

# SunRise : Smart Urban Networks for Resilient Infrastructure & Sustainable Ecosystems

## Smart City Demonstrator

*Professor Isam Shahrour*

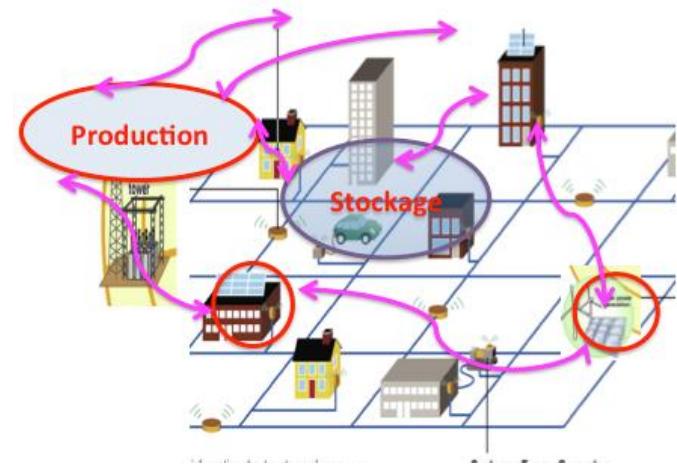
*Director, LGCgE*

*Professor Ilan Juran*

*Director W-SMART R&D Center*

*(University Lille1/Polytech'Lille)*

*Bruno Nguyen,  
President, W-SMART*



## 70 km Urban Network:

- Water (drinking and sewage)
- District heating
- Gas
- Electrical
- Public lighting



# Scientific City Campus



## Small town:

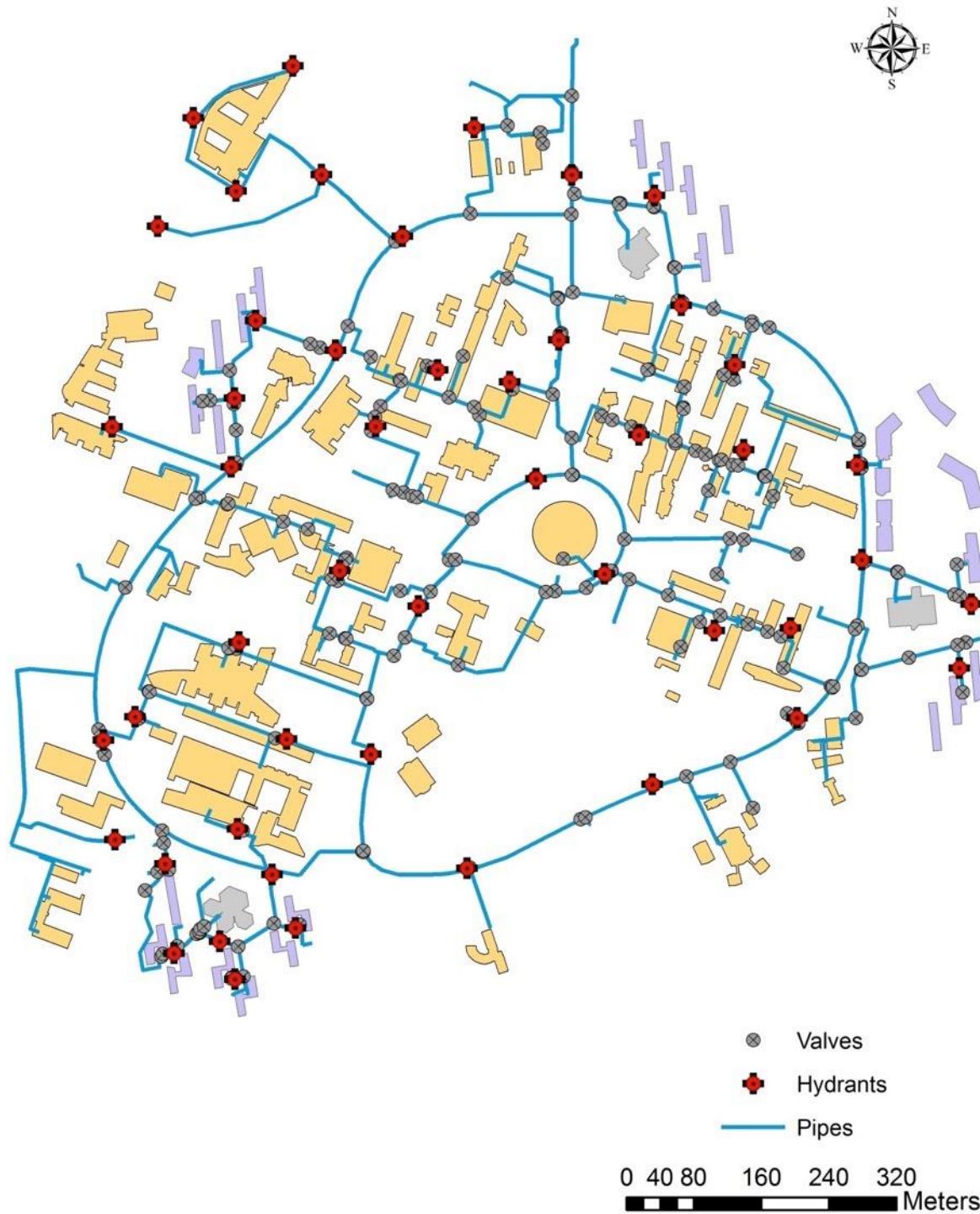
- 110 Hectares
- 23 000 users
- 70 km of Urban Network
- 300 000 m<sup>2</sup> of constructions



## SWN:

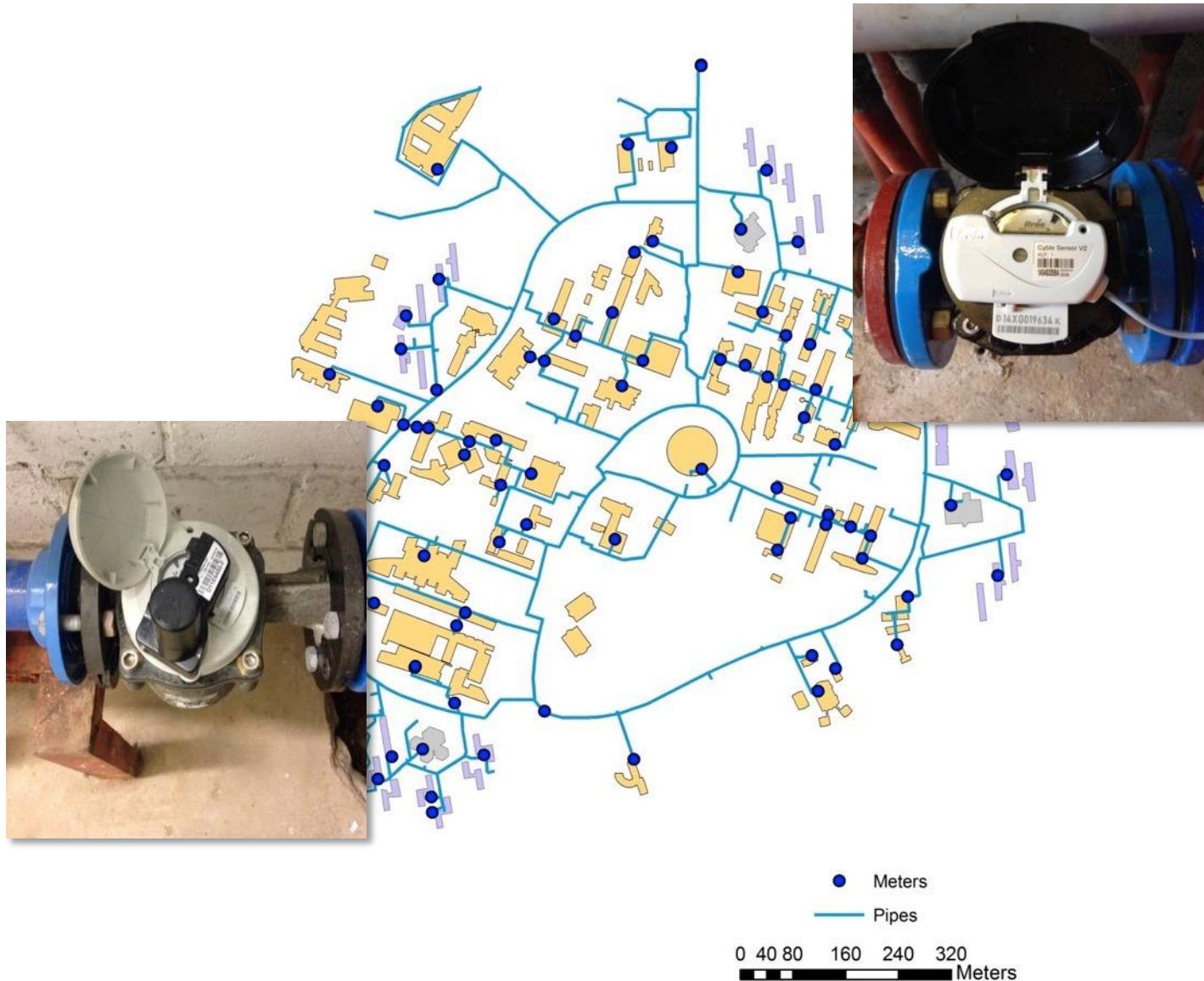
- VITENS
- EAU DE PARIS
- EAUX DU NORD
- KWR
- Université de Lille
- CEA-List
- CALMWATER

- 15 Kms of networks
- 49 hydrants
- 250 valves



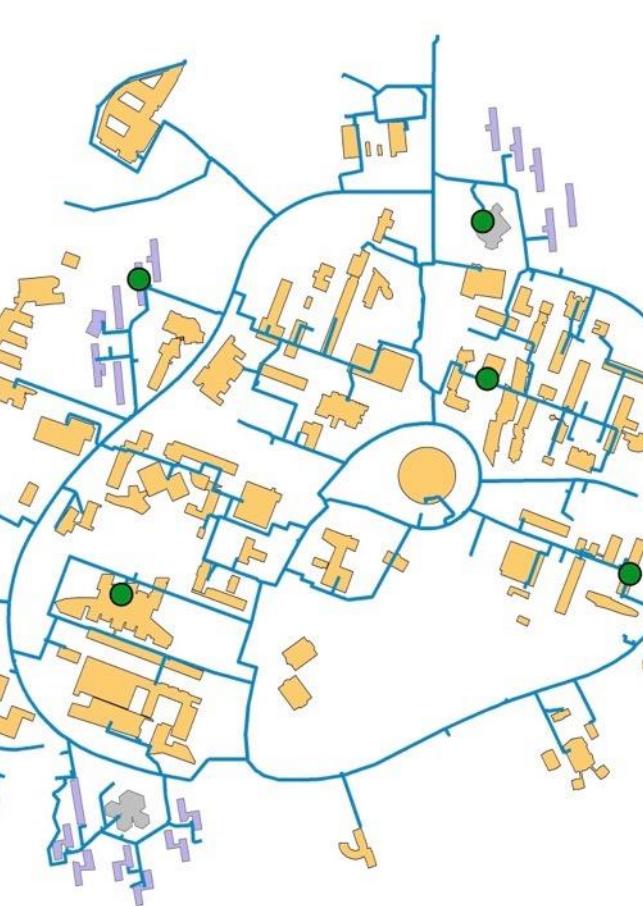
# Monitoring :

