SYGEME: INTEGRATED MUNICIPAL MANAGEMENT FOR WATER RESSOURCES

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ABSTRACT

The **SyGEMe** project's framework is as follows:
Aim.
To offer management and monitoring tools for urban networks (water, energy, communication, transport)
Objectives
To develop an Internet platform designed for the management of the complete water cycle of a municipality (drinking and waste water)
Target
Political representatives and technical managers of public collectivities (small and medium-sized municipalities)
Project Added Value
The SyGEMe project is innovating, because it combines the various systems currently used to manage the technical networks of our municipalities
Mainly, the three most important systems are:

- *Geographical information systems:* The data stored in this type of system are georeferenced, but they are mainly static. The system allows connections between the data and their use. For instance, that allows the determination of impacts on the network of a potential breakdown.
- *Flows monitoring systems:* The dynamic data stored in this system result from any kind of measures. They facilitate the phenomena's understanding and the dysfunctions' detection by a flows monitoring.
- *Expert systems:* This system entails experiences, rules, indicators and any available information that can assist urban managers in decision making.

Therefore, SyGEMe is an innovating project, that intends to develop a global integrated management and monitoring tool for urban technical networks (water, energy, communication, transport).
This paper will mainly present the development of project specifications, and experiences validating the project.

KEY WORDS

Urban Technical Network Management - Water Cycle Management – Georeferenced Information Systems (GIS) – Monitoring and Decision Making Tool

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INTRODUCTION

The Organisation for Economic Co-operation and Development (OECD) reveals that cities are actually confronted with urging problems related to evolutions and recent events they can hardly cope with.
Most of the world's population lives nowadays in cities. For urban network managers the challenge is to run a good working infrastructure with respect to the citizens' needs.
The way to achieve this challenge is to conceive operations in a horizontal way and with a sustainable scope of development.
The challenge is nowadays intensified by more and more complex political and economical environments.
To respond effectively to this challenge, urban-related people (decision-makers, planners, builders, managers, etc.) need to have specific methods and appropriate tools, so that they will increase multidisciplinary cooperation and build sustainable partnerships.

Furthermore, to improve their operations, cities have to manage a large amount of flows: drinking water, waste water, electricity, district heating, and cable TV.

However, at our current knowledge, it seems that few integrated monitoring tools to help policy and technical managers are available on the market. Current market tools are mainly specific, not interconnected and do not allow global vision and management.

SyGEMe is therefore a tool between georeferenced information systems (GIS) and data acquisition systems. It intends to improve urban flows management, through the development of a new product providing several services.
Therefore, this project's development intends to meet a market niche in the sector of urban management.

URBISTICS: AN INNOVATIVE APPROACH IN URBAN MANAGEMENT

Limiting financial investments, reducing environmental degradation and developing our local resources while guaranteeing an optimal life quality to the citizens... are the technical and political goal of *Urbistics*, an innovative global and integrated approach in the urban management of small to medium-sized municipalities, using and integrating new Information Technologies.

The main fields and methods of *Urbistics* are:

- A systemic and integrated approach that considers connections between effects and consequences linked with decisions.
- An emphasis on an information management methodology: measuring urban flows; capture relevant data; understanding the links; acting effectively
- An integration of sustainable urban management factors:

- Social efficiency: identification and management of population needs.
- Energy efficiency: leak minimization and energy efficiency maximization.
- Environmental efficiency: reduction of waste and resource consumption
- Economic efficiency: maintenance costs reduction and investment rationalization

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OBJECTIVES OF THE PROJECT SYGEME

QUALITY URBAN NETWORKS MANAGEMENT

A quality management, mainly for underground urban equipment such as water or heating pipes, will be facilitated by an efficient decision making tool. Such management helps municipal leaders to carry out the following tasks:

- Equipment management
  - Updated monitoring of equipments and operations.
  - Development of preventive maintenance: improved equipment management trough their life cycle.
  - Optimization of spatial plans for energy distribution through energy municipal planning.
  - Quality management of maintenance "in time".
  - Avoiding useless maintenance actions
  - Minimizing construction and maintenance costs

- Resource management
  - Lead the municipal services to supply all consumers' needs (both qualitative and quantitative)
  - Minimize or diversify natural resources' importations
  - Adapt supply to effective needs (at the distribution stage)
  - Adapt demand (public, industrial and household) to effective needs and influence on demand by pricing or communicating.

