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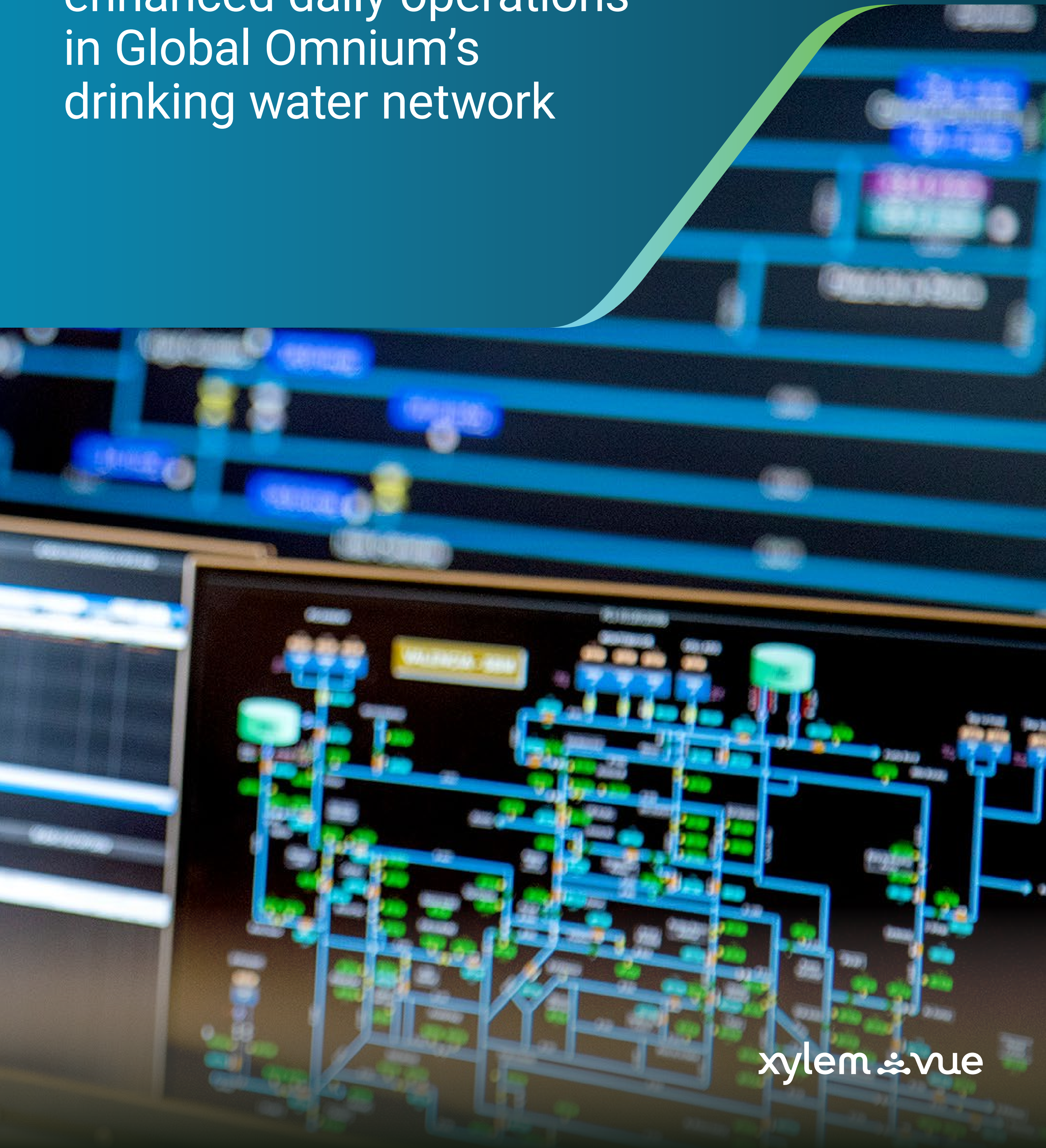
Project summary

Valencia, Spain

How a digital twin enhanced daily operations in Global Omnium's drinking water network



xylem vue

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Summary

Water transport and distribution systems in many cities have become complex to manage as they are forced to adjust to the problems of population growth, resource shortages, aging infrastructure and optimization of daily network operations. Consequently, digital twins of water networks are increasingly widely used for decision-making around their operation and management.

A digital twin is a virtual model which replicates the elements of a system and the way it behaves, enabling us to predict how it will respond under any given set of circumstances.