## 90 Automatic Meter Readings (AMRs)



# Monitoring :

## 5 Pressure sensors

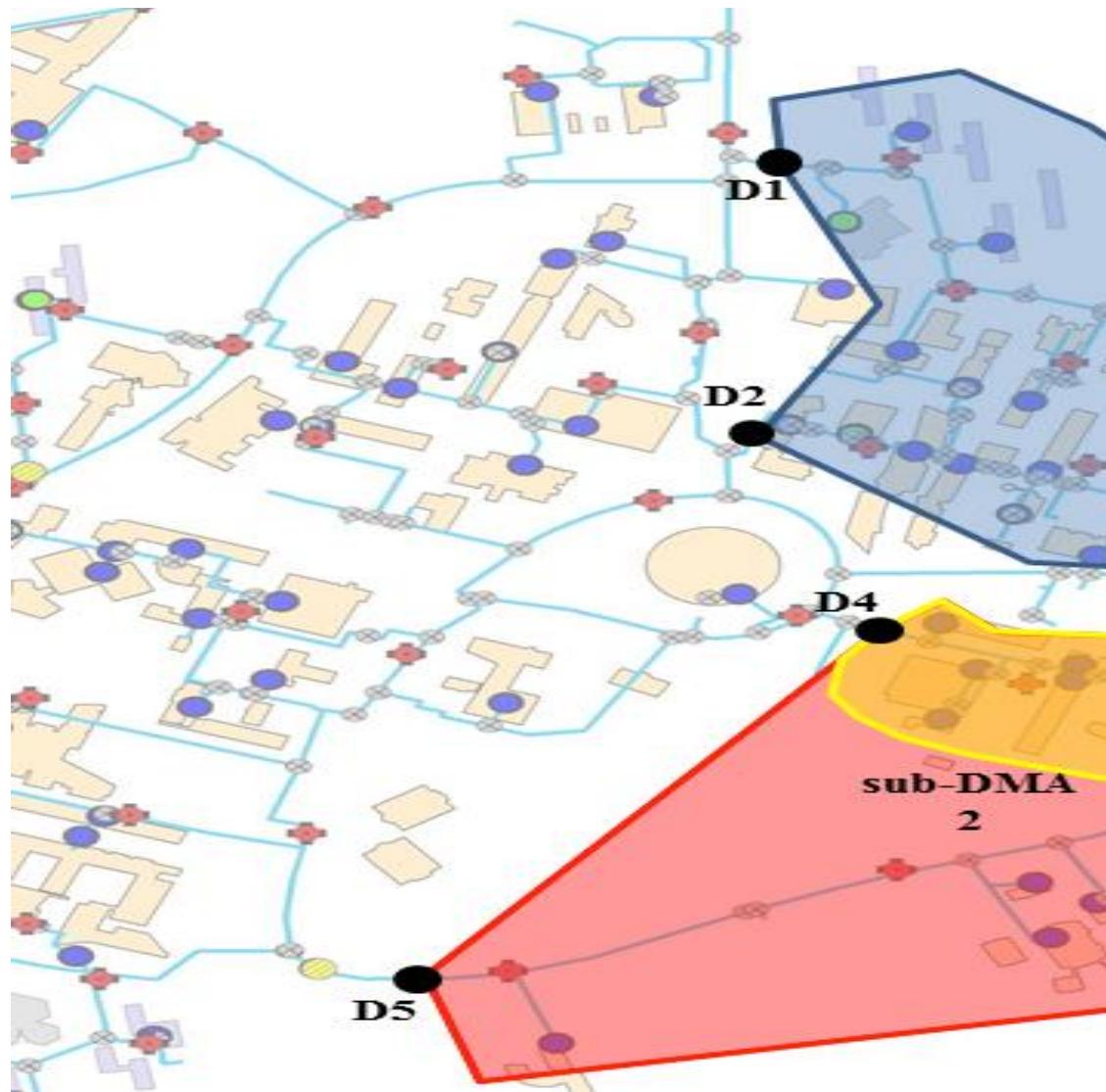


● Pressure sensors  
— Pipes

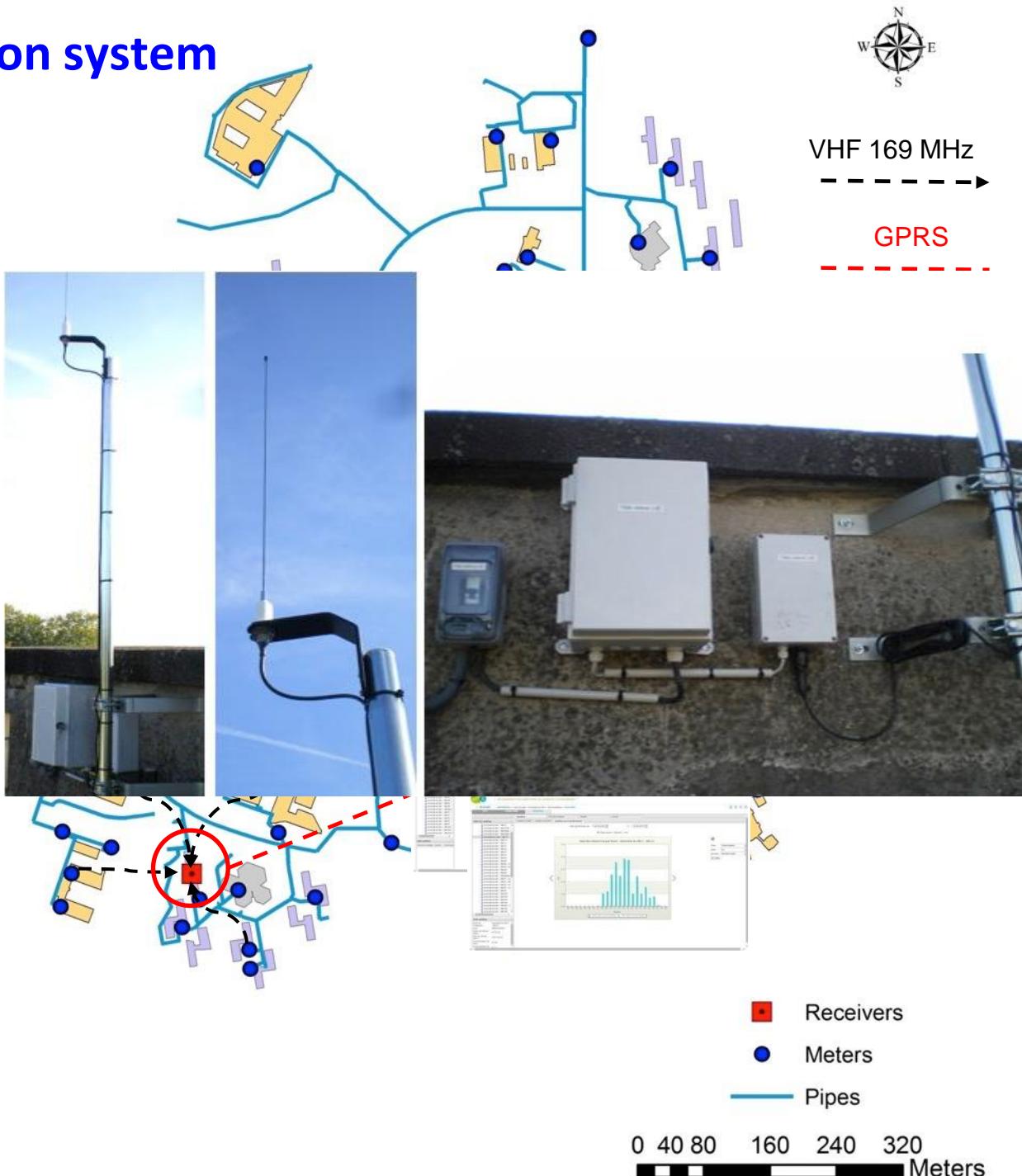
0 40 80 160 240 320 Meters

# Monitoring

## District metered areas (DMA) (under construction)

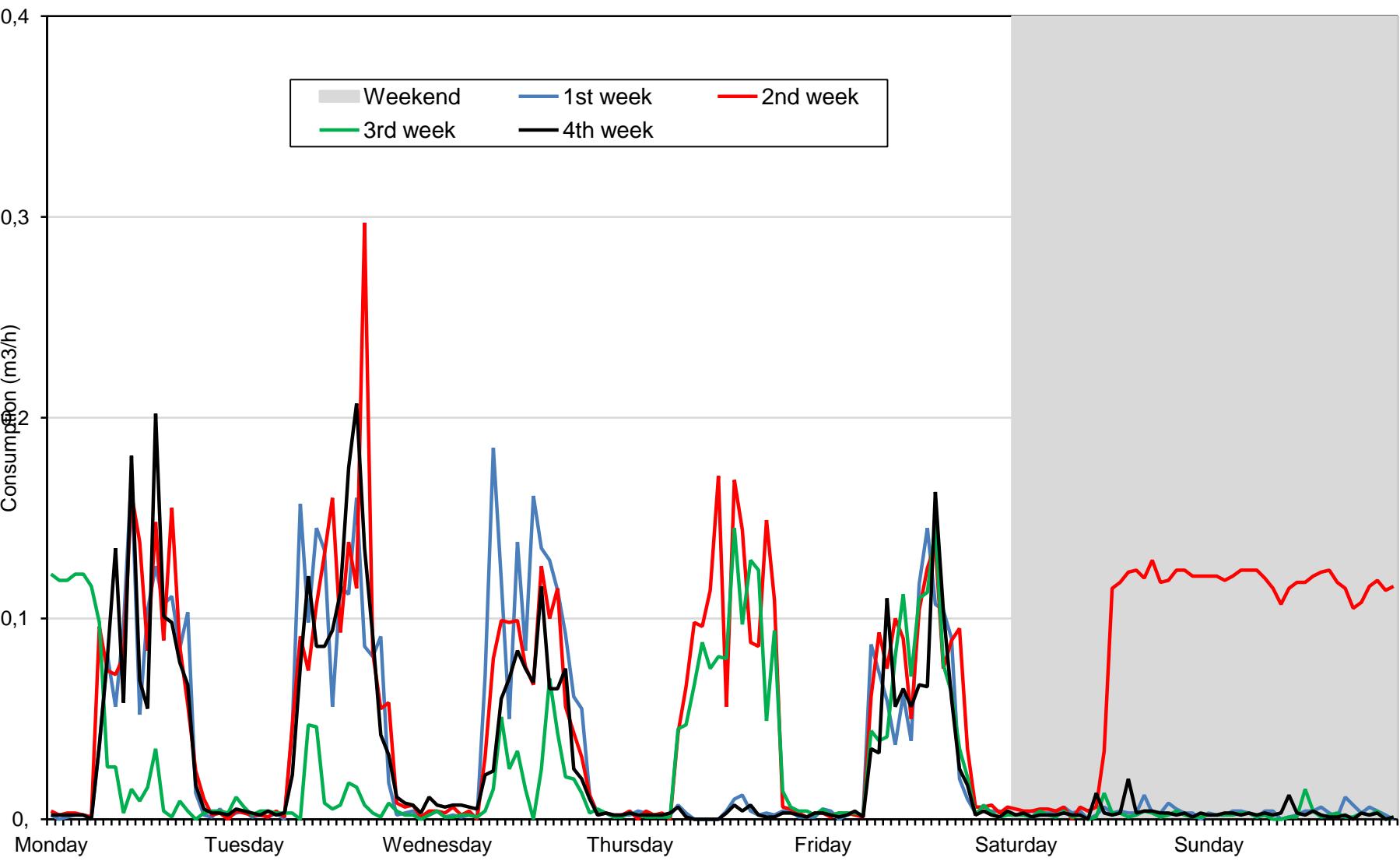


# Data collection system

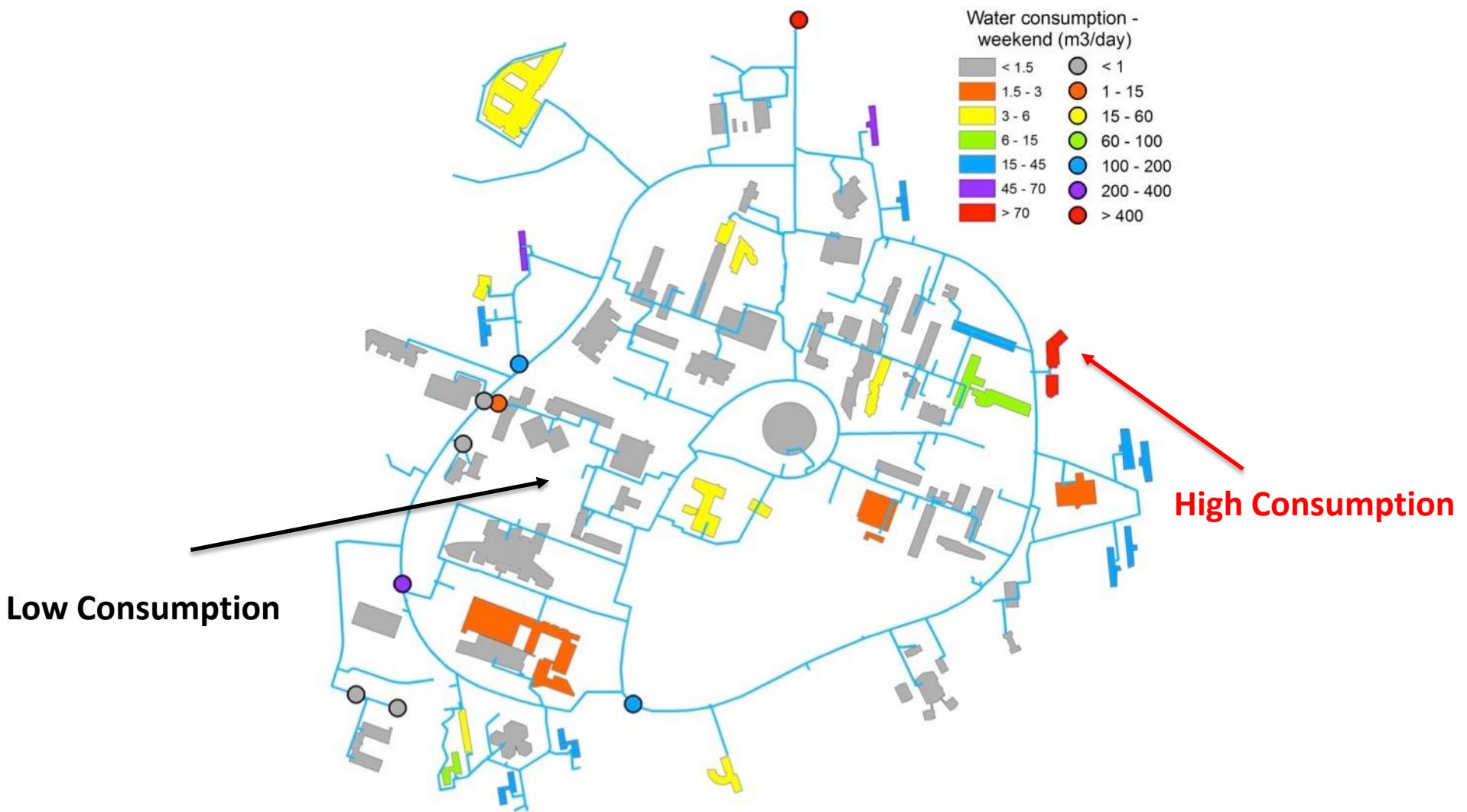


# Example of AMR reading

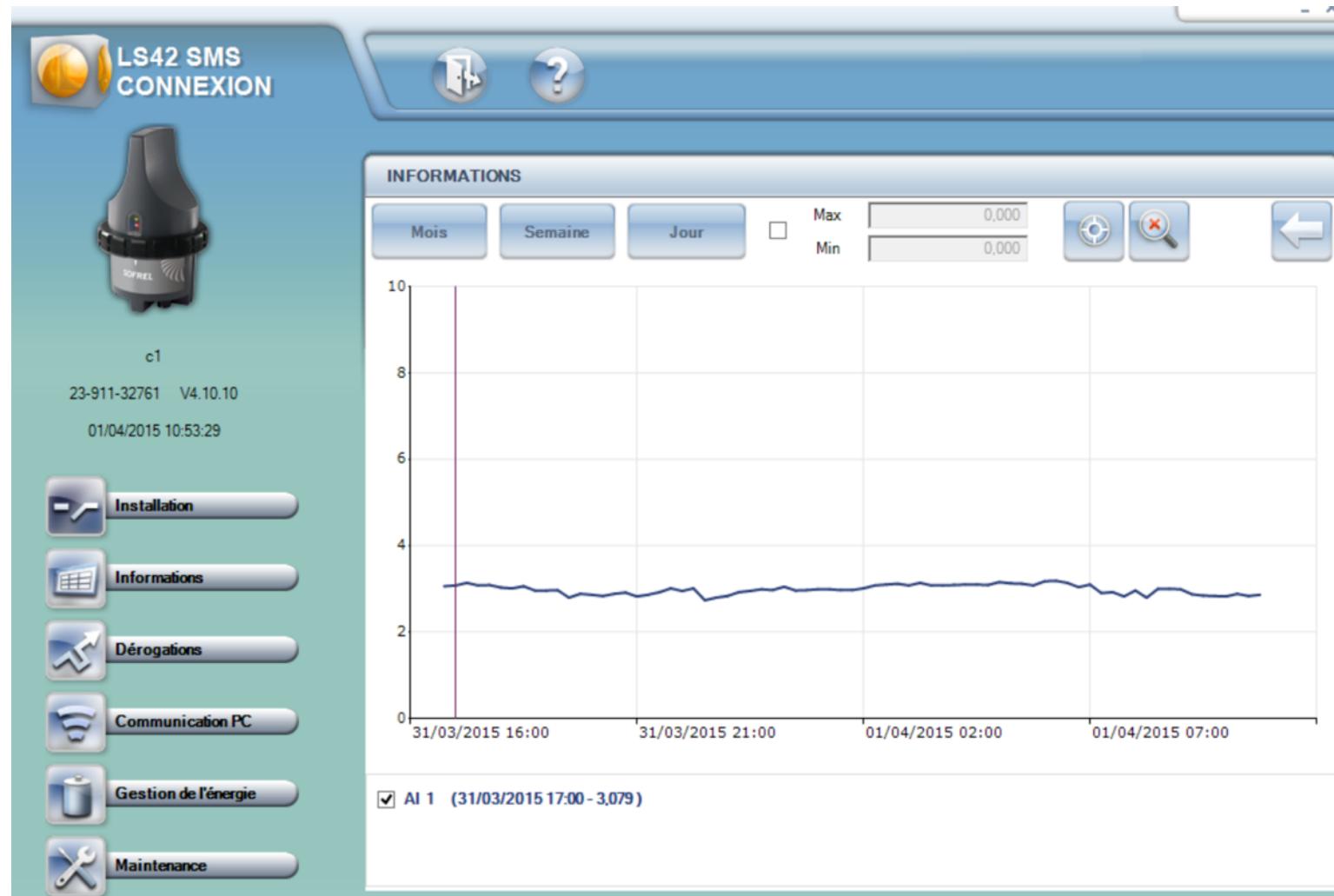
Water consumption of P2 (May 2014)



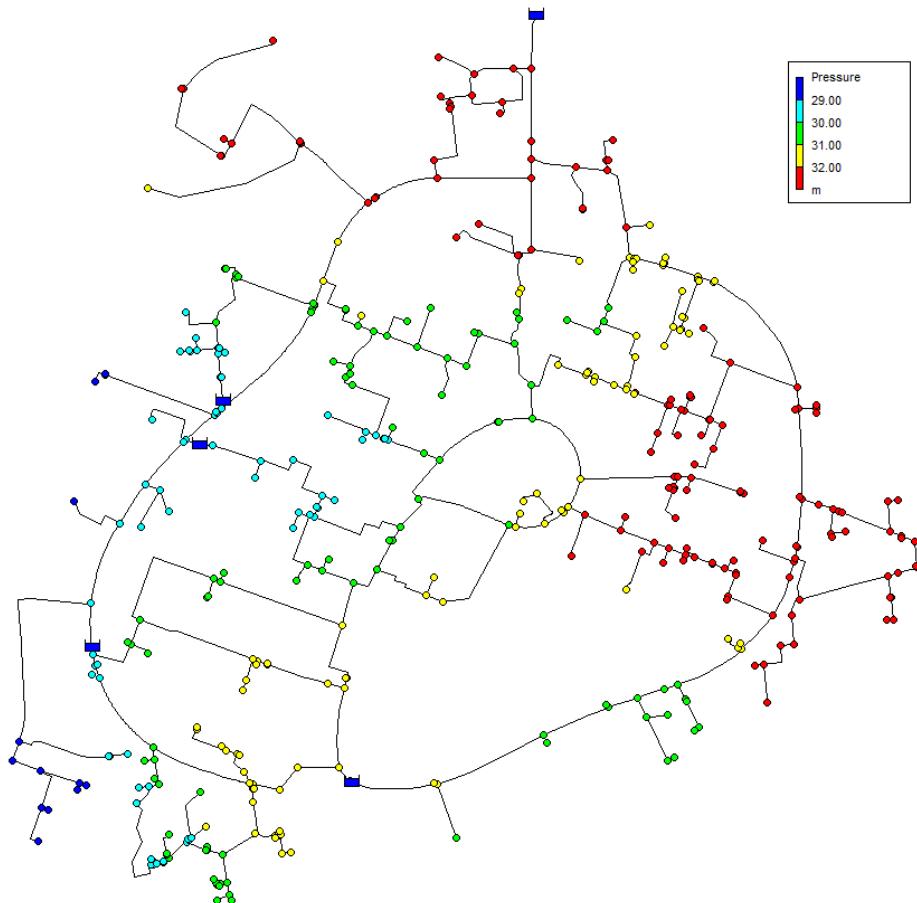
