Why Smart Water Networks Boost Efficiency

by Jeff M. Miller and Mark Leinmiller

Executive summary

The Smart Water Network (SWAN) is the water utility industry's equivalent to the energy industry's Smart Grid. However, water utilities are trying to determine how new SWAN technologies will help maintain or improve service and profitability levels at existing water billing rates. This paper explains how data, performance measurement, and integrated systems can streamline water utility management and boost business productivity.

998-2095-08-06-14AR0

Schneider Electric

Introduction

A common challenge for a water utility is to maintain or improve service and profitability levels at existing water billing rates. The reduction of non-revenue water (NRW) — comprising real (physical) loss and apparent (commercial) water loss — is a key issue. Executing a plan to improve operational efficiency and financial performance requires a proper blend of vision, technology tools, and business process simplification.

With so much attention focused on delivering safe water, the efficient operation of water utilities is rarely planned or managed. The unfortunate result is that most utilities waste substantial amounts of water. The first problem utility stakeholders face is not having data regarding the performance of their facilities. On the other hand, even if they do have data, they don't know how to evaluate it or how to benchmark performance against the efficiency of other similar facilities. Utilities are also challenged with how to compare the actual data with the as-designed performance they should expect from their facilities.

It is this lack of business acumen that limits the effectiveness and efficiency of most water utilities. Key performance indicators (KPIs) are the quantitative measurements that help stakeholders to objectively assess the performance of their operations and identify where service can be improved and costs controlled.

Today it is both possible and prudent to measure and improve water utility efficiency (see **Figure 1**). In addition to reducing the amount of NRW, new technologies can help operations be more productive. This paper explains how water utility efficiency can be measured, evaluated, and modeled utilizing a Smart Water Network (SWAN) interface.

The SWAN is, in essence, the water utility's counterpart to the energy industry's Smart Grid. It integrates data to adjust operations in order to improve bottom-line performance and operational effectiveness. Collected data is leveraged to provide real-time visualization of the network. Status and streamlining of business intelligence (BI) functions allow stakeholders to make better decisions as a result of solid reporting and unambiguous planning.

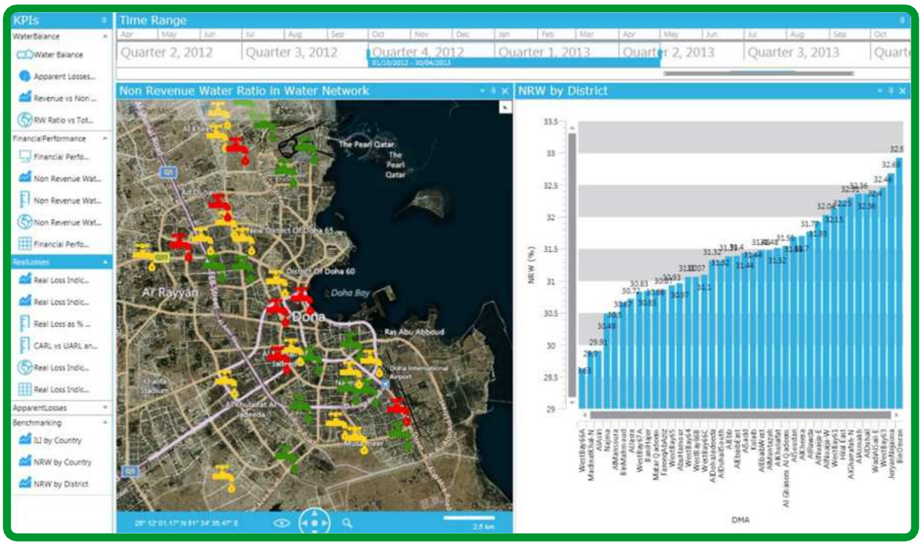

Figure 1

Raw data gathered from intelligent devices is transformed into information that facilitates decision-making.

In a SWAN environment, software that analyzes real-time signals from supervisory control and data acquisition (SCADA) systems can indicate the presence and approximate location of distribution system leaks. This directly reduces the operation's NRW. Network simulation interfacing with maintenance management software supports efficient communications with field crews and customers, which helps streamline repair, restore service, and keep consumers satisfied. Pressure management systems use control software acting on real-time data. Hydraulic models interfacing with analysis software and other information technology (IT) tools support "replace or repair" decisions, condition assessment programs, and management of network assets. Meter data management (MDM) solutions, coupled to advanced metering infrastructure/automatic meter reading (AMI/AMR) systems, help identify apparent losses resulting from malfunctioning meters or errors in the manual processing of meter data.

The KPIs derived from such systems allow the utility to analyze performance against both industry benchmarks and other internal data, helping to identify areas that need improvement and providing consistent communication to all stakeholders.

