



LoRaWan for Smarter Management of Water Network: From metering to data analysis

Jorge Francés-Chust¹, Joaquín Izquierdo² and Idel Montalvo^{3*},

¹Aguas Bixquert, S.L., c/ José Chaix 7, 46800 Xàtiva, Valencia, Spain

²FluIng-IMM, Universitat Politècnica de València. Cno. de Vera s/n, 46022 Valencia, Spain;

³IngeniousWare GmbH Jollystraße 11, 76137 Karlsruhe, Germany;

* Corresponding author. Tel.: +49-162-5459360;
imontalvo@ingeniousware.net

Water distribution systems (WDSs) are large complex infrastructures made from pipes, valves, pumps, tanks and other elements designed and erected to transport water of sufficient quality from water sources to consumers. The amount of the above elements, which can reach up to tens of thousands of links and junctions, their frequently wide spatial dispersion and the WDS characteristic of being very dynamic structures make the management of real WDSs a complex problem [1-4]. However, although the main objective is to supply water in the quantity and quality required, other requirements are essential, namely maintaining conditions far from failure scenarios [5,6], ability to quickly detect sources of contamination intrusion [7,8], minimization of leaks [9-10], etc.

Advances in low powered sensors and data transmission are making their way on the creation of smarter water networks. Despite prices are getting attractive, the return on investment is far from being clear for many water company managers in the water distribution industry. To be prepared to arouse in these managers a real interest in the need for the implementation of an adequate lattice of sensors in their water distribution networks, and to provide them with convincing arguments for their rapid implementation three important questions should be first answered that should be clearly perceived as main support elements in ad hoc decision-making: firstly, how many sensors are needed; secondly, where sensors should be located in order to get the most out of them; and, finally, what to do with the measurements in terms of improving operation and customer services. This contribution addresses the third of these questions without forgetting the other two and present a pilot project at early stage.

There are three aspects crucially important for water utilities and where the correct use of measurements makes the difference on what the company can achieve: reduction of non-revenue water, network operation optimization and provisioning of a quality service. This contribution presents the development of a platform for Smarter Water Network Operation and Management specifically aimed to support the three mentioned aspects. It uses a water network analysis engine to estimate the state of the water network based on measurements taken from the field combined with a mathematical model of the water distribution network. The estimation of the network state is done starting

from the current moment of the analysis and looking 24 hours ahead. This makes possible to optimize the operation of pumps for the next 24 hours considering the price of energy, the expected demands and the available tank capacity in the network. The operation decision of pumps is corrected every hour and can be directly transmitted to the pump station or introduced there by an operator depending on the technology available.

A sensible element in the mathematic modelling of water networks is the estimation of demands. Sub-estimating demands when optimizing the operation of the network can result on a lower quality of the service. Overestimating the demand would result on over costs. The platform developed includes the possibility to receive the consumption measurements directly from water meters installed at the client side or at different interest points of the network. This way, demand values and forecasting algorithms will be periodically getting updated based on the information received. Measuring demand will help in this case not only to improve the results of the operation optimization but also to create a water balance between the water volume supplied and consumed in the network. Water balance is the first analytic step to start estimating non-revenue water in a distribution system. Running water balances for subregions or sectors of the network can help to locate zones with a higher leak impact. Identifying these zones and eliminating their leaks will improve the levels of non-revenue water at utilities. The effect of leaks and as consequence the non-revenue water volume can be also improved by managing properly the pressure of the network based on a robust mathematical model of the distribution system. Additionally, consumption measurements will also help to achieve a better quality in the service: the platform checks the plausibility of consumption and inform both the utility and the client about potential leaks at the client side. Discovering leaks at the client side will avoid the surprise of receiving an expensive invoice with a high consumption due to undetected leaks.

The development of the platform described here is the result of a collaboration between the group Fluing of the Polytechnic University of Valencia, Aguas Bixquert S.L. and Ingeniousware GmbH. This collaboration has resulted in a pilot project developed at a water distribution system managed by the company Aguas Bixquert S.L. For instrumenting the water network, it was considered convenient to use high energy-efficient sensor nodes, preferable battery based and able to communicate across long distance. These characteristics motivated the use of Low-Power Wide Area Networks (LPWAN) [11] technologies for supporting measurements in the pilot project. A LoraWan [11] antenna was installed at a high point of the zone and it redirects all measurement data to the servers of Ingeniousware where the platform for smarter water network is running. About 30 water meters transmitting consumption via LoraWan has been already installed at different part of the network. Installation directly at clients will happen in the next phase of the project. A first version of the mathematic model of the water network has been developed and can be visualized directly from the platform. Consumption at all water meters installed can also be visualized as well as transmission statistics. Installed water meters has a temperature sensor integrated and transmit also the temperature value at the installation point. Temperature is a factor that improve significantly the estimation of the water consumption in the network.

The coverage of the data transmission, its stability and the accuracy of the received consumption measurements compared to manual reading of the water meter has been

evaluated. A water meter test bank has been created for these purposes. The most important conclusion of our evaluation is that certification authorities should include an additional error produced at water meters when converting the mechanical movement of the device into a digital signal. Differences from up to 18% were obtained when comparing transmitted values with values read directly from the water meter. It makes think about the necessity of extending the certification of metering devices that consider the maximum error they can have depending on the existing flow. This certification that defines the class of the device and the range of flow where it may work should also consider the potential errors happening when converting the mechanical movement of the water meter into a digital signal. Note that all water meter installed until now in the pilot project are mechanical. A different situation may happen in the case of water meter based on different measurement technology like the ultrasonic but it is still to be tested. At the current stage of the project water meters from only one company has been tested and it is expected to include at least two additional water meters providers for comparison purposes.

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