Smart water Network

Presented by: Chanel el Hifnawy

Smart Water Network definition

GreenKode Consulting Engineers s.a.r.l.

A smart water network refers to an intelligent system that uses advanced technologies to monitor, manage, and optimize the distribution of water within a network.

Components of a Smart Water Network

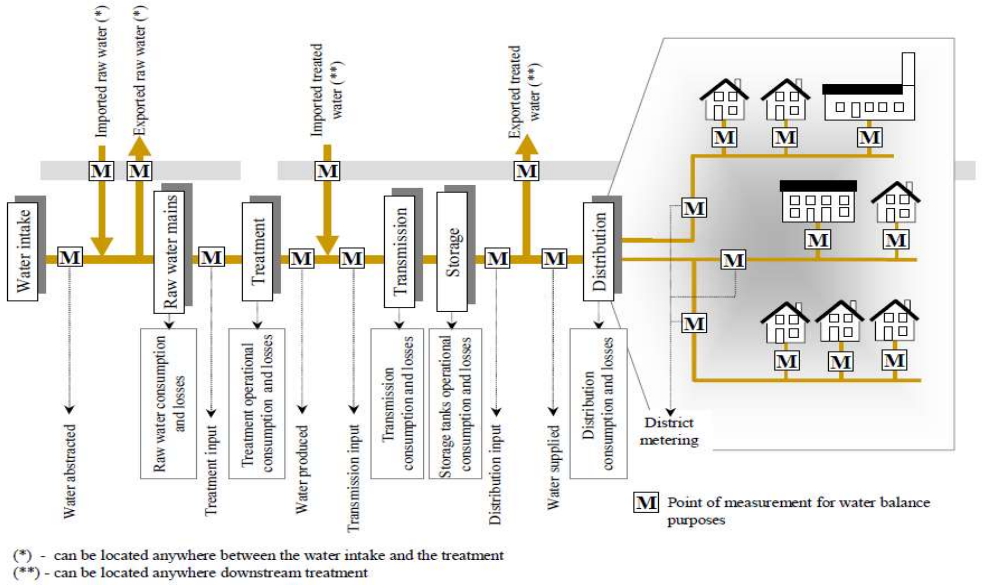
GreenKode Consulting Engineers s.a.r.l.

A. Sensors and meters
- Flow meters
- Pressure sensors
- Water quality sensors
- Leak detection sensors

B. Data collection and communication
- Communication technologies (e.g., wireless networks, IoT)
- Data transmission and aggregation

C. Data analytics and management
- Overview of data analytics techniques
- Role of machine learning and AI in data analysis

D. Real-time monitoring and control
- Monitoring network performance
- Remote control of valves and pumps



Key Features and Functions of Smart Water Networks

GreenKode Consulting Engineers s.a.r.l.

Key Features and Functions of Smart Water Networks A. Leak detection and water loss management

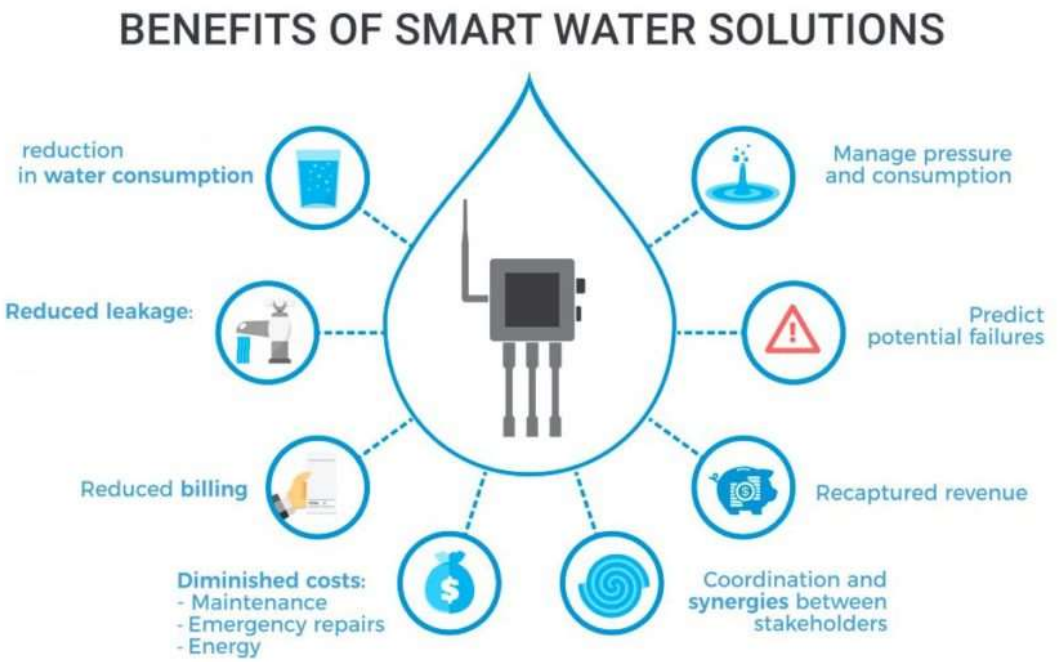
1. Importance of leak detection
2. 2. Strategies for reducing water losses

