Events

During system deployment, the Bentley support team assisted AEGEA during the first eight weeks after gaining access to the system's sensors, billing, and hydraulic modeling information. Two separate sensor databases were connected – one in Oracle and the other in SQL Server – pushing historical and live data with 15 minutes registration frequency, as well as enabling the pattern curve calculation for each. Some of the sensors provided important data that was used as boundary conditions for the hydraulic model, including the valve operational status, tank level, and input flow for each district metered area.

Hydraulic models were mainly used by the engineering department; however, AEGEA learned that by using OpenFlows WaterSight, they could easily and successfully leverage the engineering hydraulic models for daily operations and maintenance. The advantage here is that AEGEA can leverage the use of an existing hydraulic model in OpenFlows WaterGEMS™, import it to OpenFlows WaterSight's cloud, and use the data to run real-time simulation of network events such as pipe breaks, pump shutdowns, valves operations, and fires to better understand and anticipate the impacts on service levels. With these capabilities, operators can have a real-time hydraulic analysis of the entire network, covering the gaps between sensor data.

Analyzing Behavior for the Best Results

Using OpenFlows WaterSight enabled AEGEA to improve the efficiency of the system by analyzing its behavior and determine the best way to operate it. Additionally, AEGEA set up alarms based on pattern curves to detect anomalies in the system to track active leakage events.

Furthermore, the deployment of the water infrastructure digital twin at Manaus' São Jorge district effectively integrated all data stored in the different systems into one single platform, providing the utility additional insights, including water balances, tank performance, and forecasts, among other insights. As a result, AEGEA could see the behavior of their systems with real data, as well as improve operational workflows to determine how to best manage their operations. Additionally, AEGEA reduced awareness and response times to network events with the support of real-time simulation and automatic events generation capabilities.

"Bentley OpenFlows digital twin solutions allow us to improve our system. With digital twins, we can analyze the behavior of our systems with real data and determine the best way to operate them. We can check the level of the tanks, and determine if we have any leaks in our network before they become a problem," said Regis Salvino. "Bentley's support was critical to the success of this project and to AEGEA's commitment to transform the lives of people and the cities where we operate."

With Bentley's digital twin for water distribution, water utilities can gain visibility of their entire system, understand network performance in real time, and improve operational response.

Learn how digital twins can help you optimize decision-making, improve performance, reduce costs, and risk-proof your water utility.

Schedule a Demo