Elements of the Smart Water Network

Smart Water Networks help supplement and enhance the investments that water utilities have already made in core infrastructure. The premise of the Smart Water Network is the use of information technology to optimize a utility's assets. By implementing Smart Water Network technologies, the "dumb," or data-less, physical layer of pipes, pumps, reservoirs, and valves is made intelligent through the deployment of data-gathering sensors and software to help interpret the data and launch informed actions to improve efficiency.

The three core elements of Smart Water Networks are:

- **Information:** making full use of all data generated by a water utility
- **Integration:** utilizing current IT systems to maximize previous investments
- **Innovation:** designing a system flexible enough to meet future challenges

"A Smart Water Network is not simply an individual system . . . but rather a means of linking together multiple systems to share data across platforms."

A Smart Water Network is not simply an individual system that optimizes a network's efficiencies but rather a means of linking together multiple systems to share data across platforms. SWAN technologies improve the efficiency, longevity, and reliability of the underlying physical water network by better measuring, collecting, and analyzing data from — and supporting appropriate action for — a wide range of network events.

Overall, the SWAN allows:

- Real-time monitoring, automation, and optimization of complex operating processes
- Database sharing and synchronization, avoiding inefficient duplication of information and discrepancies
- Visualization of information coming from different systems in unique yet standardized platforms, such as a geographic information system (GIS)
- Streamlined business intelligence functions, such as KPIs, benchmarking, report generation, and planning

There are some basic levels of Smart Water Network integration that provide utilities with almost immediate benefits. One example is the transformation of real-time data into valuable information for faster decision-making in areas outside of the control room. By moving real-time information out of the control room, utility operators remain aware of what is going on in the field at all times and respond quickly and appropriately when a problem arises.

Monitoring real-time data improves maintenance procedures because the system is automatically generating information as events occur. For example, when there is a faulty piece of equipment or when a pipe leaks, utility managers can dispatch crews immediately to the exact location of the incident with specific information for that type of equipment. Using an advanced GIS system to dispatch crews to the precise location of the incident reduces labor costs. Utilities can decrease the time between when an incident occurs and when the problem is fixed, thus reducing the risk and the cost associated with that event.

In addition to improving response times, linking real-time data from the field has also proven critical for constructing accurate hydraulic models that utilities use to compare what should be happening in the field with what is actually happening. By performing online simulations, utility operators have a very powerful tool that allows them to establish an accurate baseline to gauge their network's operational efficiency.

Water loss management

Non-revenue water (NRW) management can benefit from a SWAN application because it involves different departments of the utility and multi-disciplinary teams.

SWAN supports efficient water loss management by:

- Implementing software that performs specific tasks, such as automatic leak detection
- Introducing new technologies in traditionally manually executed activities: for example, mobile GIS solutions that support outage management operations
- Integrating systems for value-added information: for example, connection of the SCADA system and the hydraulic model to detect leaks or faulty metering equipment
- Reducing meter inaccuracies through advanced water meter stock management, which integrates customer information system (CIS) and specific software for optimum meter selection and replacement
- Eliminating metering data-handling errors through the implementation of automatic meter reading (AMR) systems, advanced metering infrastructure (AMI), and meter data management (MDM) solutions.

SWAN addresses four aspects of the NRW issue: active leakage control, pipe repairs, pressure management, and asset management.

Active leakage control Leak detection systems (LDS), also known as computational pipeline monitoring (CPM), are specific software tools that analyze real-time signals from SCADA systems. They allow the operator to assess the presence and the approximate location of leaks in different areas of the water network (see **Figure 2**).

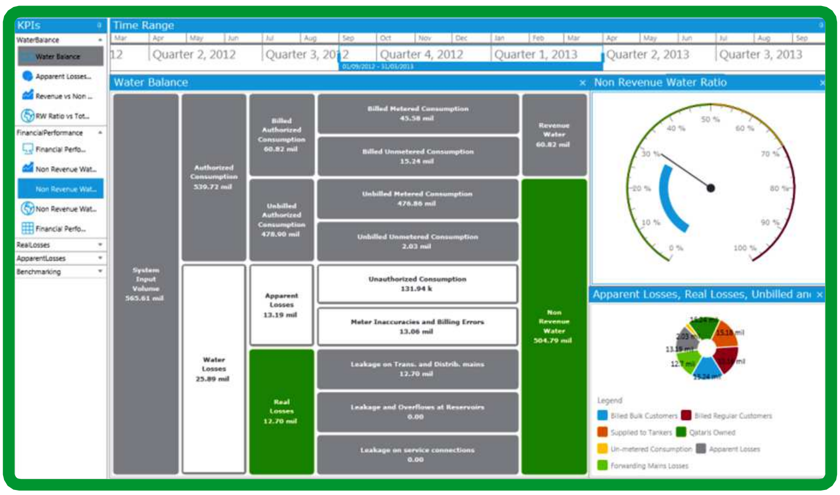

Figure 2
Real-time water velocity data is linked to network analysis to detect leaks along the water network.

