Optimizing Leak Detection with a Virtual DMA

PROGRESSIVE UTILITIES ARE LEVERAGING TECHNOLOGY TO IMPROVE THE ECONOMICS OF WATER MANAGEMENT

After experiencing significant real water losses in its distribution system and having difficulty locating the root causes, this large water authority in United Arab Emirates took a proactive approach by using real-time data to identify the source of leaks, reducing non-revenue water and gaining system intelligence to improve future operations, maintenance, and capital planning.

According to World Bank, **a 30% gap exists between the volume of water delivered by utilities versus the amount of water billed**, costing the global economy $14 billion every year. This discrepancy of non-revenue water (NRW) is driven by a combination of real losses (leakage in the distribution system) and apparent losses (water consumed but not paid for caused by inaccurate meters, billing problems or theft), as well as unbilled authorized consumption (i.e., firefighting and system flushing).

In the 1980s, water utilities in Europe began to divide their distribution networks into sectors called district metering areas (DMAs). This practice became synonymous with reducing water loss and good **NRW management**. Even with this improvement, there were limitations of these physical DMAs, many of which still persist today, from being costly to implement to having adverse effects on both hydraulics and water. Today, **progressive utilities are using digital technologies to create virtual district metering areas (vDMAs)**, eliminating the limitations of the physical DMA by utilizing data to provide actionable insights into the condition of their networks. **With more employees working remotely, this will help utilities facilitate the automation of the water loss process.**

Basics of DMAs

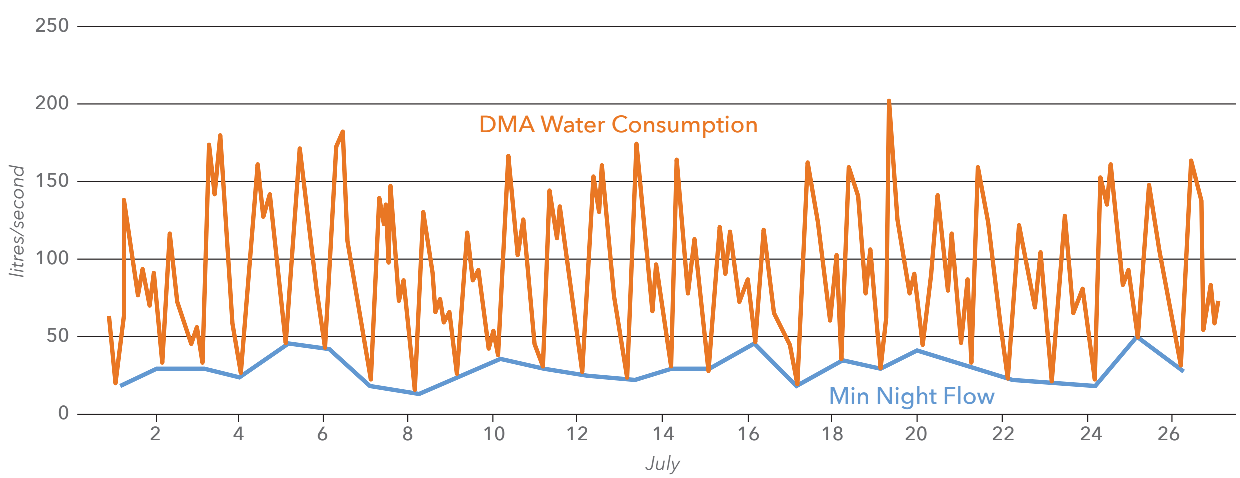
A thorough water audit across an entire network is critical to understanding the overall water use efficiency of a distribution system. While this type of broad water audit attempts to account for the total volume water in the system against the total volume of water billed, it often lacks the detailed granularity necessary to understand each component of the water balance and the sources of water and revenue loss. **Insight into these critical areas can help utilities realize millions of dollars in savings and change the economics of water management.**

A pipe leak will typically lead to a noticeable change in the flow velocity and pressure in the surrounding area. This measurable information can be used to locate the leaking pipe.

Tracking Nighttime Flow

To achieve a deeper understanding of water balance and more precise calculation of NRW, water utilities have implemented DMAs across their networks for decades, dividing areas into zones with strict hydraulic boundaries. This allows operators to use flow meters to closely monitor flow into these areas and apply nighttime low-flow monitoring techniques to identify leaks. The minimum nighttime flow approach is used in both traditional DMAs and vDMAs due to its effectiveness and simplicity in tracking water losses. Unexpected and noticeable increases in flow velocity and pressure can indicate potential leakage.