B. Real-time monitoring and optimization

1. Tracking water usage patterns
2. Demand prediction and optimization

C. Customer engagement and empowerment

1. Providing real-time consumption information to customers
2. Tips for water conservation and efficiency



FIBER OPTIC SENSE WATER LEAKAGE

GreenKode Consulting Engineers s.a.r.l.

These sensors utilize the principles of optical fibers to monitor changes in light transmission and reflection caused by the presence of water.

Here's how fiber optic sensors work in water leakage detection:

1.Principle: Fiber optic sensors rely on the phenomenon of total internal reflection, where light propagates through an optical fiber by bouncing off the internal walls. When the fiber is surrounded by air or a liquid with a lower refractive index, the light remains confined within the fiber. However, when water comes into contact with the fiber, it changes the refractive index, causing some light to escape.

2.Sensing Mechanism: There are different types of fiber optic sensors used for water leakage detection. One common approach involves placing the fiber optic cable along the potential leakage path or in close proximity to water pipes or structures. If a leak occurs, water seeping into the surroundings will cause a change in the refractive index of the fiber, leading to light loss or attenuation.

3.Detection and Analysis: Fiber optic sensing systems are equipped with specialized equipment to detect and analyze the changes in light transmission. Optical time-domain reflectometry (OTDR) or optical frequency-domain reflectometry (OFDR) techniques can be employed to measure the light intensity and identify the location and severity of water leakage along the fiber optic cable.

4.Benefits and Applications: Fiber optic sensors offer several advantages in water leakage detection. They provide high sensitivity, allowing for the detection of small leaks. Fiber optics are immune to electrical interference, making them suitable for harsh environments. They can cover long distances and can be installed in difficult-to-access locations. Fiber optic sensors are commonly used in various applications, including water distribution systems, underground pipelines, dams, and buildings, to monitor and prevent water leakage

District Metered Area

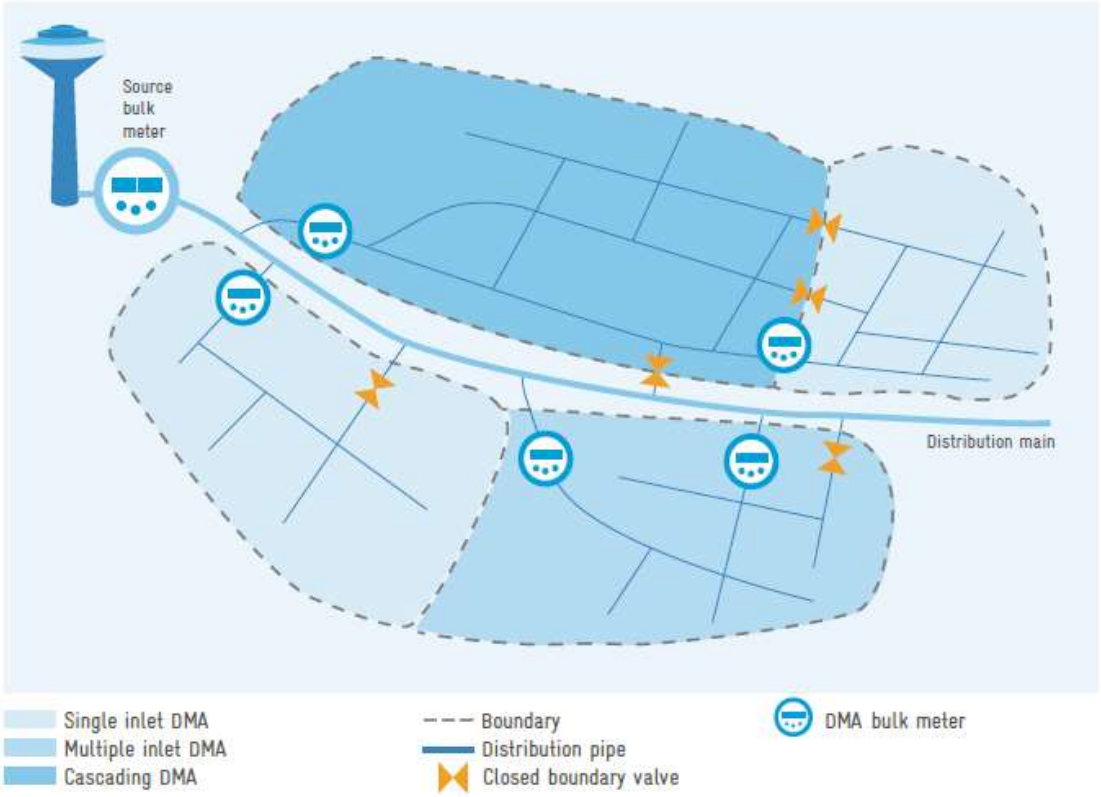
GreenKode Consulting Engineers s.a.r.l.