WHAT ABOUT AN INTEGRATED TOOL

The use of information and communication technologies (ICT) for urban management is currently usual. More and more municipal services decide to integrate measures in their drinking and waste water networks.
Other municipalities go on and use georeferenced information systems (GIS), or flows monitoring system. (telemeasures, telealarms)
The next challenge is the development and the implementation of an optimal management and preventive maintenance system ("man-machine" interaction), at the municipal or at a higher level.

The technological difficulty lies in the integration of several tools, currently used by distribution and treatment services, to enhance the efficiency of urban networks management.

To ensure this approach, the "user's oriented toolbox" needs to contain three interlinked drawers:

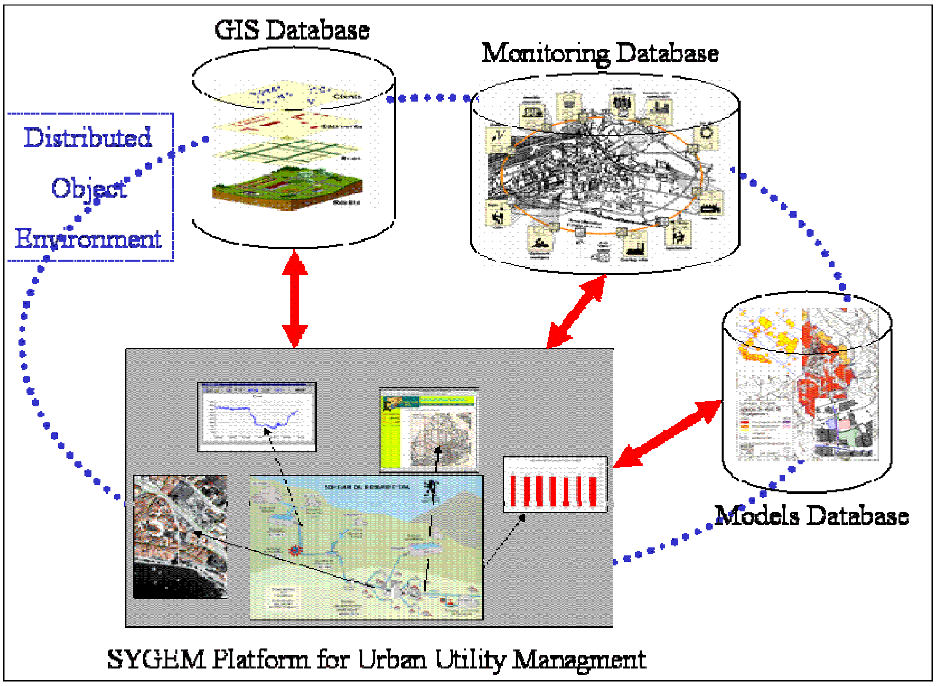

Figure 1: Coordination Model for Integrated City Management within the SyGEMe Project

I. GIS Database

The first drawer contains georeferenced static data. These captured and updated data are used to document technical equipments. The system has to be able to transfer quickly relevant information on specific objects (for a pipe replacement case: pipe diameter, length, material, pressure max, etc).The objects and their uses need also to be linked to the data stored within the system (for example: knowledge of the building addresses connected to a pipe in case of a located supply failure)

II. Monitoring Database

The second drawer contains all dynamic data. These data are used to measure and understand the operation of networks and equipments, through flow monitoring. First, managers have to define the types of values necessary to control the system (temperature, flow, pressure, quality of drinking water, etc.). This qualitative and quantitative monitoring enhances the quality of predictions related to the situation "in time" of resources and operations. Furthermore, such information also facilitates the understanding and the control of the demand, leading to improved current and future adaptations of the networks.

Most current measure systems are available to capture, record and treat automatically data. Modern transmission systems allow adapting tele-transmission to almost any situation, regarding reliability, localization, electricity supply and proximity of a physical communication network.