Its potential derives from its ability to merge the real world and the virtual world using real-time data as input parameters to create simulations. In the water sector, this gives water management companies the chance to acquire in-depth knowledge of the processes concerned. Amongst other functionalities, this enables organizations to prevent problems and downtimes, to experiment with new business opportunities, to plan future scenarios and actions using simulations and to optimize system performance.

Developing a digital twin of a system is not an easy task, since the twin must be capable of faithfully reproducing the reality it represents. In addition, to be useful, it must be updated and capable of accurately reproducing any system operation context, whether in the present (real time) or past and near future (next 24 hours), for both real and fictional scenarios.

Since 2009, GoAigua's technology has enabled the water management company Global Omnium to use a digital twin for the main water distribution network for the city of Valencia and its metropolitan area in Spain. Over 10 years' experience in the development and application of this tool made GoAigua's digital twin a comprehensive, reliable decision-making tool.

There are a number of factors behind the success of a digital twin for a system as complex as the one supplying water to Valencia and its metropolitan area, which serves a population of 1.7 million residents and is made up of two treatment plants, 28 storage tanks, 47 pumps, 219 operating valves, and over 20,000 readings taken every day. One of the key components of the digital twin is the hydraulic model of the system. The construction of the model is vital as it must be properly built and calibrated. The model for Valencia and its metropolitan area is extremely reliable with error rates below 2% for pressure and 4% for flow.

Building a digital twin requires real-time information from the real physical system. The technology developed and deployed enables all of this information to be connected to, incorporated into and standardized for a single platform that feeds the model.

The sheer quantity of information handled daily underlines the importance of having high quality data. To achieve this, information screening techniques developed using both statistical and hydraulic criteria are used.

In addition, the way results are displayed is based on the various different uses to which the digital twin is put and on the needs of its users. Synoptic SCADA displays are more suitable for control rooms, while displays against geographical backgrounds are more suitable for planning tasks.

It is also worth pointing out that the digital twin was designed to be scalable for use with any size of supply system, thanks to its universal algorithm, and it is easy to update in line with any changes that may be made to the system.

The utility now uses **Xylem Vue** technology, built on Idrica's GoAigua technology. Idrica has since partnered with Xylem to combine its proven GoAigua technology with Xylem's global team of technical and water industry experts.

As part of the partnership, the companies offer the Xylem Vue integrated software and analytics platform that enables utilities to connect and manage their digital assets and streamline operations in a simple, secure and holistic way.

Background

Characteristics of the supply network

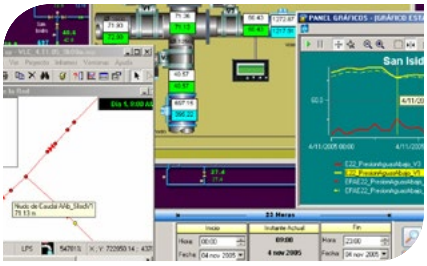
The water supply network that provides Valencia and its metropolitan area with drinking water is supplied from two treatment plants, both of which are around 10 km from the city. They each offer different guarantees in terms of supply and water quality at source, as well as different production costs and different storage capacity at different elevations. All the water has to be pumped before it flows into the network.

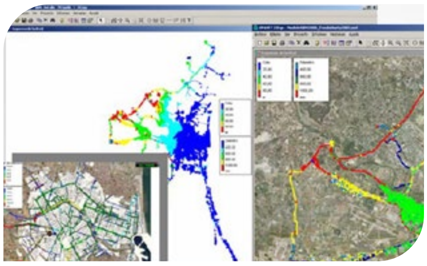
From these plants, the water is distributed by gravity to the city and 51 municipalities that constitute the metropolitan area through a 200 km-long main system, which supplies water directly to the secondary distribution networks in the municipalities. Pressures are regulated through a series of valves and tanks, which are all controlled and operated in real time from the control center, which collects information from more than 150 RTU's.

The relief of the land on which the system is built has created a very looped network, where all elements of the system are interconnected. Consequently, an intervention in one area of the network may affect another point some distance away.

In terms of operating capacity, the closely meshed network offers some advantages since it makes the system more flexible and capable of successfully dealing with any eventuality. However, the disadvantage is that it is complex to operate and requires extremely in-depth knowledge of the system and its operation, as well as real-time monitoring of its behavior.