Note the reasons for which the losses are generated we must locate them in a portion of the network to simplify the research activities in the field. District management can be used for this purpose. A district metered area (**DMA**) is defined as a discrete area of a water distribution network. It is usually created by closing boundary valves so that it remains flexible to changing demands. However, a DMA can also be created by permanently disconnecting pipes to neighbouring areas. Water flowing into and out of the DMA is metered and flows are periodically analysed in order to monitor the level of leakage. DMAs can principally be categorised into three different types: single inlet DMAs, multiple inlet DMAs and cascading DMAs.

The net inflow rate into the generic district can then be easily obtained as the difference between inflow and outflow time series.

District Metered Area

GreenKode Consulting Engineers s.a.r.l.



For the creation of DMAs we need to have a high level of knowledge of your water network. Possibly on a reliable digital mapping system (GIS).

GreenKode Consulting Engineers s.a.r.l.

Pressure Management

Excessive water pressure can aggravate the risk of new water mains outages. The pressure loss relationship also means that high pressure can cause excessive leakage flow rates. Conversely, reducing the water pressure in a pipe network can reduce leaks. Pressure management therefore includes regulating and controlling the water pressure in water supply systems at an optimal level.

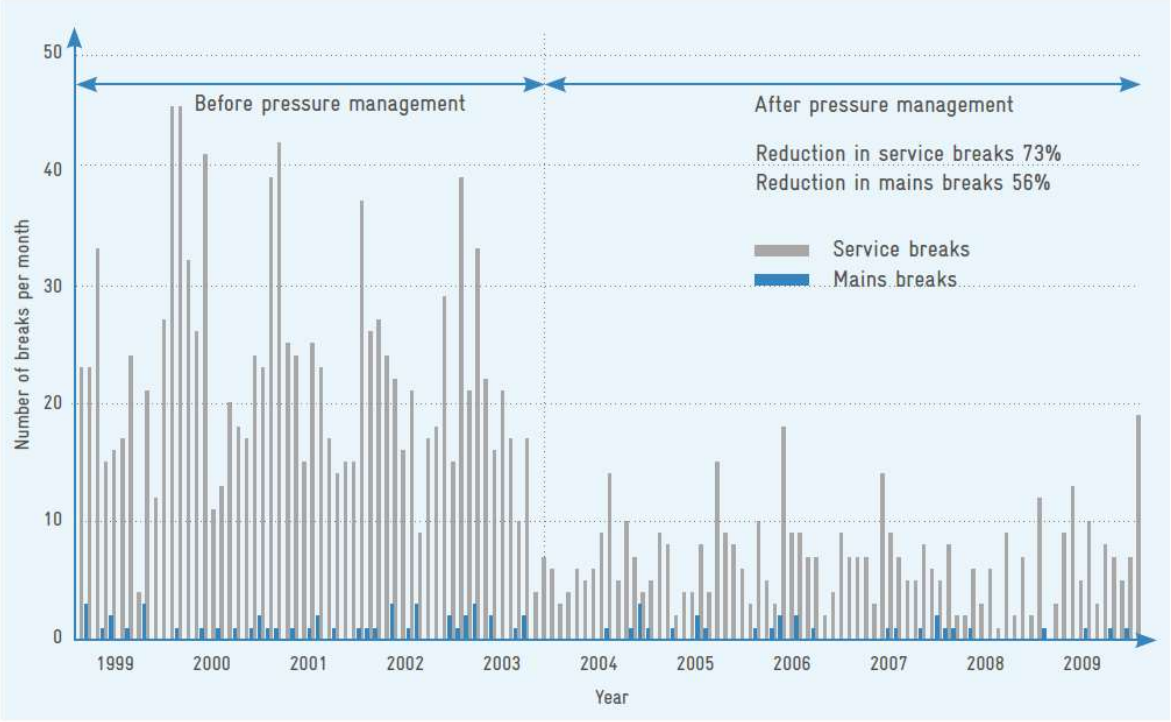
It is also important to evaluate the fluctuation of pressures during the day.