"Even utilities with low water loss can benefit, since the cost of keeping their water loss to a minimum may far exceed the efficiency of an active leak control system."

Even utilities with low water loss can benefit, since the cost of keeping their water loss to a minimum may far exceed the efficiency of an active leak control system.

Pipe repairs An outage management system (OMS) using the utility geodatabase and interfaced with other enterprise systems — such as the CIS, the SCADA system, the computerized maintenance management system (CMMS), and a hydraulic model — provides an advanced, comprehensive solution for managing pipe repairs. This integrated approach streamlines field communications and operations in order to efficiently manage utility resources and minimize customer inconvenience (see **Figure 3**).

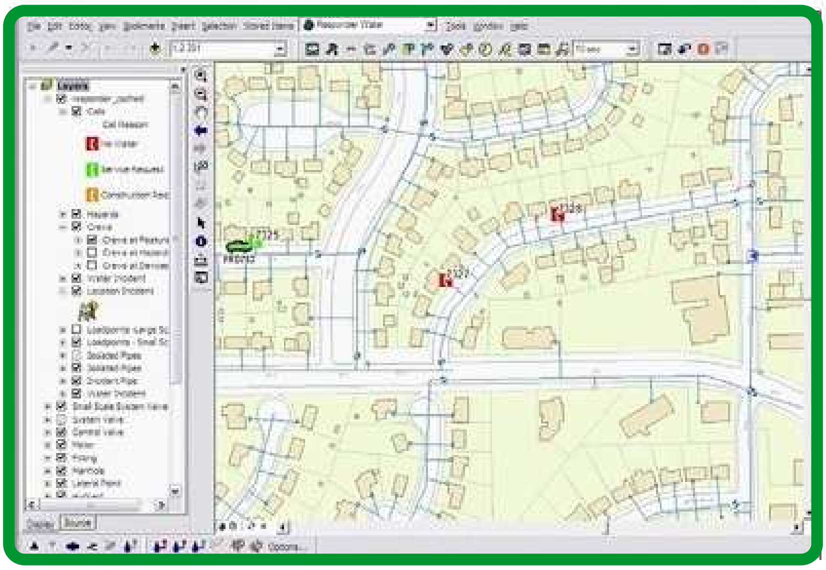

Figure 3
When a leak repair requires an outage, a GIS-based system assists operators in identifying the valves and washouts that would be least disruptive to service.

Pressure management Efficient pressure management usually combines the installation of equipment and devices — e.g., pressure reducing valves and variable speed pumps — with their respective control software. Advanced network operations are characterized by dynamic valve settings and pump scheduling based on variable water demand (see **Figure 4**).

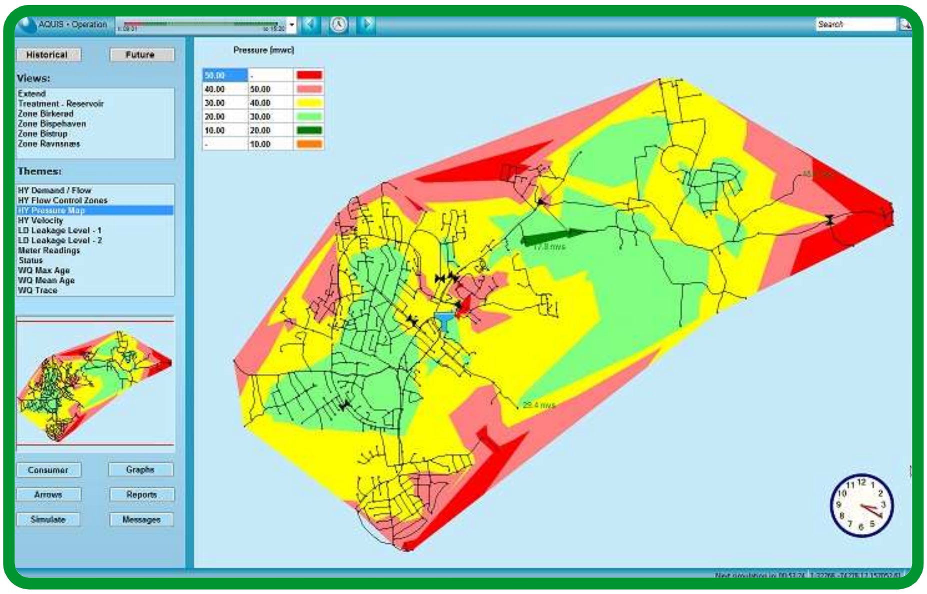

Figure 4
An online hydraulic model identifies where pressure problems might exist.