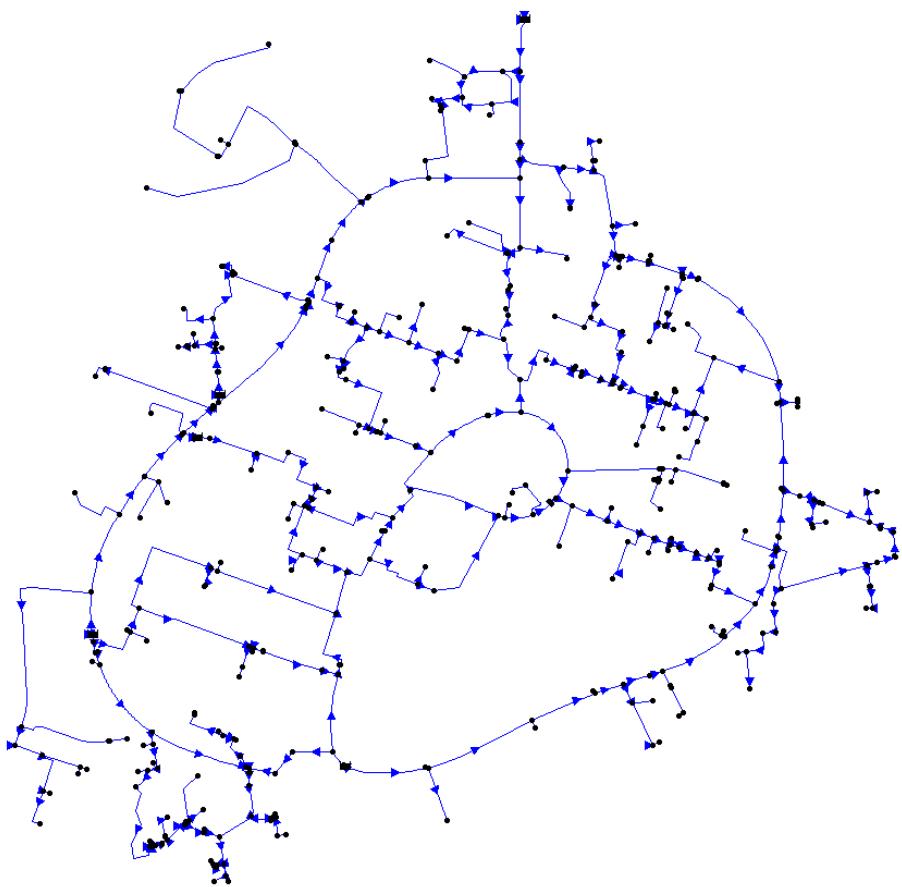
# Water Consumption in the Campus (week-end)



## Example of pressure variation



# Hydraulic Modeling (EPANET)



## “W-SMART”

**Water Security Management Academy for Research & Technology**

**–University Industry Collaborative Research & Development Center**

**University Lille-1 – W-SMART – KWR Research Institute – CEA LIST Institute**



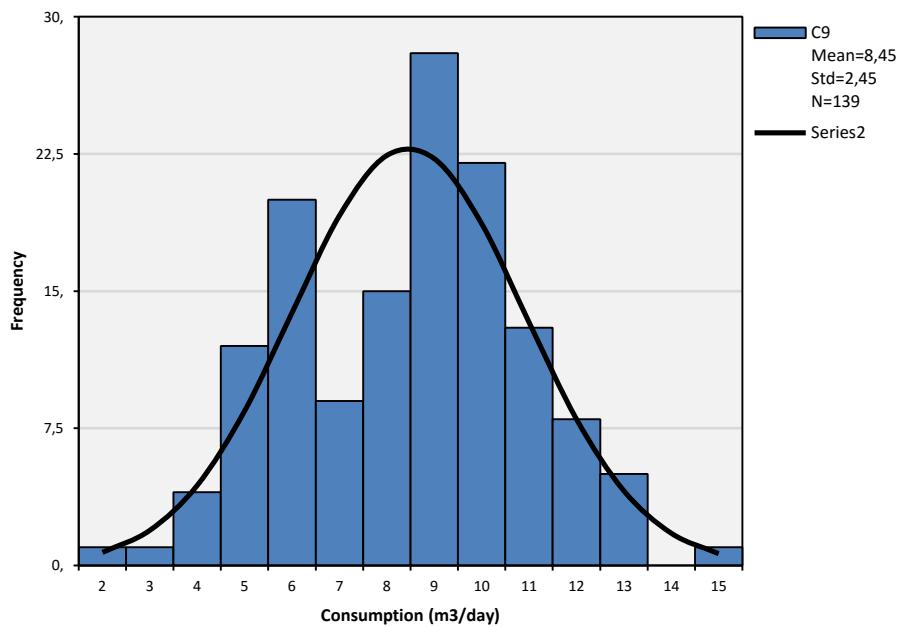
**Bio-SMART sponsored by EDP, SEN, VITENS**  
**Bio-Safety Monitoring & pro-Active Real-time conTrol**