When reducing pressure, the minimum required supply pressure must always be ensured at the critical point in the network. It should be noted that the location of the critical point within a network might alter depending on variations in consumption behavior or due to changing system structure.

GreenKode Consulting Engineers s.a.r.l.

Pressure Management

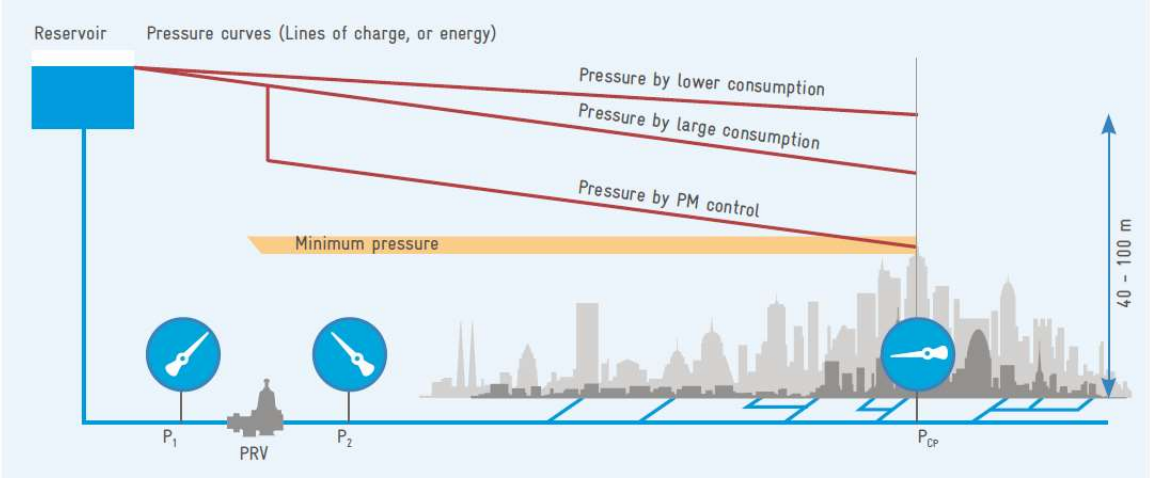
Influence of pressure management on break frequency information from *Joshua May (Gold Coast Water, Australia)*



GreenKode Consulting Engineers s.a.r.l.

Pressure Management

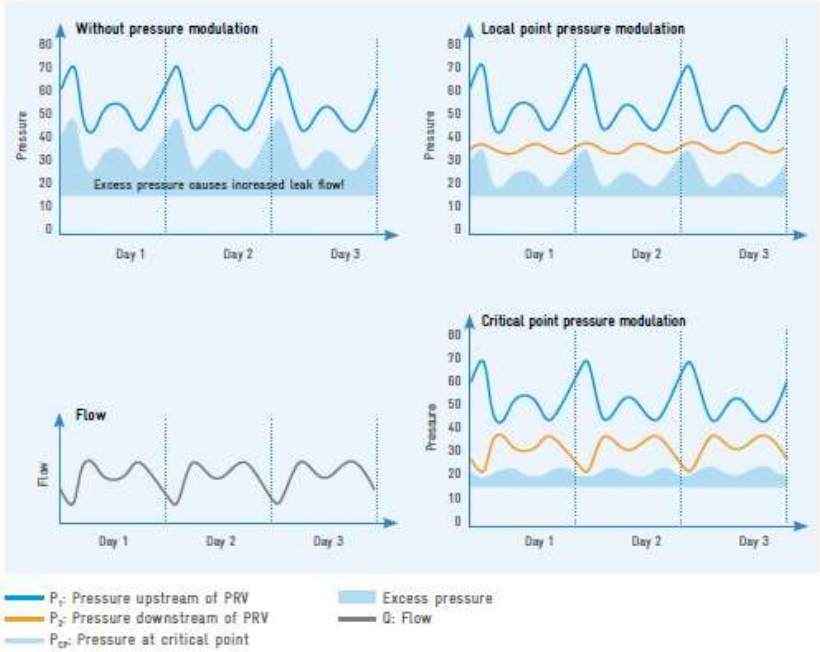
Figure shows a sketch of a typical **pressure management area** (PMA) with single inlet and one pressure regulating valve (PRV). In the sketch, P_1 refers to the pressure upstream of the PRV, P_2 refers to the pressure downstream of the PRV and P_{CP} refers to the pressure at the critical point, namely the point of lowest pressure within the PMA. The critical point can be located anywhere in the PMA and depends on topography, pipe diameters and water consumption behaviour within the network.

