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Clean Water Monitoring (CWM) Project

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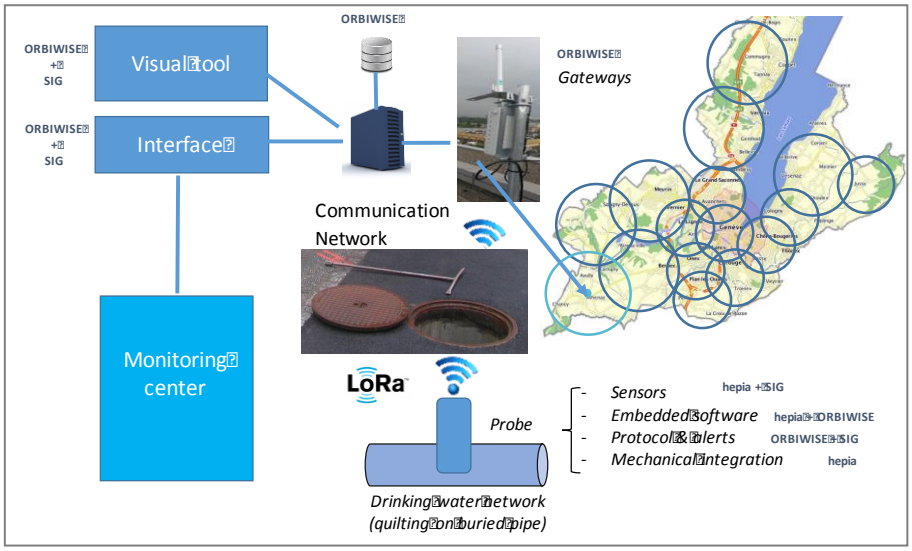
Key words
Drinking water monitoring, multi-sensors probe, residual chlorine, turbidity, water velocity, Internet of things, LoRa

Aim of the study
Development of a multiparameter self-powered probe with a data transmission over a wireless network to monitor in real time the evolution of the quality of drinking water on the network.

Material and methods
The global concept of the Clean Water Monitoring (CWM) project is the following. The probes will be inserted in buried pipes at specific locations of the water distribution network. Each system communicates wirelessly by LoRaWAN™ and the measured data are send via a communication network to the dispatching center located in the Geneva Water headquarter.



One of the challenges was to integrate all the needed sensors (see Table 1) in a unique probe of less than 40 mm of diameter. The probe will be installed into a pipe having a diameter ranging from 100 to 500 mm, without interrupting the water distribution.

Parameters	Details	Measuring ranges	Accuracy / Resolution	Critical element for the project
Turbidity	. Sensor developed in this project (photometry)	Range 1 : 0.1 to 1 NTU Range 2 : 1 to 10 NTU	0.1 ± 0.1 NTU 0.5 ± 0.5 NTU	-
Residual Chlorine	. Existing solution (Microsens SA) using the amperometric method . Very small sensor chip	Range 1 : 0.01 à 0.2 mg Cl2 / L Range 2 : 0.1 to 0.5 mg Cl2 / L	0.01 ± 0.01 mg Cl2 / L 0.1 ± 0.1 mg Cl2 / L	X
Temperature	. 2 sensors in 1 . Existing solution (conductomety)	0 à 30 °C	0.1 ± 0.1 °C	X
Conductivity		5 à 1 000 µS / cm	5 ± 5 µS / cm	
Water velocity	. Existing solution (paddle wheel) . Ability to know the direction of the hydraulics flow	0 à 2 m/s	0.1 ± 0.1 m/s	-
Pressure	. Existing solution (piezoresistive)	0.1 à 16 bar	0.1 ± 0.1 bar	-

Table 1 *- Measured parameters, range and accuracy/resolution requested*

The electronic modularity concept allows to integrate additional sensors: two printed circuits are needed for the six measures but inside the probe there is two complementary slots for the sensors extension.
The probe encompasses a wireless communication module (on 4a specific board) to regularly transmit measurements results and raise at any time potential alerts. The most suitable wireless communication is based on the emerging LoRaWAN™ protocol. The frequency of the measurement sampling can be selected by the user. The acquired data are stored in the probe and transferred in one time at a lower frequency than the sampling, in order to reduce the energy consumption. Nevertheless, in case of detection values going out of expected ranges, a transmission to the dispatching center can be triggered by the probe itself without waiting for the next scheduled transmission slot. The whole system is integrated with the dispatching center's SCADA system, and information is displayed on operational control screens. The operators can send in return specific commands to the probes from their control panel (modify the probe configuration, launch calibration procedures).
From the mechanical side, an original and innovative design concept has been applied for the probe and the manipulation tools in order to safely install the system into the buried pipe without interrupting the water distribution.

Results and significance

The project is currently in phase of prototype tests. Due to the great variety and complexity of the sensors, the interaction between the electronics, the mechanics and the communication, it has been necessary to delay the tasks of validation and calibration. Tests have been undertaken in our laboratory, others in the Geneva Water facilities in order to be as close as possible to the final application, and to compare and validate all of the integrated sensors and conditioning electronics.
To this date, the Clean Water Monitoring project is very promising and awaited by Swiss water suppliers in order to improve the control of the network operations and monitoring the water system. At this time (August 2016), the first trials are those expected and the validations are on-going. The prototype for functionality and performance tests on the water network distribution, with data collection, will be fully operational during the last quarter of 2016. We expect to deploy additional probes early of 2017.

Publications, posters and presentations

Giandomenico, N.; Mastrocola, R.; Hélal, D.; Dubouloz, S.; Jeanneret, B.; Perdaems, P. (2016) Clean Water Monitoring Project. Water Research, journal of the IWA.
LoRa Alliance: www.lora-alliance.org

Project *4.16.a*

Project duration *October 2014 – June 2016*