Background to the development of Global Omnium's digital twin





Global Omnium has a wealth of experience of creating hydraulic models. The first strategic model of the city of Valencia was created in 1993 in collaboration with the Universitat Politècnica de València. It had 500 nodes and was used for the planning of several major pipelines. Since then, significant progress has been made in the mathematical modeling of the system. However, these models could only be used for planning tasks as they were only able to simulate the network's behavior for a standard day.

The inclusion of SCADA systems in network management opened up new opportunities for mathematical models to serve as a decision support system. In order for a model to be a useful basis for decision-making in daily network operations, it must be capable of simulating the network's behavior under any circumstances whilst also being perfectly calibrated. This is only possible if the model is connected to the SCADA system in real time (Martínez et al., 2017).

The SCADA system was first connected to the mathematical model in 2007 and since then the Control Center for the supply network for Valencia and its metropolitan area has had a real-time network simulator. The simulator is currently based on a mathematical model which covers not only the city of Valencia, but also the entire main metropolitan supply system.

Using the experience gained, in 2016, Global Omnium and the Universitat Politècnica de València began the ambitious project of building a digital twin for the system. It was to be interoperable with new IT platforms and have new features, such as scalability to any size of supply system. GoAigua's Digital Twin, now known as Xylem Vue Real-time What-if scenarios application, is the result of that development.

The digital twin is now fully operational and in use in the control room for the main supply system for Valencia and its metropolitan area. It is a vital tool supporting decision-making both for daily operations and planning tasks.

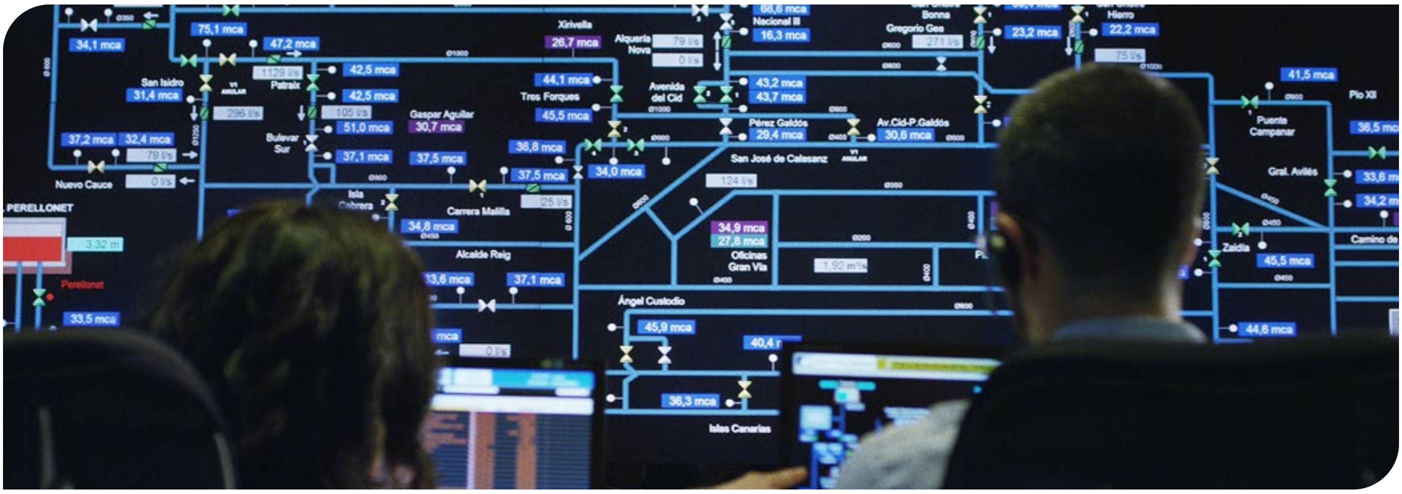
The hydraulic model

The hydraulic model is the basis for the digital twin's decision-making as it can simulate the system's response to any set of operating conditions. To achieve this, a reliable 'living' model is required. It must be capable of precisely replicating the behavior of the network at any given time span under any circumstances. Moreover, the simulations must be performed quickly, so its development has been a key factor in its success.

In this case, the base hydraulic model, which is strategic in nature, currently includes all pipes in the network down to a diameter of 200 mm, and some that are even smaller, along with all the elements used to regulate supply, specifically the tanks (separated by containers), the pumps, which are identified individually (including the reserve pumps), the valves, which are controlled remotely from the control center, and all the hydraulic valves which are able to maintain a set point, including those regulating input to the demand sectors. To sum up, it replicates the 900-km-long supply network for the metropolitan area of Valencia and consists of 10,340 pipelines, 28 tanks, 47 pumps and 254 operational valves (which are primarily remotely controlled and hydraulic).