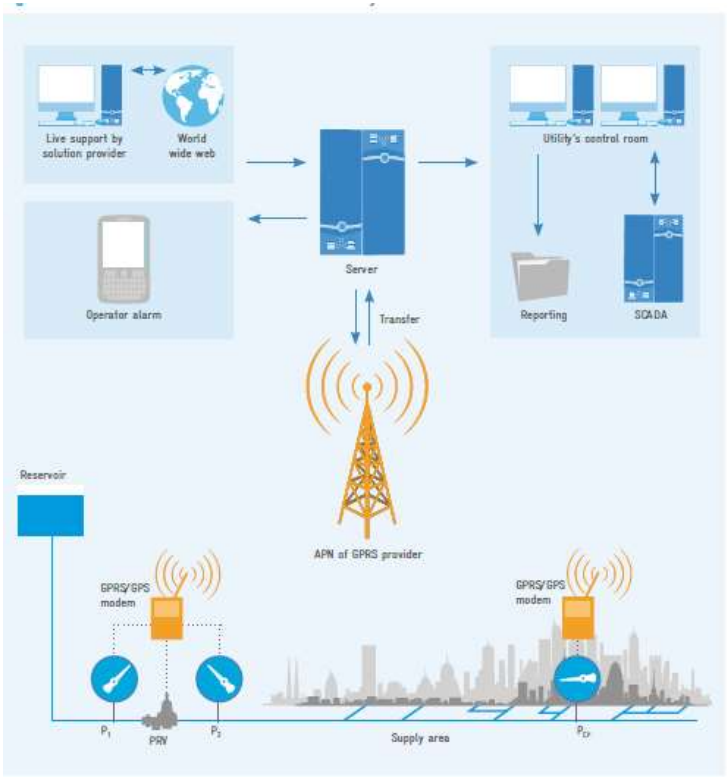


Pressure Management

GreenKode Consulting Engineers s.a.r.l.

a) Modulation location:
   - **Local point pressure modulation**
   - **Critical point pressure modulation**