III. Models Database (Expert system)

The third drawer entails all rules, experiences, lessons, and technical characteristics. The expert engine has to give alarms and recommendations determined by the experience database and/or the calculation model. The aim of this tool is to lead to a dynamic system diagnosis. (Figure 2: Expert system structure)

Such a system has the following advantages:

- Real time failure detection: failures are detected by the system before first important effect
- Intervention diagnosis: type and localization of failure, even recommended actions are determined by the expert engine
- Quick and reliable interpretation: a first consultation of history is done by the expert engine, before the diagnosis process.
- User friendly: An existing graphical user interface (GUI) can be used to manage the whole system
- Experiences storage: the know-how stored in the brain of the specialist managers can be numerically stored.

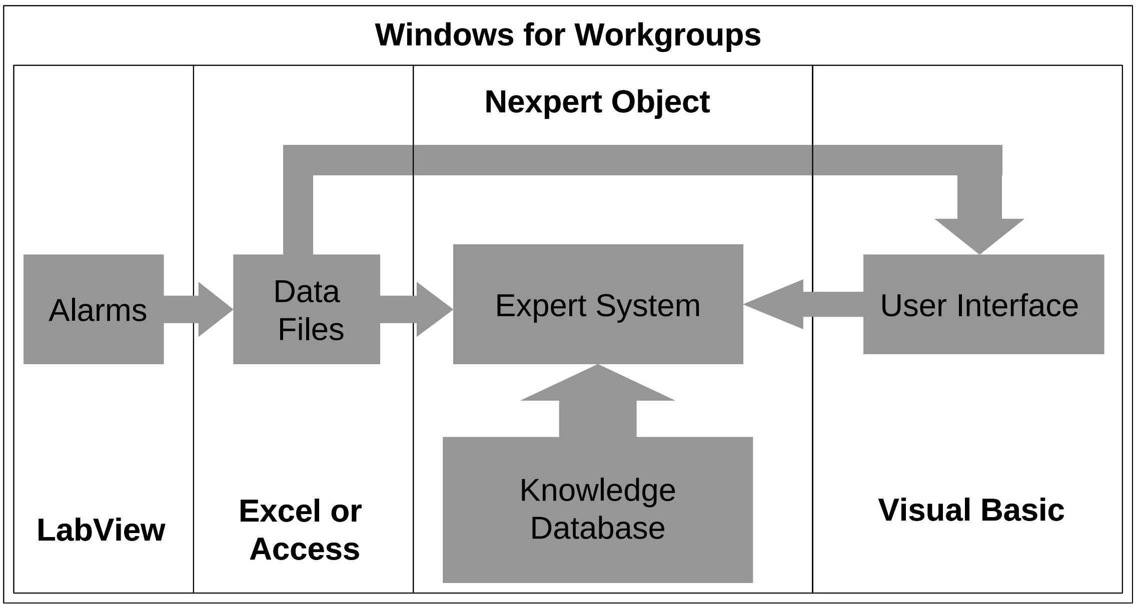

Figure 2: Expert System Structure

WATER SUPPLY CASE

The SyGEMe project will focus on water cycle management, responding to the needs of municipalities and their authorities. Especially, the case of supplying drinking water will be analyzed (water catchment area, distribution zone, …)

Indeed, a large amount of municipalities in the Alps have not enough water at the lowest water level of their sources, mainly when there are a lot of tourist or sprinkling related activities.
The technical services of such municipalities mention that the main problem they face is the reaction system used: They need to receive a complaint to know the existence of a failure in distribution or in provision. It often leads to a time-consuming repair: visiting water tanks, contacting concerned specialists.
So, the public sector in relation to water distribution intends to guarantee supply security and fire defense, and to safely manage networks operation and maintenance.

CASE STUDIES: TWO EXAMPLES OF A WATER PROVISION MANAGEMENT AND A DISTRICT HEATING MODELISATION

1. THE CASE OF MARTIGNY, A LABOARTORY CITY[3] IN SWITZERLAND

The case: During the 80's the city of Martigny had drinking water supplying problems in summertime. Thanks to the telemeasuring network running on the Cable TV network, the CREM specialists were able to get relevant measures and:

- To detect that there was abnormal water use within municipal buildings
- To detect that sprinkling was done during rainy day
- To highlight that the dynamic pressure indicating that the water net was stable.

The result:

- A water tank (amounting to CHF 10 millions) was planned and the CREM results demonstrated that such a water tank was not necessary.