The basic model is fed daily by a total of 20,000 readings providing both real-time and recorded data through the remote-control system in order to replicate the real behavior of the network.

Calibration is also vital to ensuring that the twin reflects the real behavior of the system. The reliability of the model and its flexibility and adaptability to new circumstances depend on calibration being carried out correctly.



Data storage and screening

The large amount of data available, its storage and screening are key to the Valencian digital twin's success. As previously mentioned, the model must be quick to load and so it is vital that the information the model will be handling is properly organized and easy to access.

Using its IoT platform and Big Data, it continuously incorporates, standardizes and integrates data from one million smart meters, pressure/flow sensors, SCADAs, GIS, CMMS and other systems to accurately virtually replicate the behavior of the network in real time.

In addition, other technologies which are part of the platform and are applied continuously, such as hydraulic modeling and advanced analytics, enhance the digital twin's capabilities enabling all its advantages to be used to the full. The quality of the data feeding into the hydraulic model is vital for correct simulations so all data received are screened by a series of AI algorithms, which were developed to detect anomalies and rectify any incorrect data received. The hydraulic model allows the digital twin to be synched with the real system every 30 to 60 seconds.

Graphical interface

One of the keys to the success of the digital twin is the development of appropriate visual displays, which bring all the information available together in an organized, easy-to-understand format, and the fact that it adapts to the user's role. The use to which a control room operator will put the tool is different from the uses to which it might be put when planning new infrastructure, for instance.

A variety of visual environments have, therefore, been developed. They include general synoptic overviews of the hydraulic system, overviews of the main elements, geographical backgrounds and special windows to display specific information on water balances, graphs showing trends and illustrations of parts. .

Measurements taken against a geographical background can also be viewed, which means hydraulic variables for the whole model network can be displayed simultaneously in real time (figure 3). This kind of display is a very powerful tool, which shows the hydraulic behavior of the entire system being modeled along with its effect on the various sectors or groups being supplied. This would be impossible to achieve through instrumentation.

In short, the data display was designed as a powerful yet flexible reference tool which can adapt to the use to which it is to be put.

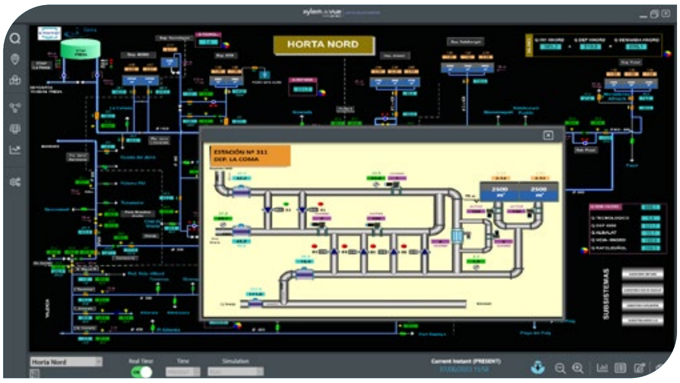


Figure 1. Graphical Interface.

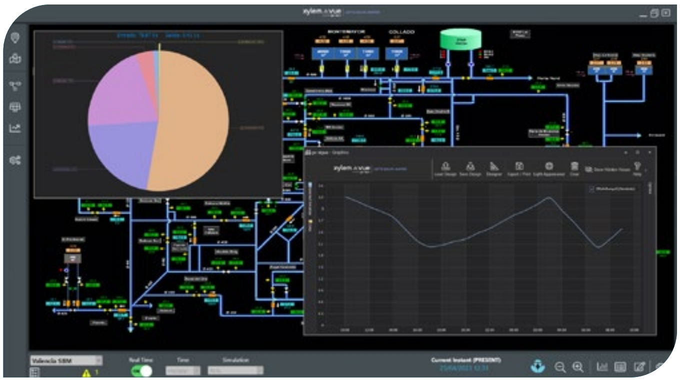


Figure 2. Examples of water balances and trend graphs.

Scalability and maintenance of the tool

The development of a standardized, scalable, easily updatable tool was key to the successful development of Valencia's digital twin. The tool keeps the twin constantly updated so that it is responsive and reliable but the platform is also ready to use in a variety of supply networks. This powerful, useful tool can, therefore, be used more extensively and the experience gained from years working with Valencia's urban supply network can be put to good use.