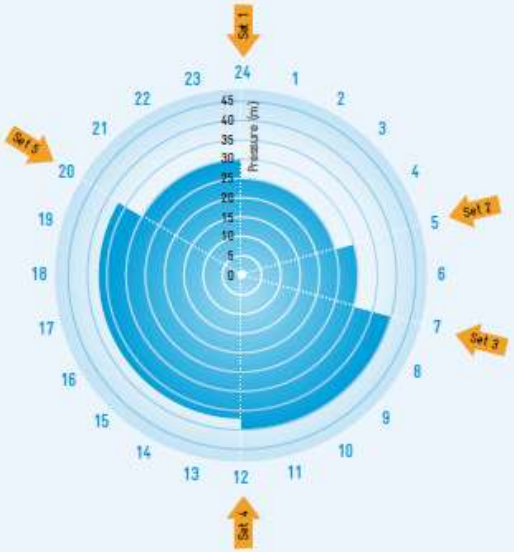
Pressure Management

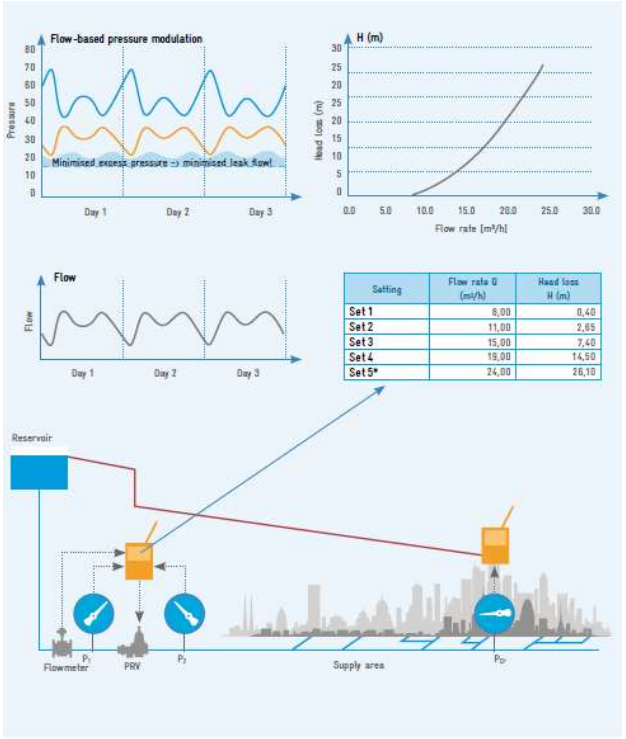
GreenKode Consulting Engineers s.a.r.l.

b) Modulation type:

- **Time-based pressure modulation**
- **Flow-based pressure modulation**

Setting	Time (hh:mm)	Pressure (m)
Set 1	0:00	25
Set 2	5:00	30
Set 3	7:00	40
Set 4	12:00	38
Set 5	20:00	30





GreenKode Consulting Engineers s.a.r.l.

How can we locate leaks for repairs?

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

The main purpose of ALC is to reduce the runtime of hidden leaks in order to minimise real water losses, regular surveys influence the awareness time for new leaks in a distribution network or DMA.

The process of ALC can be divided into three major steps:

- Awareness, continuous monitoring and analysis of flows is essential to gain awareness of new leaks at an early stage
- Leak detection, this is the process of narrowing down leaks to a certain area of the network or to a certain pipe section
- Leak location, punctual location of the leak to carry out the repair

Most acoustic leak location technologies depend on the availability of precise information about pipe material, diameter and length. Poor input information leads to incorrect leak location which results in cumbersome and needless excavation works, known as dry holes

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

Awareness methods:

- Flow monitorning, monitoring of the variation of flows within the network or DMAs
- Pressure monitoring, monitoring of pressure variation within the network or DMAs
- Noise monitoring, leak can be detected by leak noise loggers which are usually installed on valves or hydrants

Working on a single district (DMA) allows you to greatly simplify this procedure.

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

Leak detection methods:

- Step testing, further subdivision to reduce the analysis area (in the DMA design phase it could be important to consider this possibility)
- Leak noise loggers, place leak noise loggers at the strategic points of the network to determine the leak's approximate location
- Sounding surveys, listening for leak noises directly at valves, hydrants and stoptaps of service connections or at the surface above the pipe alignment

Leak location methods, consists in the precise definition of the loss for possible excavation and repair

Working on a single district (DMA) allows you to greatly simplify this procedure.

Active leakage control (ALC) Instrumentation

Active leakage control, it can be performed with various instruments with acoustic or non-acoustic functioning:

- Geophone
- Listening Stick
- Leak Correlators
- Leak Multi Correlators
- Noise logger

Acoustic method

- Tracer gas
- Ground penetrating radar (GPR)
- Cosmic rays
- Internal free swimming
- Software

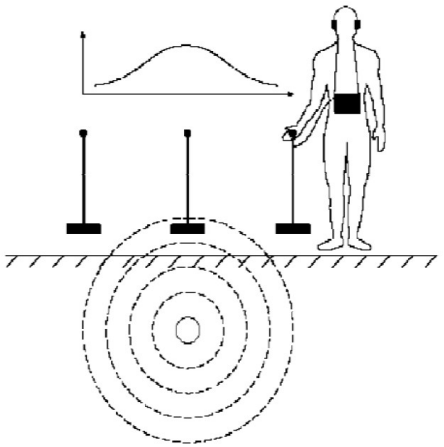
Non-Acoustic method

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

The **geophone** (Leak detection/location) is the fundamental tool for the search for leaks. This tool allows to amplify the noise transmitted by the leak to the ground.

It is very important for the technician to understand the presence of possible background noises that can confuse the search for the leak.