**INCOM sponsored by EDP, SEN**  
**Intelligent Network Control & On-site Monitoring**

**SmartWater4Europe sponsored by EU-FP7**  
**Smart Water Network Demonstrator Project - VITENS**

# Leak detection methods

- Analysis of the minimum night flow (MNF) measured
- District metered areas (DMA)
- Statistical analysis of historical data



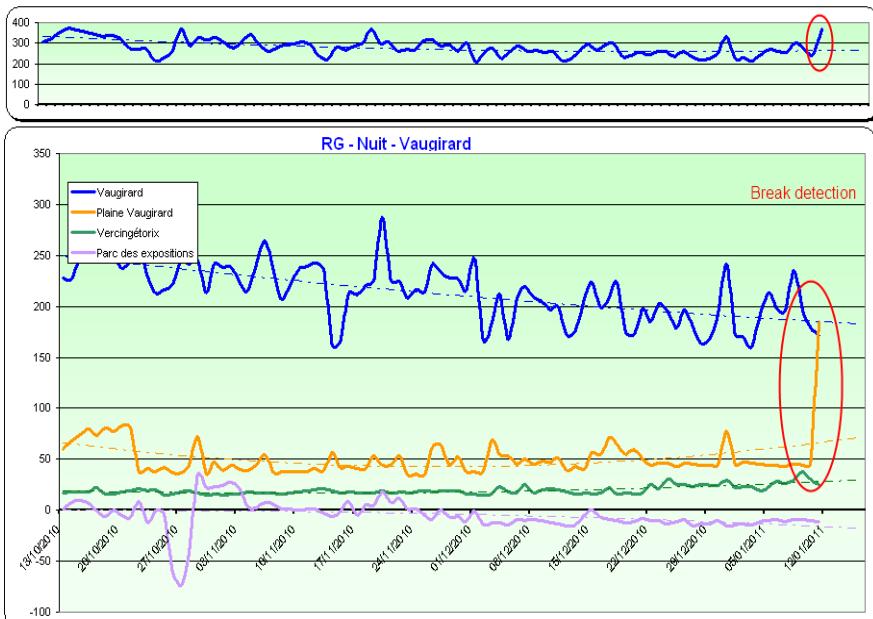
# Leakage Detection

## Leakage detection with increasing average night flow and daily distributed volume

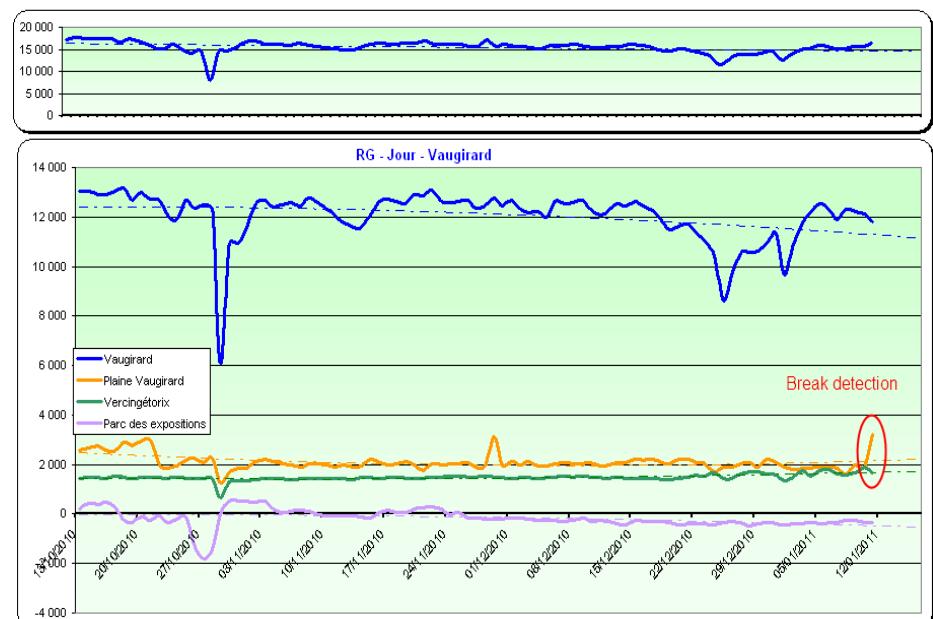
Most of leakage detection are detected with the average night flow and confirmed with the daily distributed volume.

Rising detection has to be correlated with operation events (it can be due to filling swimming pool for example).

Average night flow

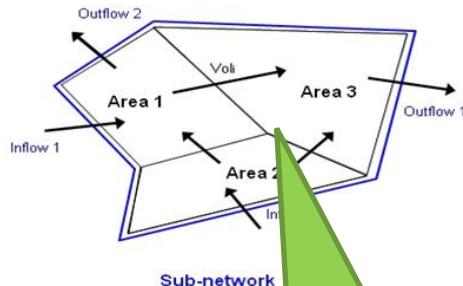


Daily distributed volume



# Limitation: Mirror Effect

Majority errors in analysis of the distribution data for leak detection are due to a default in the human identification of the mirror effect.



Deficient flow-meter between two areas (volume transferred not measure) therefore “mirror effect” while the sub network curve of distributed water is not affected.

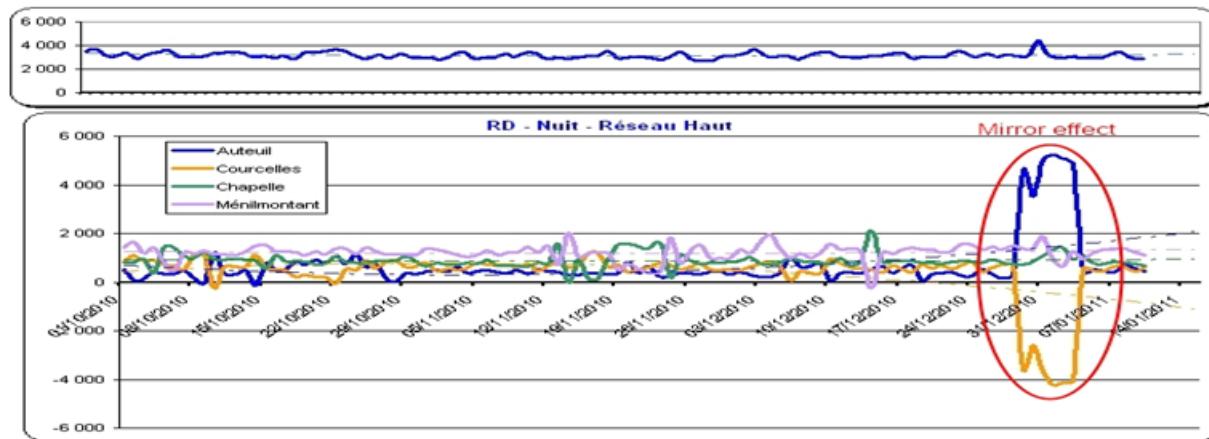
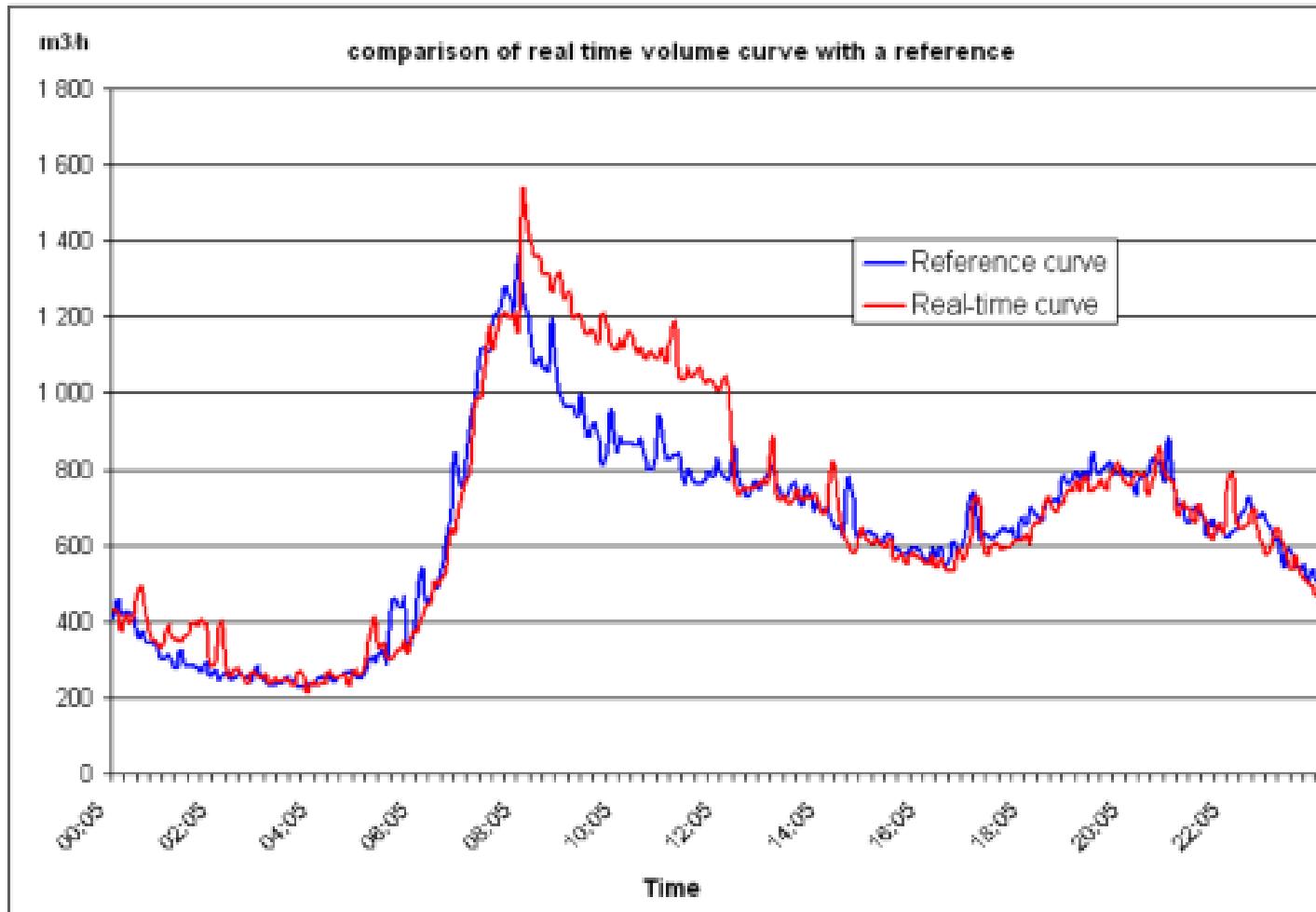


Figure 16: Mirror effect of an area flow-meter default.