Figure 3. Results of hydraulic simulation shown against a geographical background.

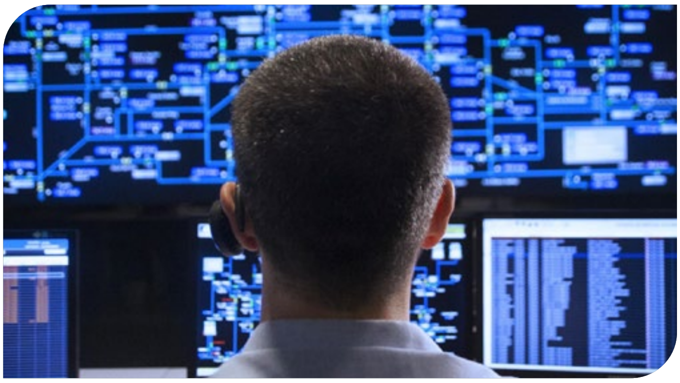
Benefits and results

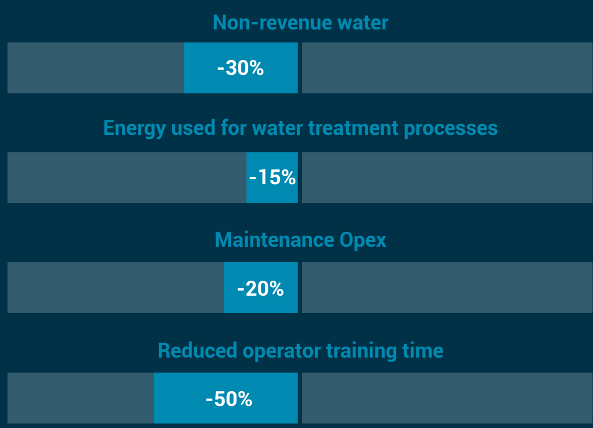
The digital twin in Valencia is seen as a benchmark in the industry. It currently enables the city to optimally manage its daily operations, to assess various operating scenarios in real time, to plan future supply development and predict how the network will behave in the future. It provides a complete overview of the network in real time, along with informative, actionable dashboards 24/7.

In addition to supporting Global Omnium's design and operational stages, it provides operational teams with valuable usage scenarios every day:

- Simulation of past, present and future scenarios under all kinds of operating conditions.
- Forecasts for network behavior in the next 24 hours, which facilitates the prediction of potential events (levels in water tanks, pressure, etc.)
- Helps operators to take short-term decisions and plan actions for the longer term, including long-term investments to optimize CAPEX and risk levels.
- Development of contingency plans for emergencies.
- Plays a key role in training new staff in network operations.
- Facilitates the analysis of hypothetical situations in real time and for both the past and the future, making it a tool which can support decision-making on the best times and dates for network maintenance and other operations.

The digital twin provides precise information on pressure and flow at the network's 10,000 nodes. This tells system operators the pressure at every point on the network and allows them to minimize leaks and improve the customer experience.





The implementation of different solutions that are part of the platform, including the digital twin, has enabled Global Omnium to reduce non-revenue water by over 30%, save 15% of the energy used for water treatment processes and reduce maintenance OPEX by 20%. The digital twin has helped to plan over 100 annual maintenance operations without incidents and reduce the time required to train operators by 50%. In addition, the water utility has drastically reduced the maintenance costs of its assets by preventing potential faults before they occur. Global Omnium has saved over 4 Hm^3 of water thanks to this technology.

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Xylem |ˈzīləm|

1) the tissue in plants that brings water and nutrients upward from the roots.
2) a leading global water solutions company.

Xylem is the connective tissue and system in plants which cleanses and transports water from the root to where it is needed most to sustain life.

And this is the essence of Xylem as a company. We are committed to driving sustainable impact by ensuring our connected technologies and solutions support our customers and the communities they serve, to tackle the water challenges that matter most to them.

For more information on how Xylem can help you, visit xylem.com

xylem vue

Xylem Vue is the result of the partnership between Xylem, a global leader in water technology and Idrica, an international pioneer in water data management, analytics and smart-water solutions. Through this partnership, Xylem and Idrica bring together their technology, innovation, and expertise to solve the world's most critical drinking water, wastewater and other water-related challenges.

Our single, integrated software and analytics platform – built by utilities, for utilities – enables utilities to take digital transformation to the next level, maximize investments, identify and solve problems more quickly, operate more efficiently and deliver water more effectively and affordably to their communities.

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