It was also noticed that the final water tank, receiving all the unconsumed water, was constantly discharging. So a new ideal consumer was provided to the network: an inverted pump regulated by the discharge level of the tank, producing electricity instead of pouring the water in the river. With that microturbine 250 MWh are produced every year without discharging any more water.

[3] They are more than two hundred and fifty measure points distributed to the various technical networks of Martigny. These results feed research projects in various scientific institutes, trough the laboratory city.

2: A TYPICAL EXAMPLE OF A SERVICE BREAK

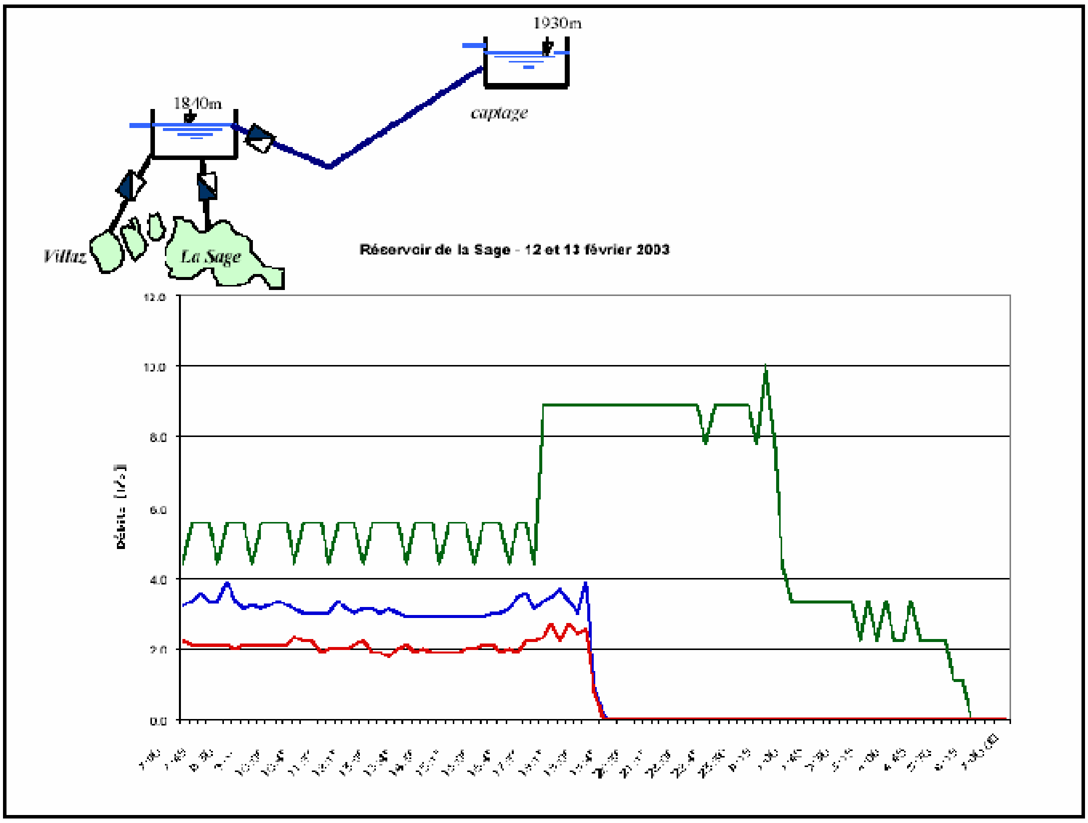

Figure 3: Example of a Water Provision Map and its Monitoring

Figure 3 shows a pipe break incident, that happened in the water provision of an Alpine municipality. Upper curve represents the flow which goes into the water tank; this water comes directly from catchment. Lower curves represent two flows providing water to two towns.

On 13 February 2003, at around 5.30 pm, the inner tank flow grew very quickly; indeed, one of the supply pipes, located lower as the water tank, broke. Then, after the water tank was emptied, the supply of both municipalities was not anymore guaranteed; time was around 8.00 pm. The first population's complaints followed quickly the water provision break, and then the water provision manager was called around 8.30 pm, almost three hours after the incident. At that time, the only information available was the water provision break in the municipalities; the municipal managers went to the tank and saw it was empty.