# Leakage detection with virtuals sensors

Efficient 2011

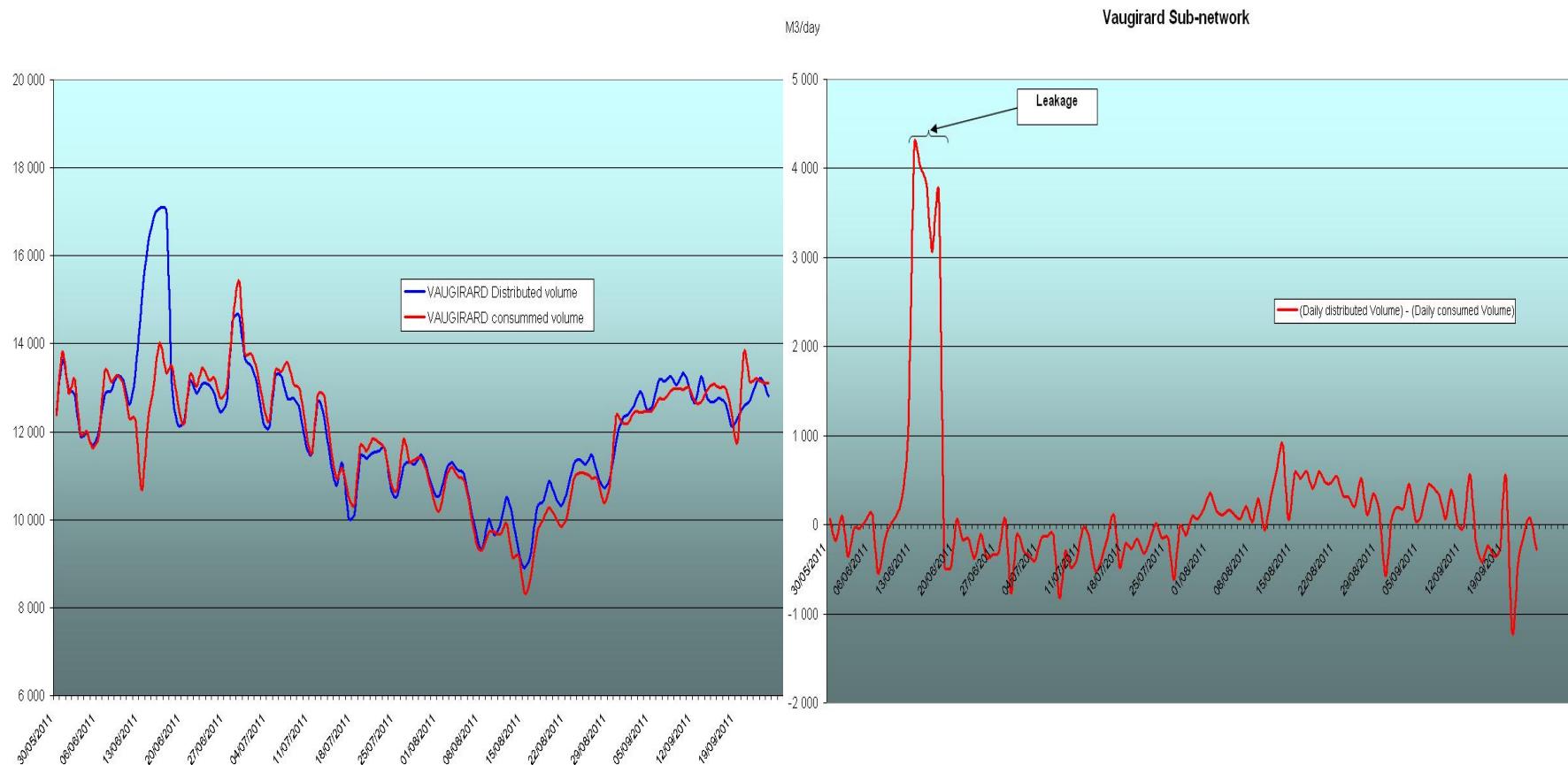
INCOM



The real-time sub-network distributed flow rate water is compared to the historical flow rate water for similar period

A low and high threshold alarm system detect abnormal evolution of the sub-network water distribution

# AMR-DMA Pipe leakage detection example

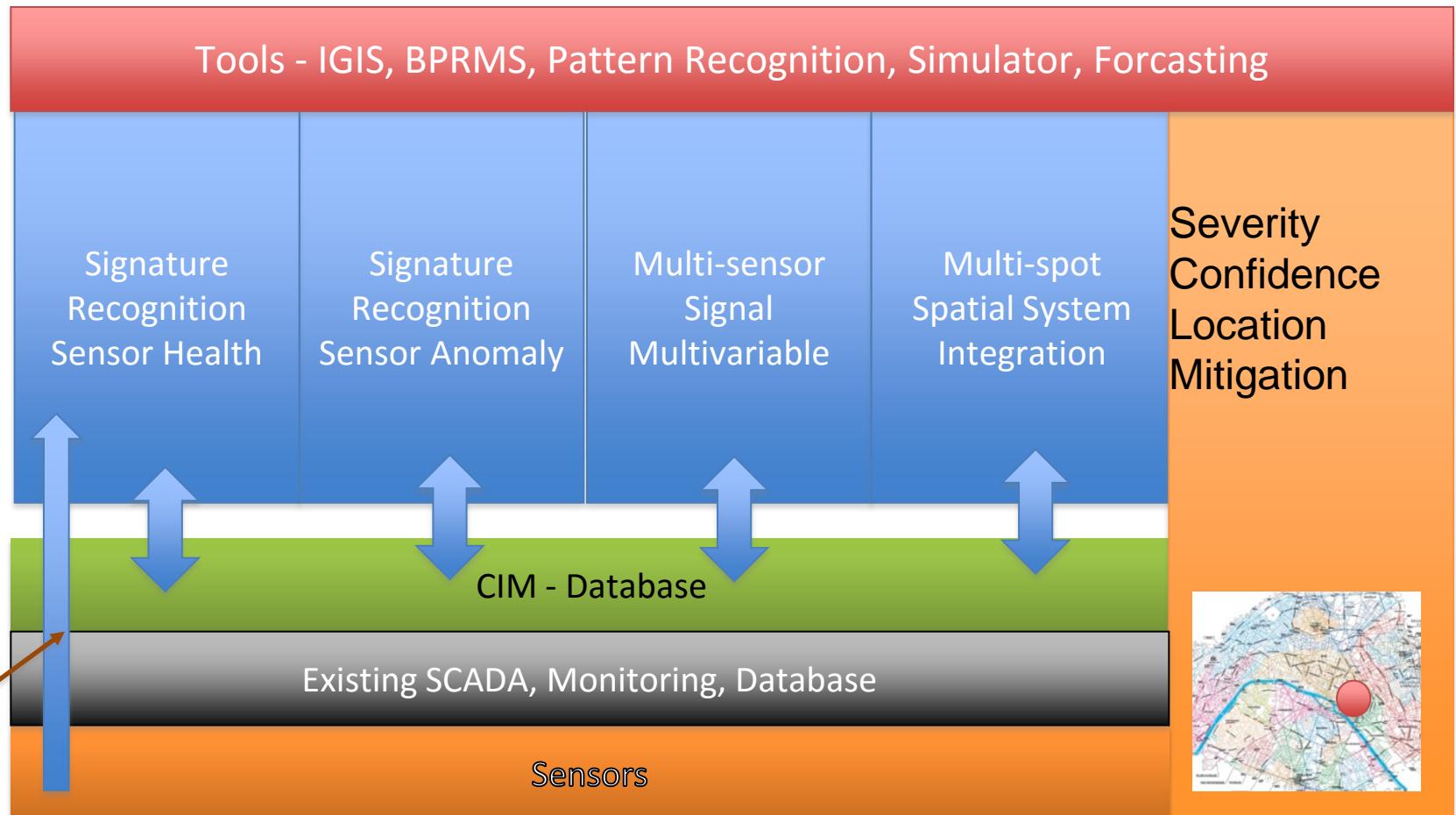


Comparison between **Daily water distributed volume** trend and **Daily water consumption volume** trend in the same sub network.

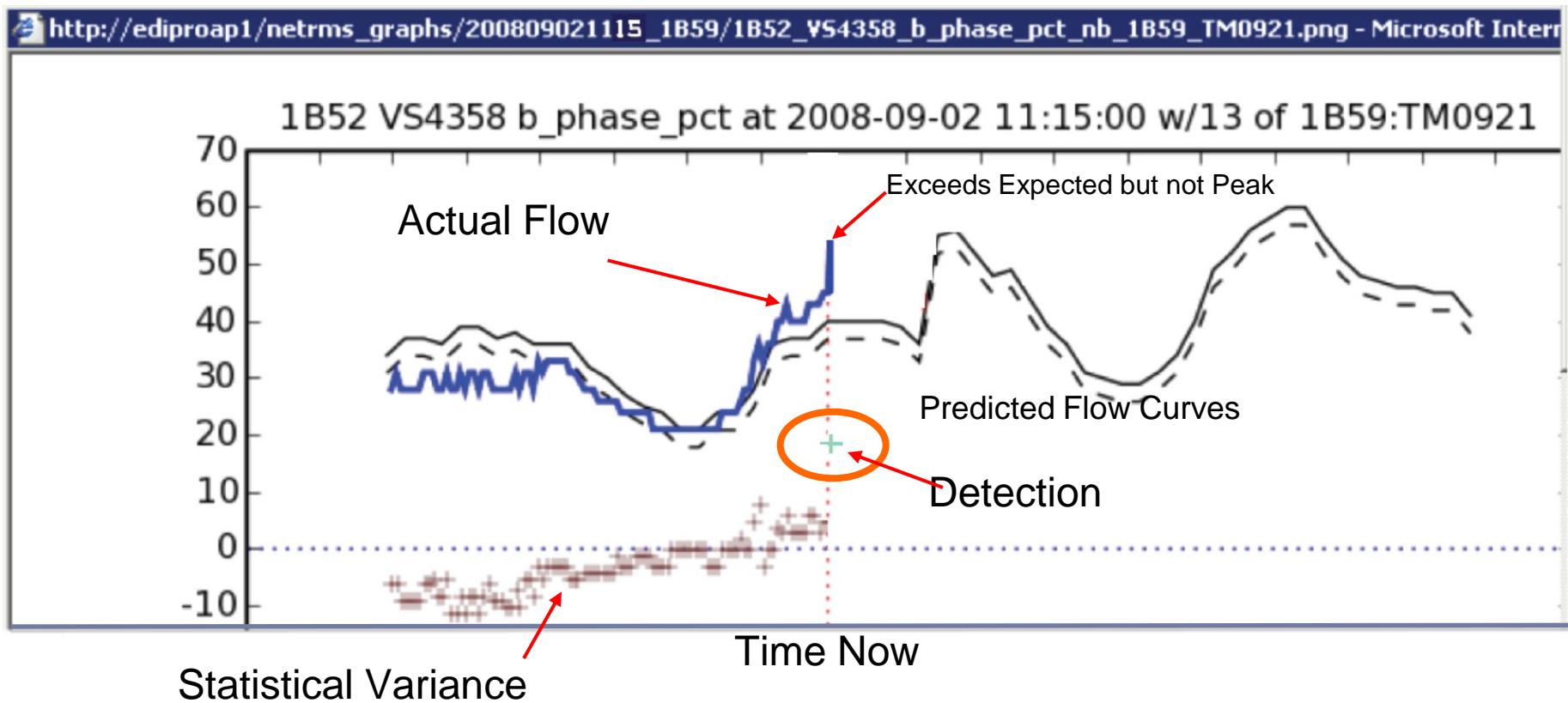
**Daily water losses** calculated trend in a sub network.