Regardless of the availability of customer metering data, the water utility will often track minimum nighttime flow, as demand is low and the flow tends to be fairly consistent. Minimum nighttime flow tracking can alert operators to leaks or bursts via a corresponding increase or spike in flow. **As a result, utilities can prioritize leakage crew deployment, pinpoint leaks both quickly and accurately and gain system intelligence on overall performance.**



Traditional DMA setup

Depending on the type of customer (residential, commercial or industrial) and aggregated water consumption, **a typical DMA consists of up to 10 miles of pipeline** with anywhere from 500 to 3,000 service connections. These zones have strict hydraulic boundaries governed by closed valves at most of the DMA boundaries, except for one or two with measured inflow into this defined sector. In some instances, DMAs can also measure outflows. The intention of limited boundaries within the DMA is to make it easier to measure water flow and determine excess leakage and identify new leaks.

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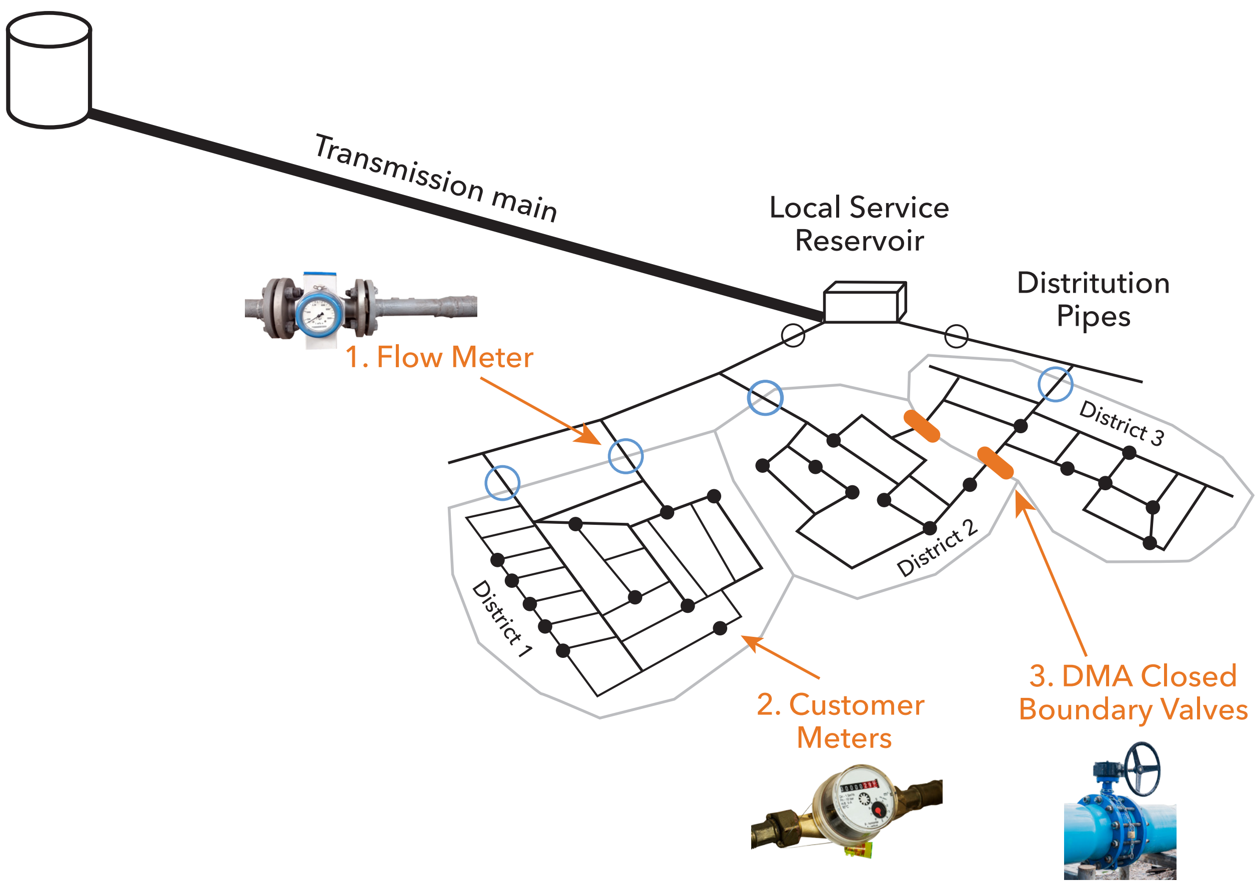
Limitations of Traditional DMAs

The subdivision of a complex network and measurement of flow at specific boundary points is useful for water accountability, but DMAs are not without limitations. For mature networks in dense urban networks, flow meter installation in sectors with 3,000 connections **requires a multiyear capital expense commitment**. It also takes significant coordination with night crews to close the multitude of service connections and properly install the DMA in these environments.