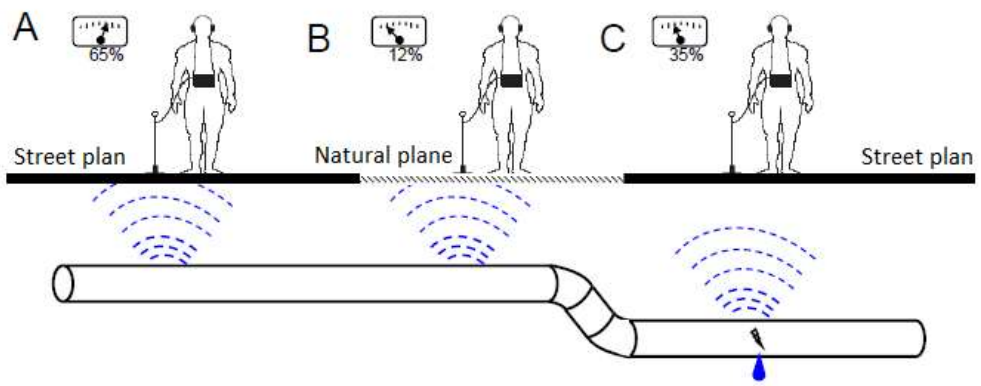


Before the beginning of the research operations, it is advisable, in a point out of scope, to detect the level of "background noises". this relief allows the operator to adjust the gain and the frequency band.

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

In search with the geophone, the operator must pay attention to the type of noise and its intensity. this may, however, vary according to the burial depth (data not always available) and the compactness of the ground (both on the surface and in the filling layer).



In the example, the noise level, conditioned by the variation in depth and nature of the ground, returns a peak in a point distant from the leak.

In position "a", even if distant from the point of leakage, the noise transmitted on the road surface is very intense because the pipe is more surface and less soundically insulated from the ground.

In case "b" the tube is as much surface but the natural ground damages the acoustic emissions, in case "c" the noise is percepable but at a lower level due to its depth.

Active leakage control (ALC) Instrumentation

The geophone is found can be mechanical (classic) or electroacoustic (more modern).

No Image

In addition to the loss search function, the geophone is also used as a tube finder, exploiting an external source of noise induced on the duct.

Despite the significant improvement of equipment, the use of the geophone needs a good experience.

Active leakage control (ALC) Instrumentation

Listening Stick (Leak detection)

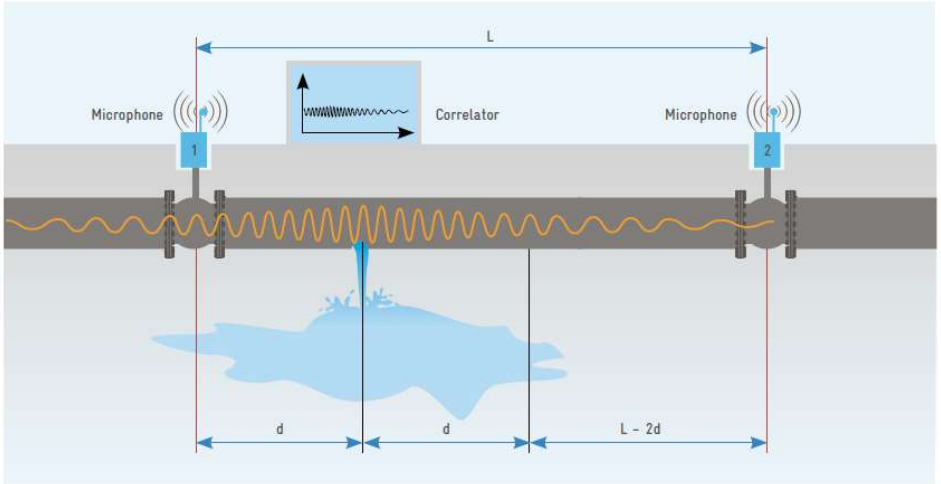
Used during the search for leaks on the switching groups or on the user sockets to carry out a pre-listening of noises in the network. This instrument too can be purely mechanical or electroacoustic.

Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

Leak Correlators (Leak detection/location)

A magnetic microphone with a transmitter is attached to the pipe on each side of the leak. The water leak noises from each microphone are transmitted to a receiver that compares the difference in time from each leak sound and calculates the distance to the leak from each microphone. The water leak correlator uses the pipe size, pipe material and length to determine sound speed in the pipe and calculate the water leak posi