# Command and Control System of Systems

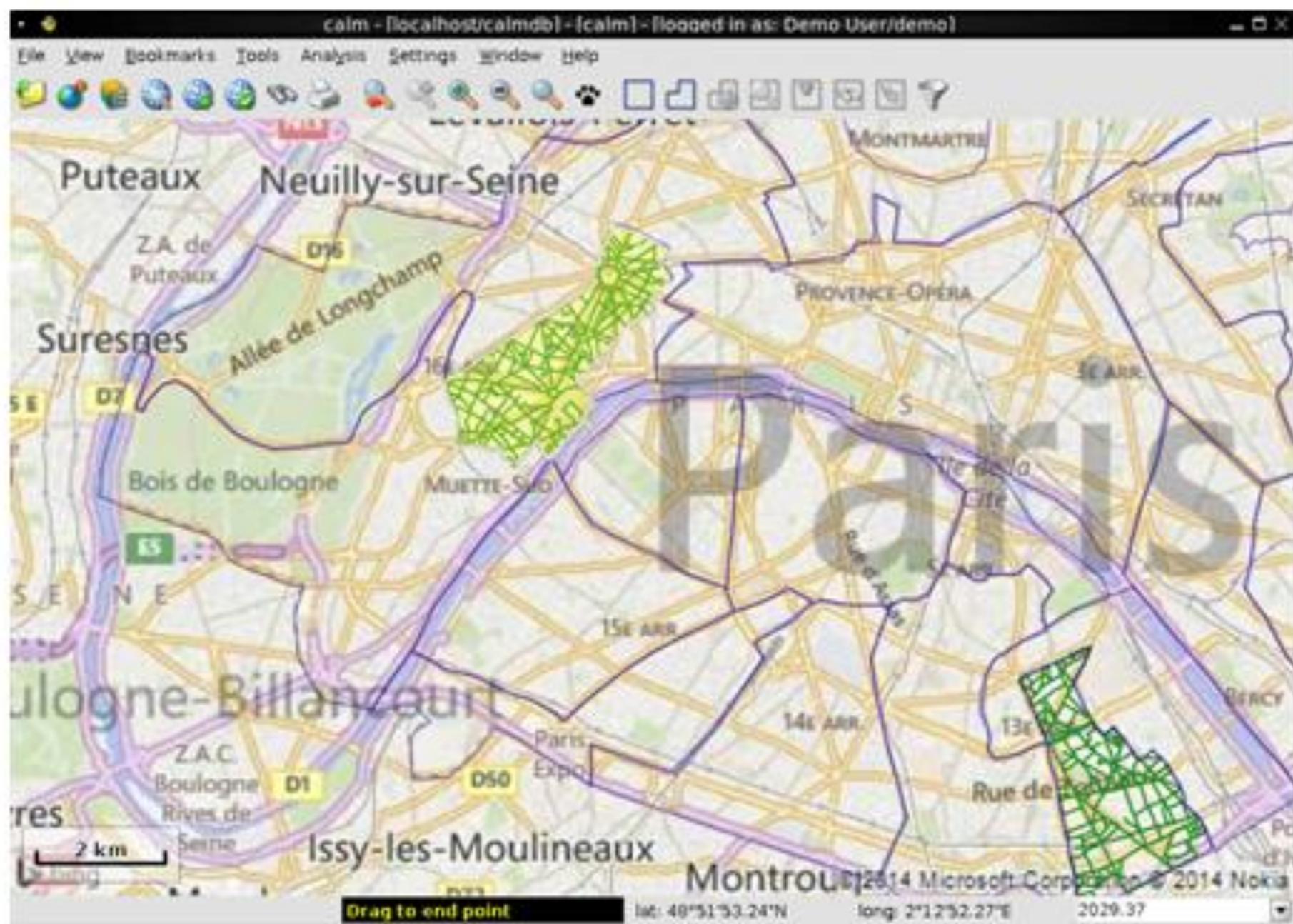
## C2SOS



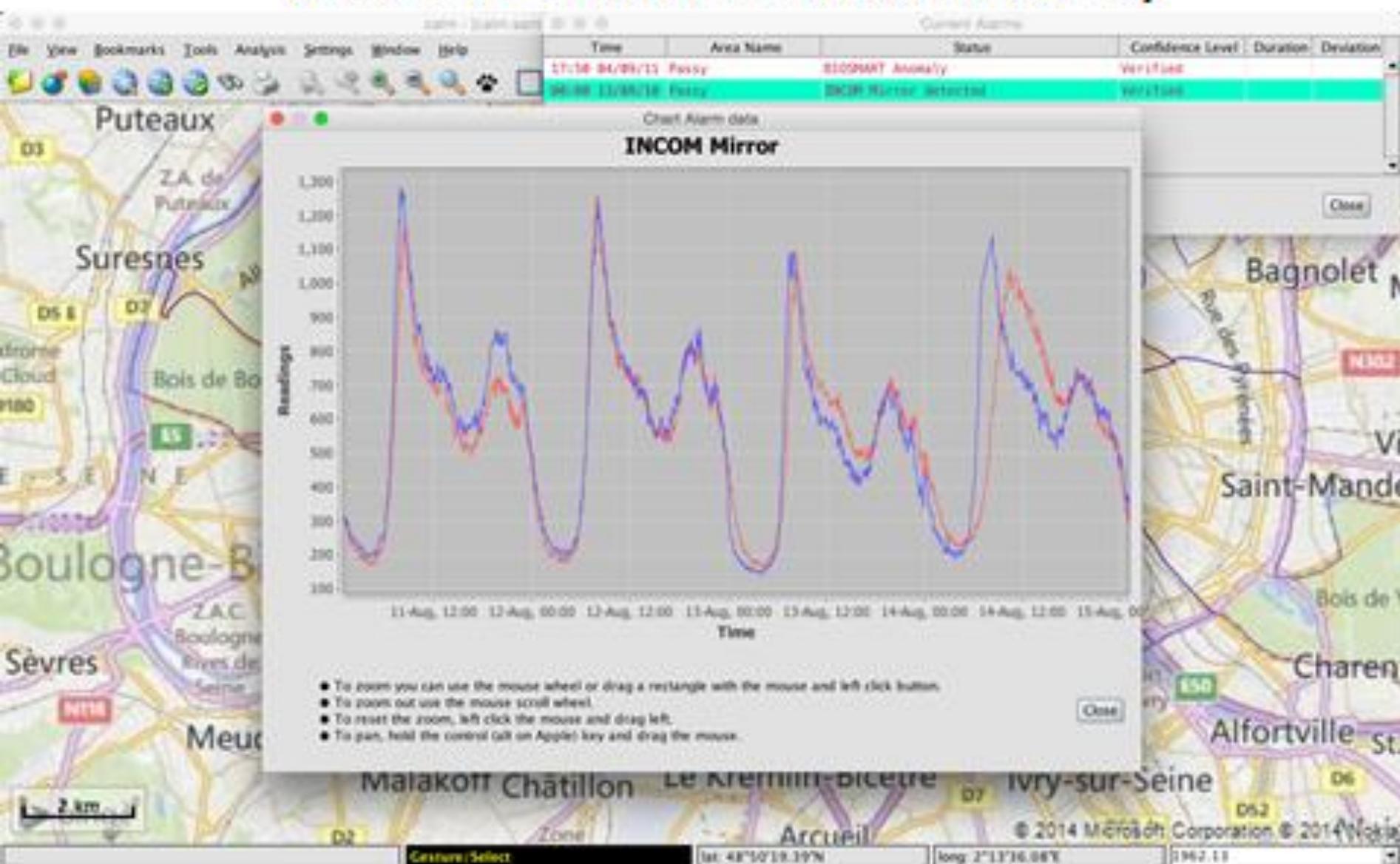
# Anomaly Prediction - Flow



## Using Actual EDP Data from two DMA to Demo-Simulate Leak Detection

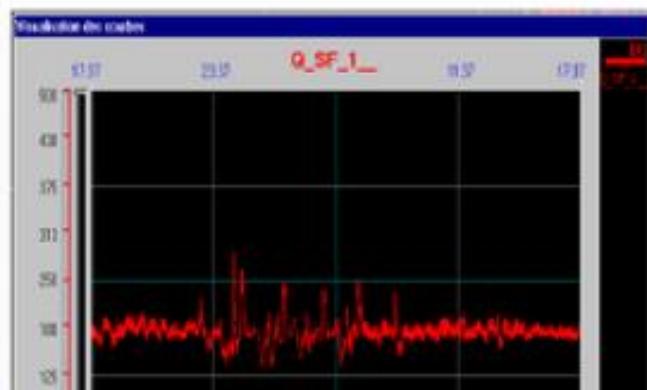
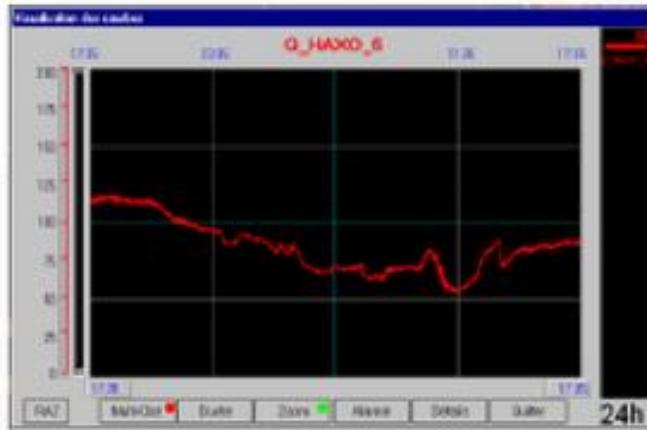
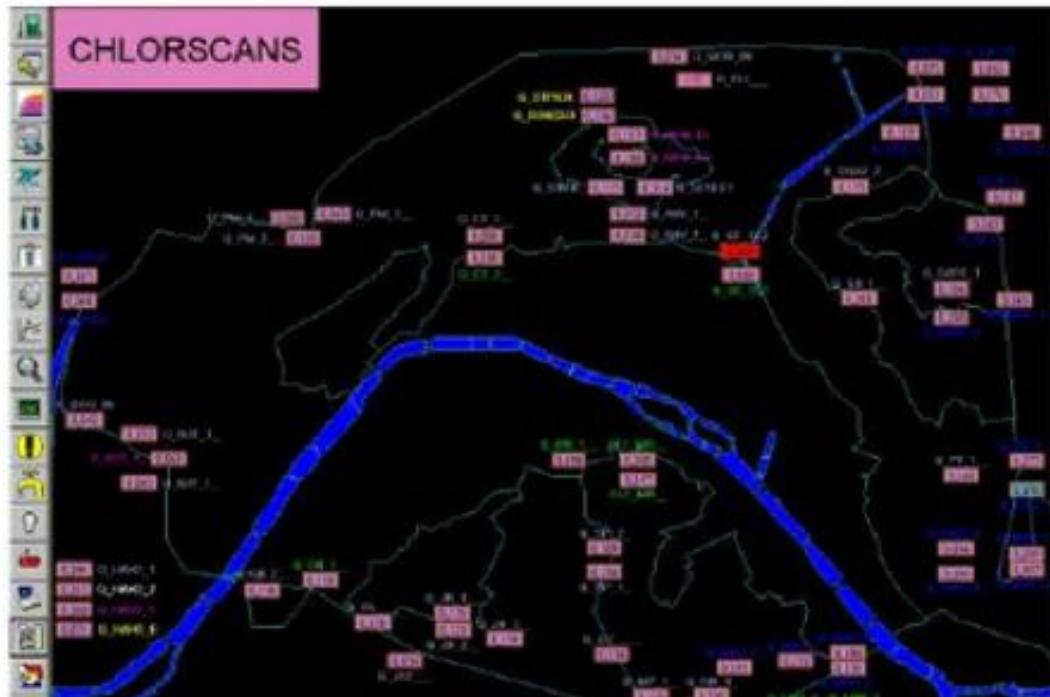


# Visualization of data from Detected Anomaly



# **Water Quality Management**

- Since 2004, 104 ChlorScans sensors have been operated online and in real time throughout Paris.