Traditional DMAs can also have **adverse effects on both hydraulics (reliability and redundancy) and water quality (water age)**. A DMA limits supply reliability as it restricts water supply to customers through a single pipe at the DMA inlet. If a break occurs, customers will likely face supply loss as water only comes from the DMA boundary inlet. This issue is less likely to affect an open network or a vDMA where water can be diverted to surroundings sections and reach customers until the break is repaired.

DMAs with closed boundary valves (BVs) can increase water age and lead to situations with low disinfection levels in certain areas due to long stagnation, especially near the DMA boundary valves. If a boundary valve is unknowingly stuck and water can't be flushed, the stagnant water can be released to a downstream DMA when the valve is finally opened.

Utilities also face significant costs to maintain DMA networks, as the boundary valves need regular checking to verify position and condition – critical information required by operational crews in case of emergencies.

DID YOU KNOW?

The national average for operable valves is 60% – which means that **40% of valves are typically inoperable, unlocatable, or in the wrong position**.

Managing Water Loss:
A 30% NRW Rate on Average

On average, most utilities without an active NRW strategy will have 30% water loss, while others with an active **NRW strategy** will have less than 15%.

For the average North American utility delivering 275 million gallons of water daily to 500,000 customers*, a 30% NRW loss equates to more than 30 trillion gallons annually.

*Based on an average daily use of 552 gallons per customer.

<table>
<tr><td rowspan="9">System Input Volume</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Loss</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribuition Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connetions up to the point of Customer Metering</td></tr>
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DID YOU KNOW?

As reported by AWWA, an assessment of validated water audit data of 246 water utilities found that collectively the utilities lost 130 billion gallons of water to system leakage. **This loss added over $77 million in treatment and pumping expenses** to utility ledgers.**

**As reported by AWWA of a 2013 water audit

LEARN MORE ABOUT THE AWWA/IWA WATER AUDIT METHODOLOGY

Monitoring an Open Network with a vDMA

Digital solutions are transforming leak detection by offering utilities new ways to identify and help prevent leaks through advanced technologies. Instead of creating a physical hydraulic control, a vDMA maintains more flexibility. In contrast to a traditional DMA, the monitored area of a vDMA has no strict hydraulic boundary and doesn't require actual boundary valve closing and pipe isolation, eliminating any hydraulic performance or water quality issues. Field costs are lowered as crews aren't required to work the midnight hours, also eliminating safety risks with crews having to manually open or close valves. **The concept of a vDMA is to continuously measure the flow rate and pressure at several points and compare the metered data with known or historical reference values.** Utility customers realize multiple benefits from implementing vDMAs:

1. **Reduce water loss (NRW)**
2. **Mitigate service disruptions**
3. **Increase water quality protection**
4. **Lower maintenance costs**

CASE STUDY:

A water authority serving the United Arab Emirates was experiencing significant water loss in its distribution network, with little to no visibility into root causes.

Ten vDMAs were created in the city, covering 200 miles of pipe to bring structure to its complex network while maintaining redundancy and avoiding hydraulic disruption.

The implementation included installation of inline flow meters and real-time monitoring and analytics to calculate water loss in each vDMA, as well as the installation of pressure-acoustic sensors to detect leaks and damaging transients.

The utility was able to visualize the source of losses and identify the specific vDMAs where advanced metering technology would effectively reduce the apparent losses.

Setting up a vDMA

To establish a vDMA, optimal locations must be identified for bidirectional flow meters that allow for the creation of sub networks to act as a virtual district. The installation of those flow meters is the only civil work required. Once complete, the automated digital process takes over.

After the flow meters are installed, they are synchronized with network analytics software that will measure and view water usage in the zones with flow meters. The analytics software displays a simple visual "map" of the distribution network with water consumers organized in virtual clusters and identified by optimal boundary locations. In other words, this is the vDMA.

Where a vDMA is established, it is possible to obtain flow profiles during the night when customer demand is at its lowest and leakage is dominant. When the defined zone is continually monitored, unexpected and noticeable increases in water flow can indicate potential leakage.

From there, a standard minimum night flow analysis and water balance can be implemented, similar to the approach used on traditional DMAs but without the negative impact of supply reliability or water age issues. The synchronized data is sent back to the utility, allowing it to easily act on the feedback. If the utility is unsure whether a leak or improperly closed boundary valve resulted in water loss, this information calculates water balance and helps identify and isolate unreported leaks with more reliability than traditional DMAs.

CASE STUDY:

By reviewing supervisory control and data acquisition (SCADA) and advanced metering infrastructure (AMI) consumption data, this resort city in Utah identified leaks in a specific area of its system.