Asset management Most utilities burdened with obsolete assets and financial constraints are faced with a "replace or repair" dilemma. Hydraulic models, GIS, CMMS, and other technology tools have proven to be effective in supporting decisions involving predictive versus corrective maintenance (see **Figure 5**). This allows operators to make informed decisions on where and when these actions should be carried out, saving time and money in the process.

Figure 5
Reports generated can include the number of customers impacted by outages and the efficiency of maintenance crews.

The role of KPIs

The water industry encourages utilities to implement KPIs to identify areas of improvement, define realistic targets, design action plans, and track improvements over time. Government legislators and environmental regulators are setting stringent leakage guidelines and are driving utilities to provide KPI-related data. Publication of reports and KPIs on water loss is now mandatory in many countries around the world. **Table 1** provides examples of American Water Works Association (AWWA)[1] water loss management KPIs.

Table 1
American Water Works Association (AWWA) KPIs that reflect water loss management

KPI	Description	Data
Disruptions of water service	Number of customers experiencing service disruptions per 100 active customer accounts	The joint use of GIS, OMS, and CIS systems provides the quantification of customers affected by outages or by planned repairs
Distribution system water loss	Percent of drinking water placed into distribution that does not find its way to customers or other authorized users	Data from SCADA, billing/CIS, CMMS, and other sources managed by different departments within the organization to build a comprehensive water balance
Water distribution system integrity	Number of breaks and leaks requiring repair per 100 miles of distribution piping	The quantification of the number of pipe breaks requires data coming from OMS/CMMS and GIS systems

However, generating and interpreting KPIs becomes a tedious and labor-intensive process when it requires access to data stored in separate systems. SWAN technology can automate these processes and provide accurate and reliable data that allows efficient KPI compilation.

[1] Benchmarks are identified and defined in the Water Research Foundation's "QualServe Performance Indicators Report," 2007

SWANs reinforce the KPI and industry benchmark concept by introducing business intelligence platforms that simplify enterprise planning and operations. These platforms offer the following advantages:

- Comparison of performance across different units within an organization (internal benchmarking)
- Generation of real-time information updating KPI calculations for more effective process monitoring and faster decision-making
- Development of indicators on a GIS map (geo-referenced benchmarking) to link KPIs to geographic units and asset conditions
- Linkage of water loss data to cost data through interfaces with enterprise resource planning (ERP) and other corporate systems
- Creation of customized performance indicators through access to data stored in various data warehouses

Figure 6 illustrates a sample dashboard that provides water loss–related KPI calculation information.

Figure 6
Water loss management information is linked to utility technical and financial performance data.

Conclusion

SWAN technologies facilitate system planning, streamline daily operations and maintenance, and improve network water loss management. Since these technologies are scalable, they provide sustainable solutions for water utilities as they experience growth.

In addition, middleware software and business intelligence (BI) tools allow utility management to extract data from multiple discrete systems. The data gathered is then utilized to calculate key performance indicators (KPIs) that provide accurate and objective information regarding water network performance.

The ability to benchmark, and to represent the data in different ways, also allows the utility to communicate performance measures in a consistent manner to all stakeholders.

In order to jumpstart a Smart Water Network initiative, the following steps are recommended:

Within the next few weeks: Bring in knowledgeable individuals who can perform an objective assessment. Identify those areas within the utility in the most need of efficiency improvements.

Within the next 6 months: Begin to plan a roadmap. Identify cases where low up-front investment can produce positive results over a relatively short period of time. This serves as an effective initial pilot.

Within the next year: Identify areas where Smart Water Network benefits can be expanded. Name a high level sponsor for the SWAN program and agree on scope, budget, and resources.

Within 2 years: Create a long-term sustainability plan for the program, create succession plans for sponsors and leaders, and deploy long-term monitoring and measurement.

About the authors

Jeff M. Miller is a Water Solutions Architect for Schneider Electric's Water Wastewater Competency Center. He holds a B.S. in Electrical Engineering and has worked as an engineering consultant and systems integrator for 25 years where he has delivered on over 30 wastewater treatment, 25 water treatment and 45 pump station projects ranging in size from small lift stations to 370 MGD treatment plants. He is the co-founder and past chair of the NC AWWA-WEA Automation Committee and is also an active member of several national and regional Automation and Plant O&M related committees.

Mark Leinmiller joined Schneider Electric's Water Wastewater Competency Center in 2006, and has worked with municipalities, contractors, engineers, systems integrators and equipment suppliers to ensure well-coordinated project designs. Most recently Mark has been involved in the Smart Cities initiative. He has worked in the electrical, automation systems, energy efficiency and production arena for 20 years, and holds a Bachelor of Science in Industrial & Systems Engineering from Georgia Tech. He has been an active participant in numerous AWWA and WEA events, presenting papers at national AWWA & IEEE conferences and at statewide water conferences, seminars, and workshops. He has presented papers at AWWA-WEA events in Georgia, California, North Carolina, South Carolina and Tennessee.