On-Line Water Quality Control at Eau De Paris

# Online real-Time water quality systems



Intellisonde



S::can



Optiqua

These sensors will be tested

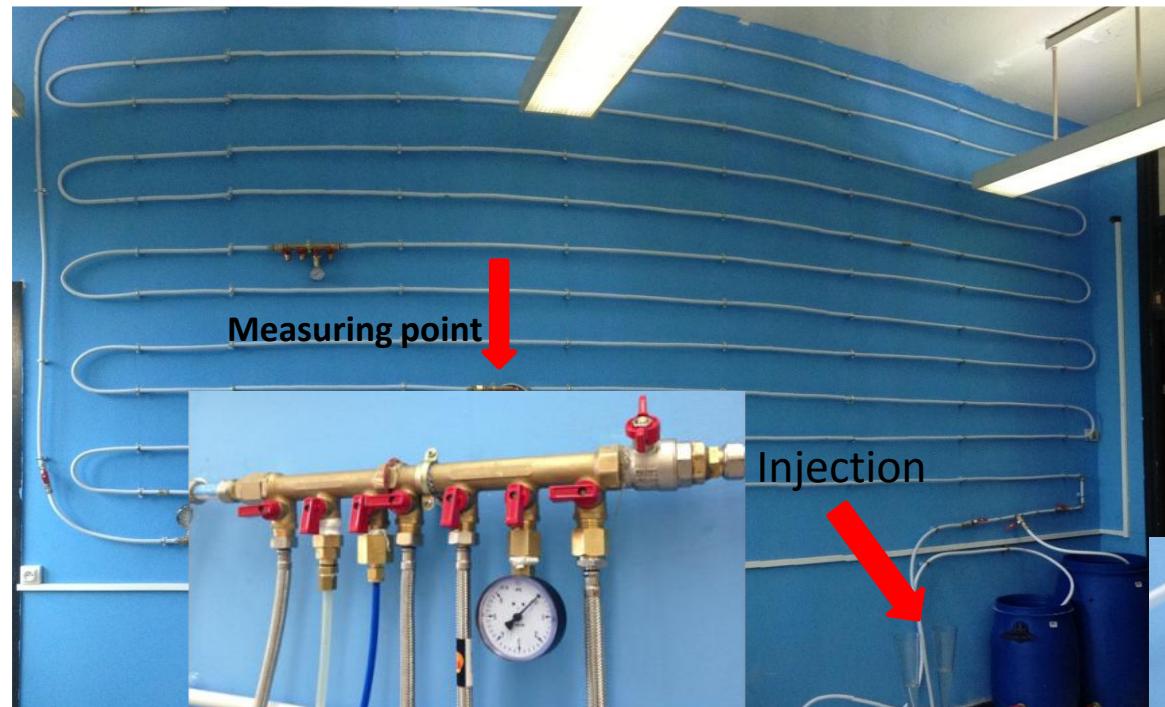
□ Laboratory →

61 m laboratory-scale distribution system

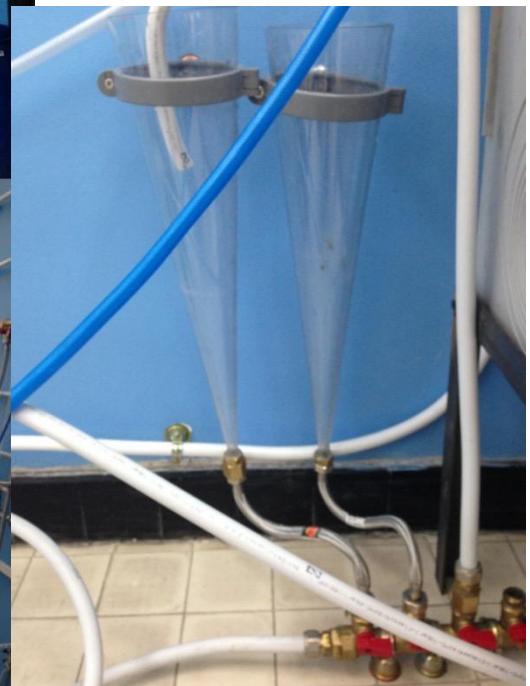
□ In field →

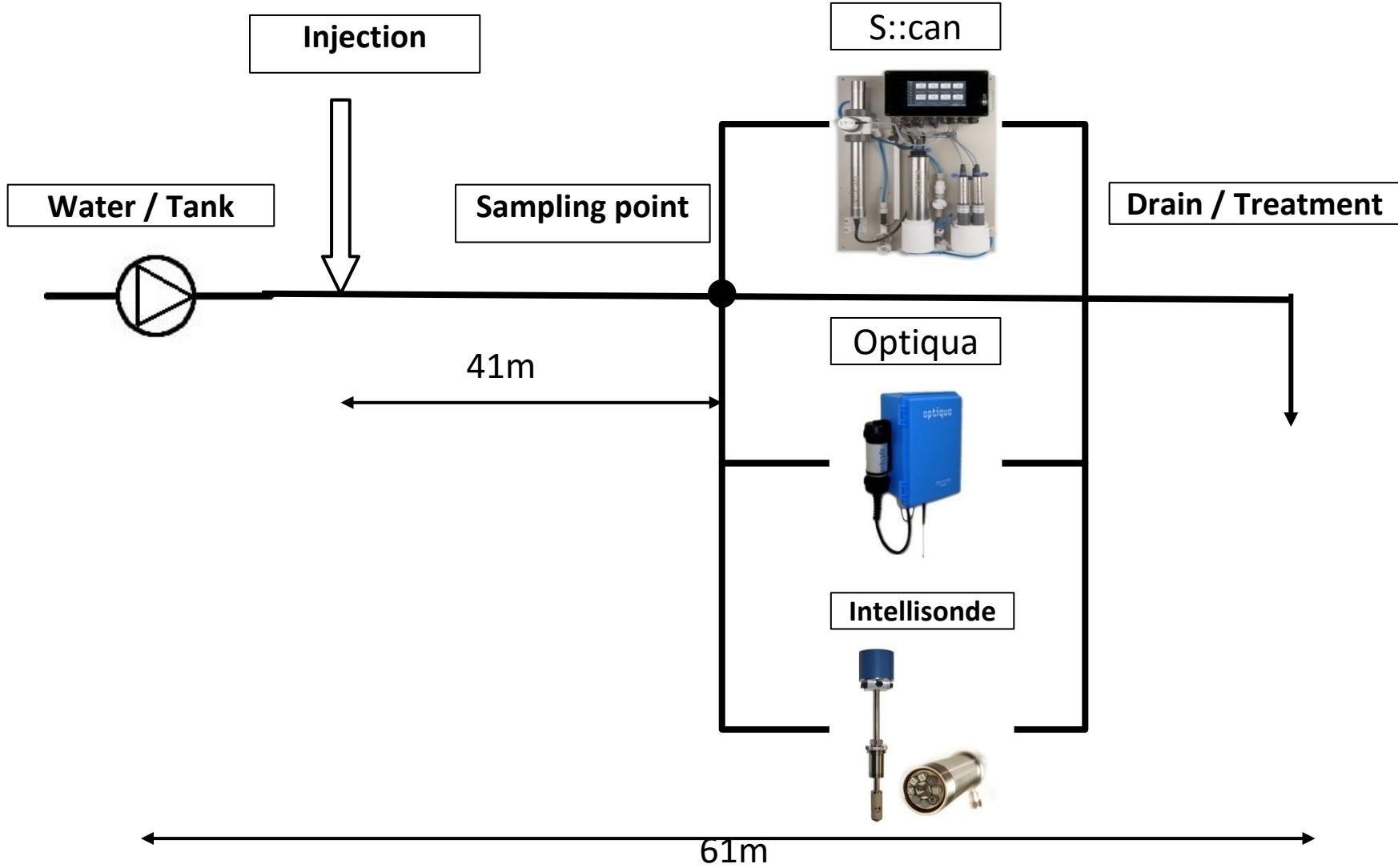
The choice of the site of city scientific of Lille 1

# Laboratory pilot system



- Total length = 61 m
- 16 mm opaque double layer pipes
- Diameter = 16mm.





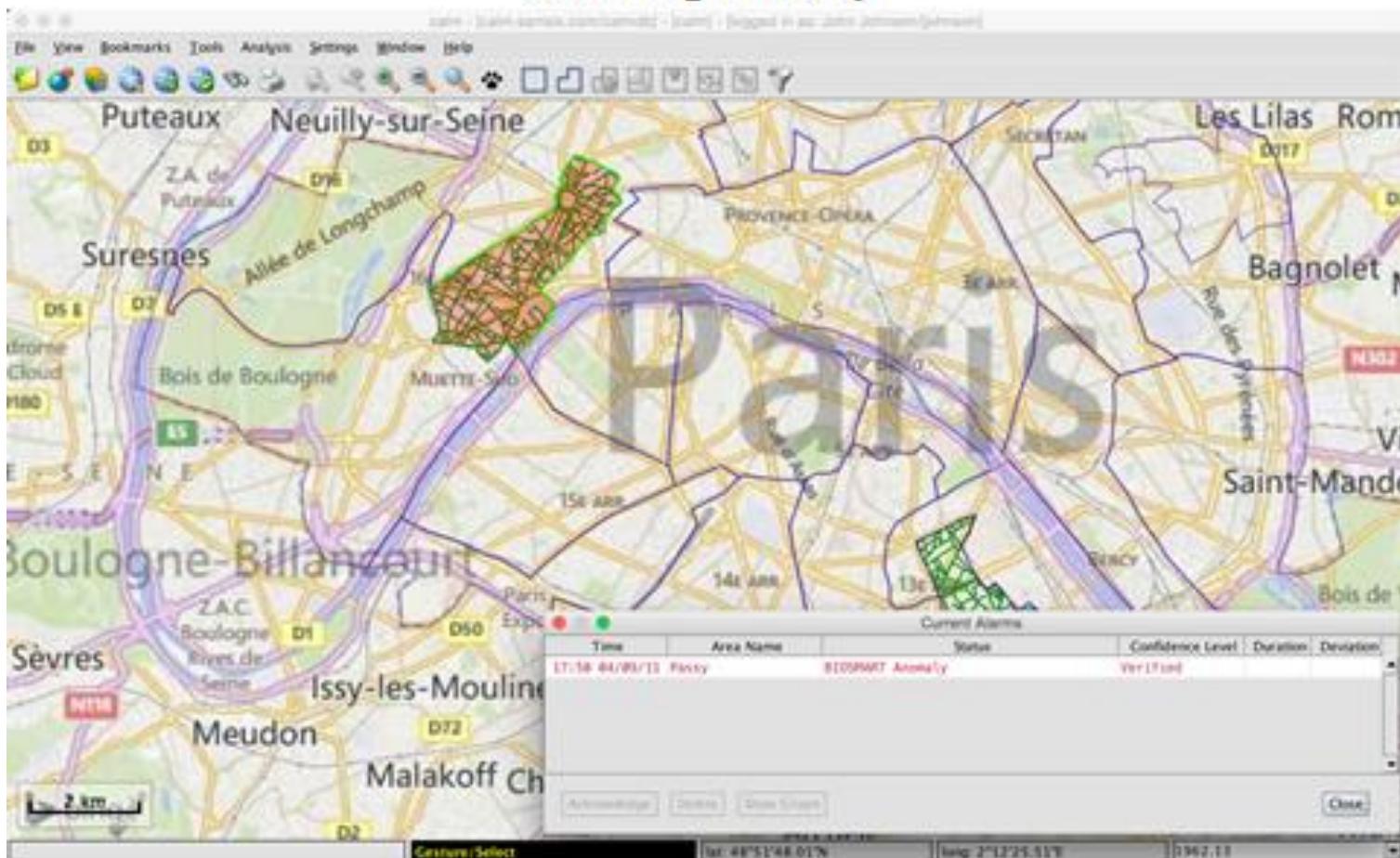
# Display of Data from EDP Chlorscan Anomalies detected via C2SOS

## Presentment of Data from EDP Chlorscan Anomalies detected via C2SOS



# Alarming at Passy

## Alarming at Passy



Source: Bio-SMART & INCOM Projects – M17 Project Meeting Minutes

# Alarm Panel to Demonstrate Anomaly Detection

Scenari Controller

(1) BIOSMART  
(2) Low BIOSMART  
(2A) Low BIOSMART + 50 min  
(3) BIOSMART - High  
(4) BIOSMART - Moderate  
(5) BIOSMART - Minor  
(6) Incom Mirror  
(7) Incom Mirror  
(8) Incom Mirror  
(9) Incom Mirror  
Reset to default alarms.

Windows Window Help

Time Area Name Status Confidence Level Duration Deviation

Time	Area Name	Status	Confidence Level	Duration	Deviation
17:54 04/09/15	Ferry	BIOSMART Anomaly	Verified		
16:48 13/08/15	Ferry	BIOSMART Anomaly	Verified		

