SYGEME: INTEGRATED MUNICIPAL MANAGEMENT FOR WATER RESSOURCES

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ABSTRACT

The **SyGEMe** project pursues the following aim and objectives.
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 and technical leaders of public collectivities (small to middle size 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 disfunctions' 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 techical networks (water, energy, communication, transport)

KEY WORDS

Urban technical network management, Water cycle management, GIS, Monitoring, Decision Making.

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INTRODUCTION

OECD reveals that the cities are actually confronted with urging problems related to evolutions and recent events of which they are not well prepared.
The major part of the World s population is living in the cities. For urban network managers the challenge is to run a good working infrastructure with respect to the citizen needs.
The way to achieve this challenge is to think operations in a horizontal way and with a sustainable scope of development.
The challenge is nowadays intensified by complexification of political, institutional, legal, social and economical environments.
To take the challenge up it is now time to provide urban fields actors such as the deciders, the planners, the builders, the managers and so on, with specific methods and appropriate tools. It is to intensify the pluridisciplinary collaborations, to define new partnerships with a general sustainable goal.
In this way, and to improve their operation, cities have to manage a large amount of flows (drinking water, waste water, electricity, district heating, and cable TV). However, currently, it does not exist any integrated monitoring tool to help policy and technical managers. Current market tools are mainly specifics, not interconnected, and do not allow global vision and management.
SyGEMe is between georeferenced information systems, GIS, and data acquisition systems. It aims to improve urban flows management, by the development of a new product supporting several services.
In this idea, this project development follows directly a free market in the cities management.

CONTEXT OF URBISTIC

Limiting financial investments, reducing environmental degradation and developing our local resources while guaranteeing an optimal life quality to the citizens... is the technical and political goal of *Urbistics*, an innovative global and integrated approach in the urban management of small to middle size municipalities, which uses and integrates new Information Technologies.

The main fields and methods of urbistic are:

- She is based on a systemic approach, with an aim of considering all connections between effects and consequences linked with decisions.
- She is supported by the management of information, leading to the method: Knowledge, comprehension, Action
- She leads to a better city management, satisfying :
    - Social efficiency: management from the needs of the users
    - Energy efficiency: minimization of leak and maximization of energy efficiency

- Environmental efficiency: reduction of waste and resource consumption
- Economic efficiency: reduction of maintenance costs, rationalization of investments

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AIMS OF SYGEME

QUALITY URBAN NETWORKS MANAGEMENT

Especially for undergrounds urban equipments, like water pipes or heating pipes, a quality management must be supported by an easier decision making process. Such management helps the municipal leaders to carry out the following tasks:

- Equipment management
  - Always control the equipment states and operations
  - Develop preventive maintenance (better equipment management trough their life cycle)
  - Optimize spatial plans for energy distribution (energy municipal plans)
  - Quality management of maintenance in the time
  - Abort useless maintenance actions
  - Minimize construction and maintenance costs

- Resource management
  - Lead the municipal services to supply all consumers needs, as well qualitative as quantitative
  - Minimize or diversify natural resources importations
  - Adapt supply to effective needs (in 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. Numbers of municipal services decided 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 (interaction men machine), 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 linked drawers:

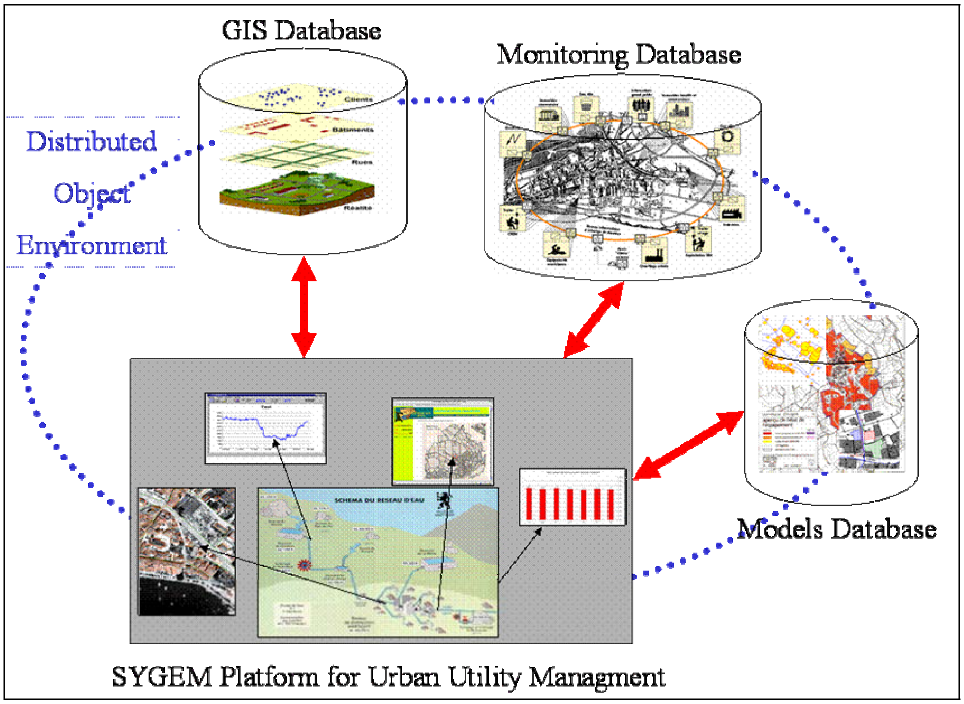

Figure 1: Coordination model for integrated city management of SyGEMe project

I. GIS Database

First drawer contains georeferenced static data. These data are used to capture, to update and to document technical equipments. The systems has to be able to quickly export information about an object (for example: pipe diameter, length, material, pressure max, etc. in case of pipe replacement). The objects and their uses must also be linked to the data stored in this system (for example: knowledge of the building addresses connected to a pipe in case of a located supply failure)

II. Monitoring Database

Second drawer contains all dynamic data. These data are used to measures and to understand the operation of networks and equipments, by flows monitoring. First, managers have to define the types of value necessary to control the system (temperature, flow, pressure, quality of drinking water, etc.). This qualitative and quantitative monitoring enhances the quality of predictions about resource state and operation in time. Furthermore, these dynamics information also enhance the comprehension and the control of the demand, leading to a better current and future network adaptation.

Most part of current measure systems are available to capture, to record and to treat automatically data. Modern transmissions systems allow to adapt teletransmission to almost all type of situation, regarding reliability, localization, electricity supply and proximity of a physical communication network.

III. Models Database (Expert system)

Third drawer contains 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 diagnostic. (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 diagnostic: 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 diagnostic 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 numericaly stored.