$$d = \frac{L - v \times \Delta t}{2}$$

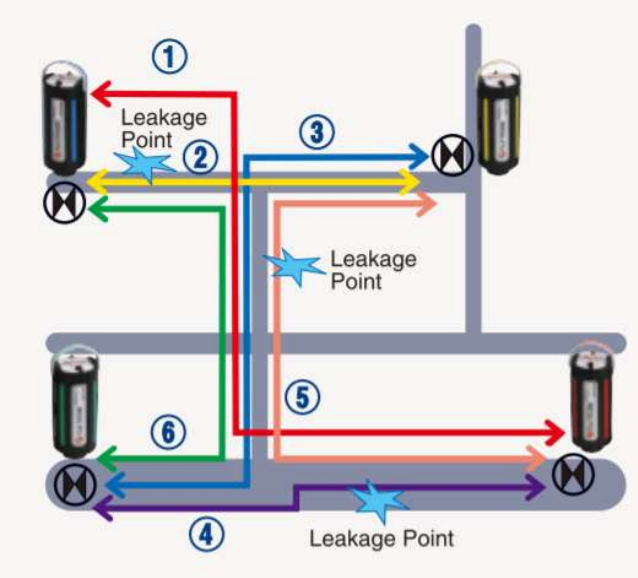
Where:

d	[m]	Distance from the leak to microphone 1
L	[m]	Length of pipe section
Δt	[s]	Time delay
v	[m/s]	Acoustic wave propagation velocity

Active leakage control (ALC) Instrumentation

Leak Multi Correlators (Leak detection/location)

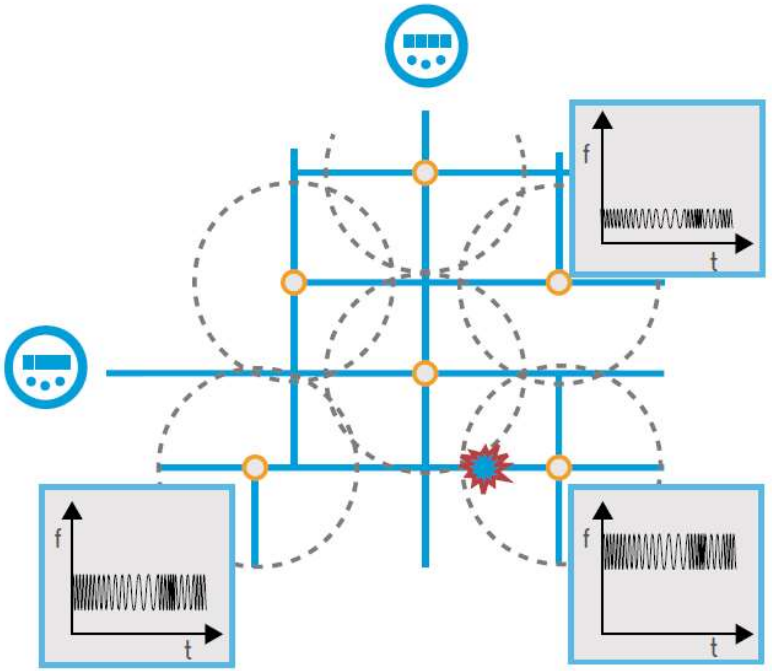
Analogous functioning of the simple Leak Correlator, there is the need to know for all the pipes their diameter, material, laying arrangement.



Active leakage control (ALC) Instrumentation

Noise logger (Leak awareness/detection)

The devices are distributed in points around the water supply, where we will monitor the noise levels on the pipes themselves, changes and distinctive patterns in the sound indicate the presence of leaks. They are easy to position but require a design for their correct positioning. Ideally deployed up to 250m apart on metallic and up to 80m apart on non metallic mains.



Active leakage control (ALC) Instrumentation

GreenKode Consulting Engineers s.a.r.l.

Ground penetrating radar (GPR) (Leak awareness/detection)

The technology consists in using series of satellite images to be able to analyze the variation of humidity or displacement of the soil to understand the possible presence of leaks.

Cosmic rays (Leak detection)

The detected rate is strongly influenced by soil moisture with an inverse proportionality relationship. Therefore, the amount of water in the soil can be assessed by monitoring cosmic rays in the air.

Internal free swimming (Leak location)

Using an apparatus that carries out an acoustic detection, small instrumentation that is inserted into the pipeline in service. Usable for medium-large diameters (DN≥200mm). Practical for supply pipelines since there is a need to isolate the section of pipeline to be analyzed by closing the gates in the boundaries.

Software (Leak awareness/detection)

There are various modeling software on the market that allow real-time management of the water network. They require very expensive data input and require subsequent calibration.

Can be used on high-level management and performance networks to refine the system.

GreenKode Consulting Engineers s.a.r.l.

Thank you for your attention!