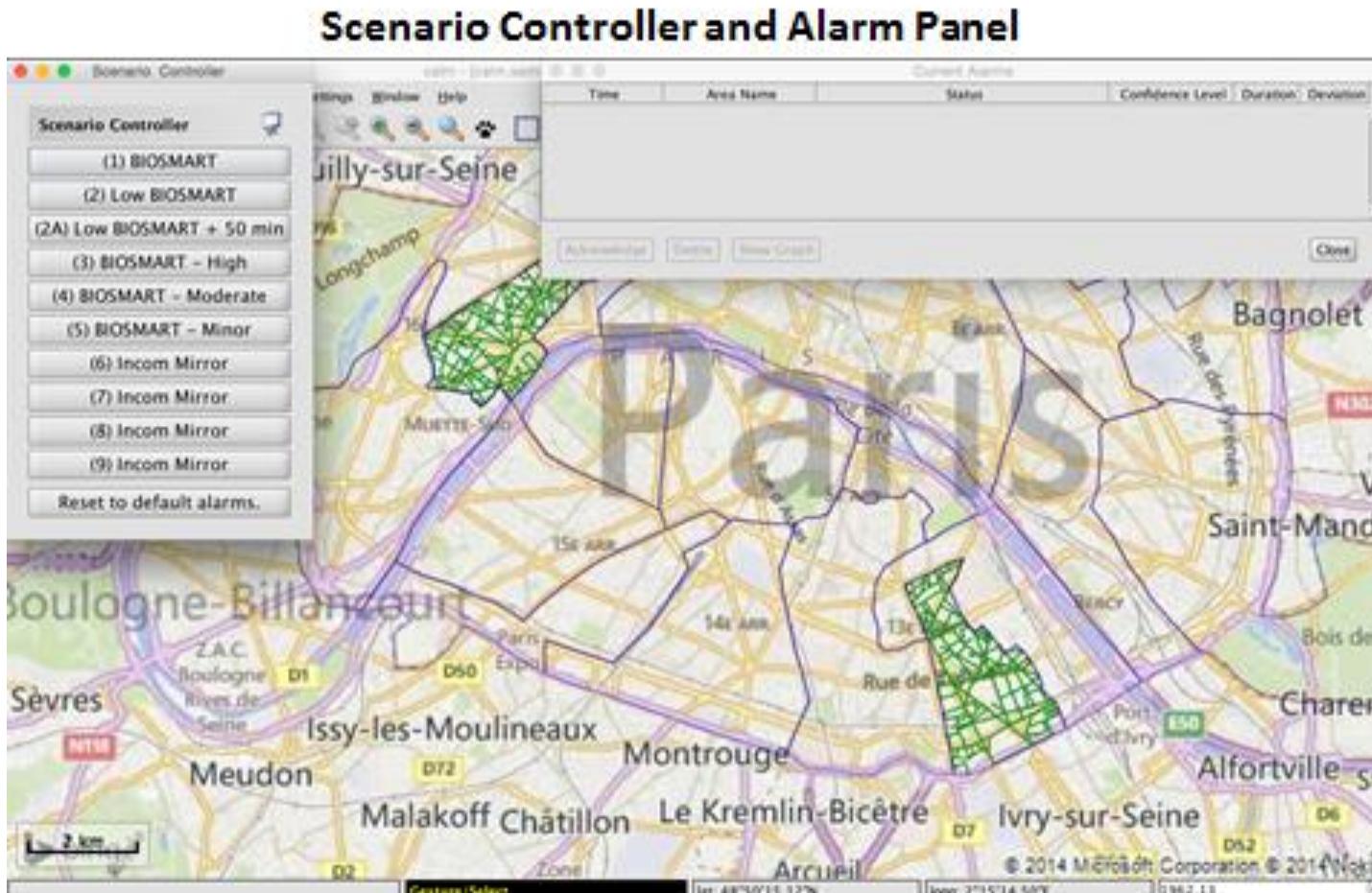
Acknowledge Close Show Graph

The map displays several areas of Paris and surrounding suburbs, including Boulogne-Billancourt, Sèvres, Meudon, Issy-les-Moulineaux, Montrouge, Malakoff Châtillon, Le Kremlin-Bicêtre, Arcueil, Ivry-sur-Seine, Bagnolet, Saint-Mandé, and Charenton. Two specific areas are highlighted with distinct patterns: one in the northern part of the city near Boulogne-Billancourt and another in the southern part near Ivry-sur-Seine. These highlighted areas represent the 'BIOSMART Anomaly' zones mentioned in the alarm panel. The map also shows major roads like D1, D50, D72, D911, D912, and D913, as well as the Seine river and various neighborhoods.

2 km

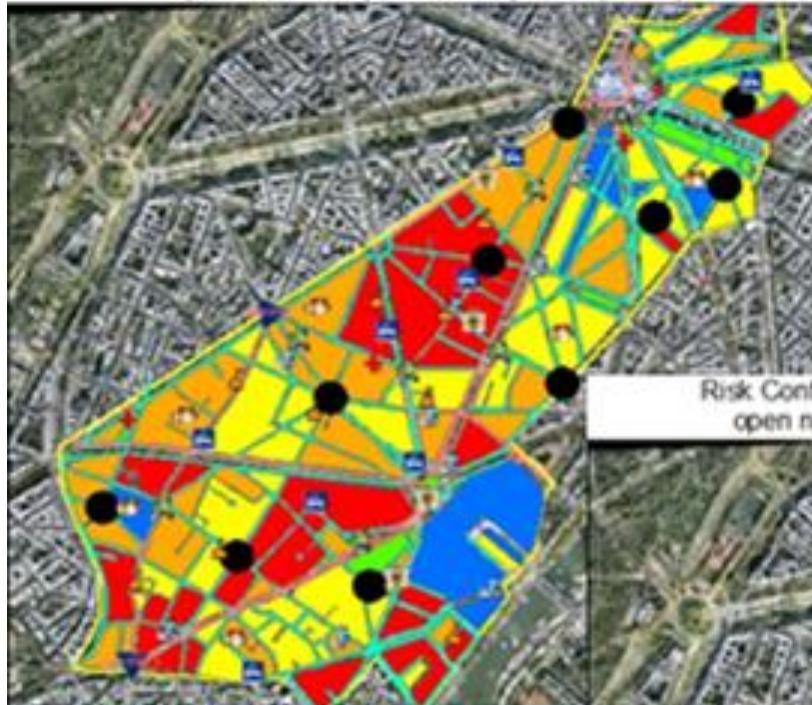
© 2014 Microsoft Corporation. © 2014 Nokia

# Scenario Controller and Alarm Panel



Source: Bio-SMART & INCOM Projects – M17 Project Meeting Minutes

Risk Control for Cost( $\Delta T$ forecasting 1 hour)-7 hours  
open new inlet open all safety outlet(with v)



Input the time

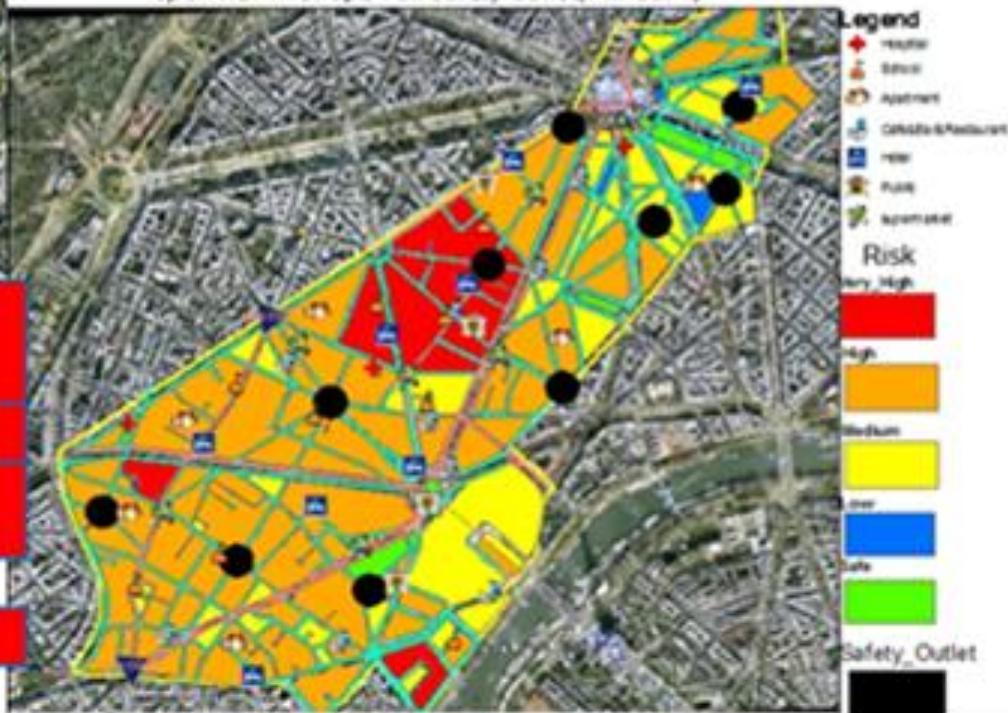
$$T_{trial} = 5.0 \text{ hour}$$

$$\Delta T_{forecasting} = 0.5 \text{ hour}$$

$$T_{trial} - T_{arr} + \Delta T_{forecasting} \leq T_{Dec} + T_{TDC}$$

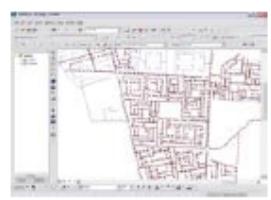
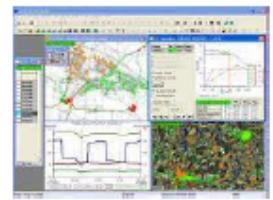
$$T_{dec} = 6.0$$

**Bio-Contamination Mitigation Decision Support System - Demo-Illustration - Eau de Paris (W-SMART, 2009)**  
Mitigation measures - impact control on risk severity



**Bio-Contamination Mitigation Decision Support System Demo-Illustration (W-SMART, 2009)**

### Integrated Response Management Decision Support System



Smart Threat Simulator  
- Propagation & Impact

Smart Mitigation Module  
- Mitigation options



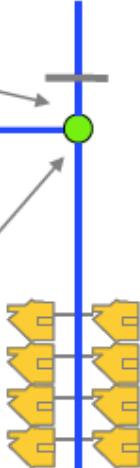
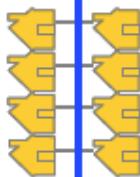
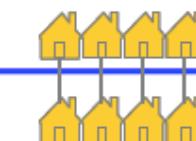
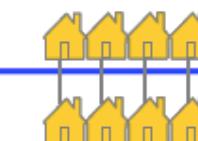
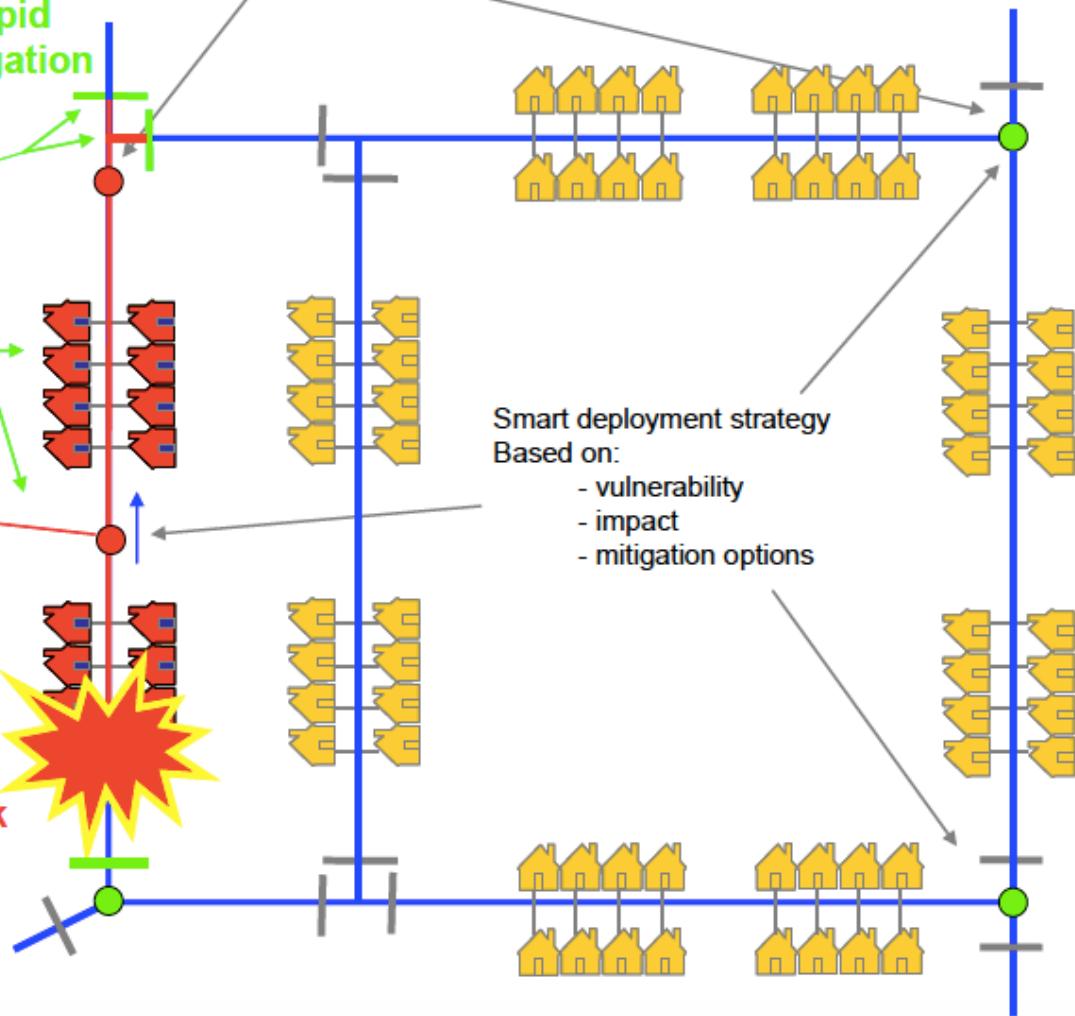
Smart Event Recognition

CBRN attack  
on drinking water  
distribution network

Rapid mitigation



Smart monitor systems



**THANK YOU FOR YOUR ATTENTION**