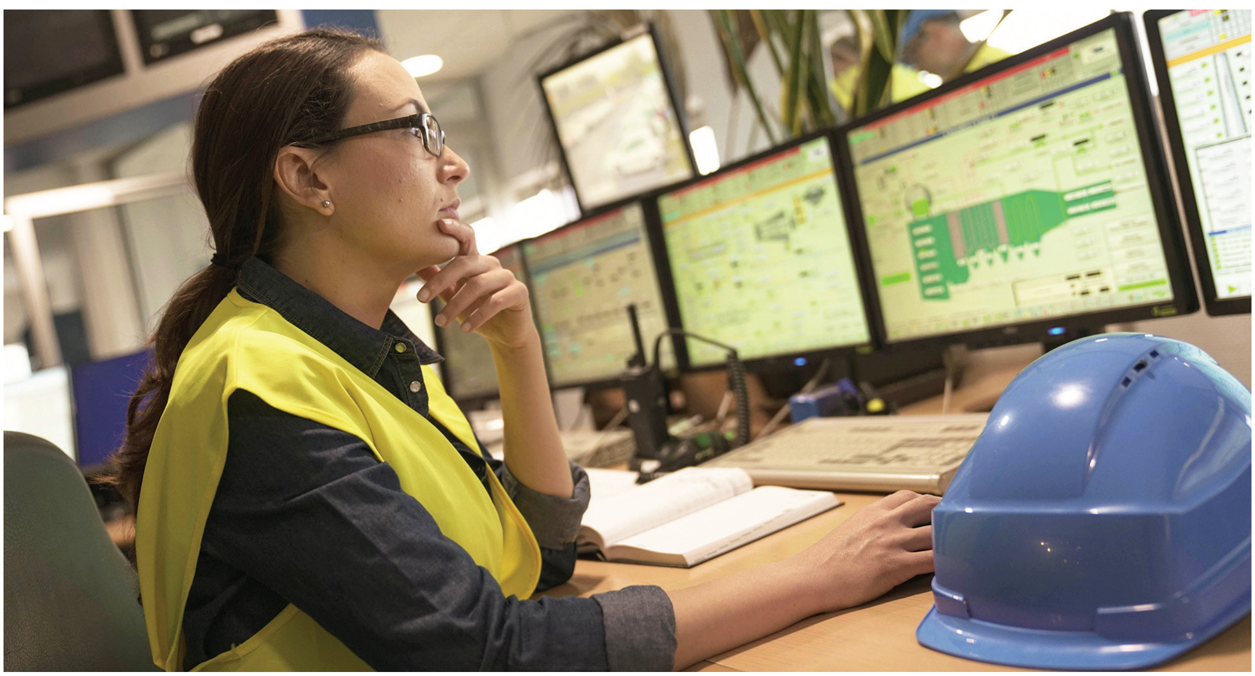
After traditional leak detection proved unsuccessful in finding the leaks, the city installed distribution system monitoring and analytics, along with acoustic pressure sensors in six vDMAs established in this area.

For five months, the city monitored for leaks and analyzed operational pressures and surges. By deploying the sensors, integrated data analytics and 24/7 system monitoring and control software, the city identified an additional seven leaks, bringing total non-revenue water loss identified and corrected to 300 gallons per minute.

READ CASE STUDY

The Value of Implementing a vDMA Strategy

Overall, **utilities are seeing immense value in implementing vDMAs to reduce water loss and gain a better understanding of their distribution systems**. The ability to monitor water networks in real time and evaluate the data to understand system performance allows operators to proactively respond. If one area is determined to have more significant water loss than expected, utility operators can pivot resources to develop condition assessment strategies, install more hydrophones or focus on leak detection technologies to guide repair decisions and provide validation on the effectiveness of current programs.



Although vDMAs require an initial capital investment in terms of chamber construction and flow meter installation, this investment is quickly recouped by mitigating the negative impacts and costs associated with physical DMAs.

A vDMA approach will help utilities:

- **Optimize operational costs (including reducing emergency maintenance costs) by prioritizing repairs and replacements**
- **Save capital expenditures (CAPEX) by proactively managing assets**
- **Reduce the number of failures by identifying and addressing water loss-related problems before they escalate**
- **Reduce leakage and related NRW**
- **Improve customer satisfaction, resulting in fewer residential service disruptions**

By understanding each component of the water balance and the sources of water and revenue loss, **utilities can avoid service disruptions, protect water quality and help change the economics of water management**.

This solution will facilitate automation of the water loss process through online analysis of night flow and mass balance in the vDMAs and will require much less manpower to address this problem.

Conclusion

Progressive utilities are using vDMAs to stay ahead of the curve regarding water loss and help drive effective water management policy.

That's the power of decision intelligence.

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

Xylem (XYL) is a leading global water technology company committed to solving critical water and infrastructure challenges with technological innovation. Our more than 16,000 diverse employees delivered revenue of $5.25 billion in 2019. We are creating a more sustainable world by enabling our customers to optimize water and resource management, and helping communities in more than 150 countries become water-secure.

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