The most obvious explanation seems to be a failure of the water source or catchment. Because of night time and large amounts of snow over the source, municipal managers decided to wait till the following morning… They found out the real problem only fourteen hours after the incident.
An expert monitoring system warned the manager right after the incident. Then, an analyze of the graphs had probably led to the determination of an inverse flow flooding trough the supply pipe, emptying the tank.

In this case, water managers went directly to the lowest point of the supply pipe and fixed the failure just some hours after the break. Then, the use of an integrated water management tool based on an *Urbistics* approach clearly improved the quality of the service.

3: EXPERT MODELISATION SYSTEM

This example doesn't concern water provision, but is presented to justify the use of an expert model engine. The last case presented a diagnosis analyze, supported by a mathematical model calibrated with monitoring data. The laboratory city of Martigny is partially heated whit a district heating network, constructed with two networks pipes outward and return. In the end of the primary network, a small sub-network constructed by a private property developer is now connected to the primary network trough a big heat exchanger. Operation temperatures in this sub network called "Les Morasses" are about 25 °C lower than in the primary network. After some inhabitants' complaints, a study was carried out to analyze the operation of this sub-network.

There were two types of data: static georeferenced and documented data; dynamic monitoring data (temperatures, flows, etc.). After some months of development, a modeling tool was able to simulate the operation of the sub-network for different external temperature and demand whit an acquaintance of about ten percent. Heat transfer coefficients of pipes as well as operation and performances of the networks heat exchanger were determined.

An analyze of the simulated sub-network showed that the performances of the heat exchanger located between primary and sub network, decrease due to a too high return water temperature. This high return temperature was produced by a permanent flow going directly from outward network to return network, trough old and inefficient security valves when the building where directly connected (Figure 4, permanent flow from 6 to 7).
In this case, a mathematical model has been used to improve system efficiency. Indeed, this experience can now be stored in an expert engine, aiming to accelerate a future decision making process, in a similar failure case.

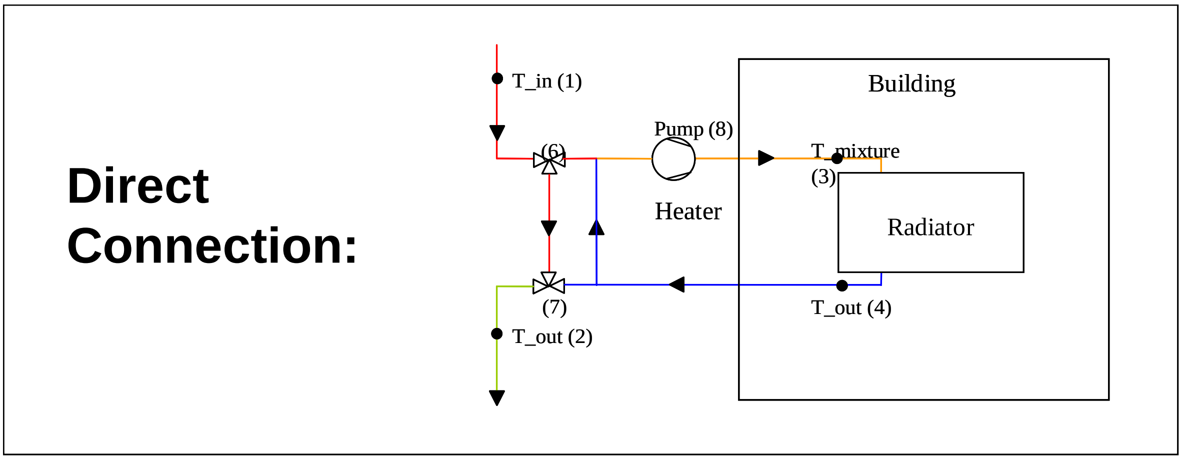

Figure 4: Direct connection structure in urban district heating

CONCLUSIONS

The integration of a GIS, a monitoring system, an expert engine (included modeling tools) and an efficient communication system can currently allow having an efficient integrated management system. This type of tool will enhance the quality of the water cycle management and moreover of all technical urban networks. It will improve the use of resources through an optimization of networks and a better demand management.

These various case studies and innovating solutions are based on the *Urbistics* approach, that seeks to optimize the management of the urban networks through information technologies.

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