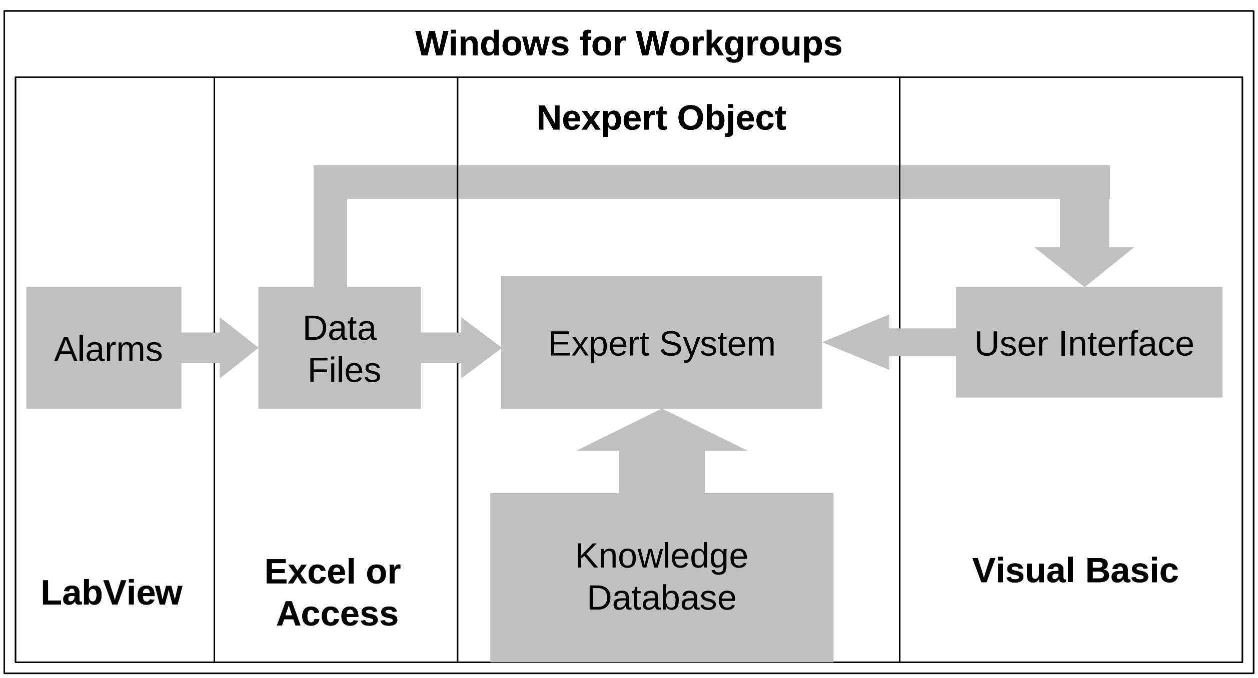

Figure 2: Expert system structure

WATER FEEDING CASE

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

Indeed, a large amount of alpine municipalities have not enough water in the lowest water level of their sources, often laying in the same time of high tourism activities. Technical services say themselves that the main problem is the reaction system used: They need to receive a complaint to know the existence of a failure in distribution or in feeding. It often leads to a long repair time (visiting water tanks, contacting concerned specialist).
So, the public sector, concerned by water distribution, aims to guarantee supply security and fire defence, and to safely manage networks operation and maintenance.

CASES STUDY: TWO EXEMPLES OF WATER FEEDING MANAGEMENT AND A DISTRICT HEATING MODELISATION

1: SUMMARILY, THE CASE OF LABORATORY CITY OF MARTIGNY IS PRESENTED

In the eighties, the city of Martigny had drinking water feeding problems in summer. Thanks to the telemeasuring network running on the Cable TV network. CREM managers

- where able to detect some abnormal uses by municipal buildings,
- could detect that the sprinkling was done during rainy days,
- could measure the dynamic pressure that indicates that the water net was stable.

Finally the systemic result was very important because a water tank (ten million of swiss francs) was planned and it has been demonstrated that it was not necessary.
An other important fact is that it was saw that the water final tank, the one who receives all the non consumed water, was constantly discharging. So a new ideal consumer was provided to the network, who was in fact an inverted pump regulated by the discharge level of the tank, producing electricity instead of pouring the water in the river. With that microturbine two hundred and fifty thousand kilowatt-hours per year are actually produced without discharging any more water.

2: A TYPICAL EXAMPLE OF SERVICE BREAK

Figure 3 shows an incident (pipe break) held in the water feeding of an alpine municipality. Upper curve represents the flow which goes in the water tank, this water comes directly from catchment. Lower curves represent two flows feeding two small villages.

On 13 February, at about 17h30, inner tank flow growth very quickly; indeed, one of the supply pipes, located lower as water tank, broke. Then, after the emptying of water tank, the supply of the two towns isn't more guaranteed, time is about 20h00. The first complaints from the inhabitant follow quickly the feeding rupture, then the water feeding manager is called at about 20h30,almost 3h00 after incident. At this time, the only information is the feeding rupture in the two towns, it leads the municipal managers to the tank, and then, he notes the empty state of the tank.

The first and simplest explanation seems to be a spring or catchment failure. Due to the night and a large amount of snow over the source, municipal managers decided to wait tomorrow morning… They discover the real problem only fourteen hours after the incident.

An expert monitoring system had allowed to alarm the manager right after the incident. Then, an analyse of the graphs had probably led to the determination of an inverse flow flooding trough the supply pipe, leering the tank. In this case, water manager went directly to the lowest point of the supply pipe and repair the failure just some hours after breakdown. In this case, the use of urbistic approach and of an integrated management tool clearly improve the service quality.

3: EXPERT MODELISATION SYSTEM

The last case present a diagnostic 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 complaints from some inhabitant, a study has been held to analyze the operation of this sub network.

There were two types of data: first were static georeferenced and documented data, second were dynamic monitoring data (temperatures, flows, …). 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. As well heat transfer coefficients from pipes, as operation and performances of the networks heat exchanger were determined.

An analyze of simulated sub network showed that the performances of 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).

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.

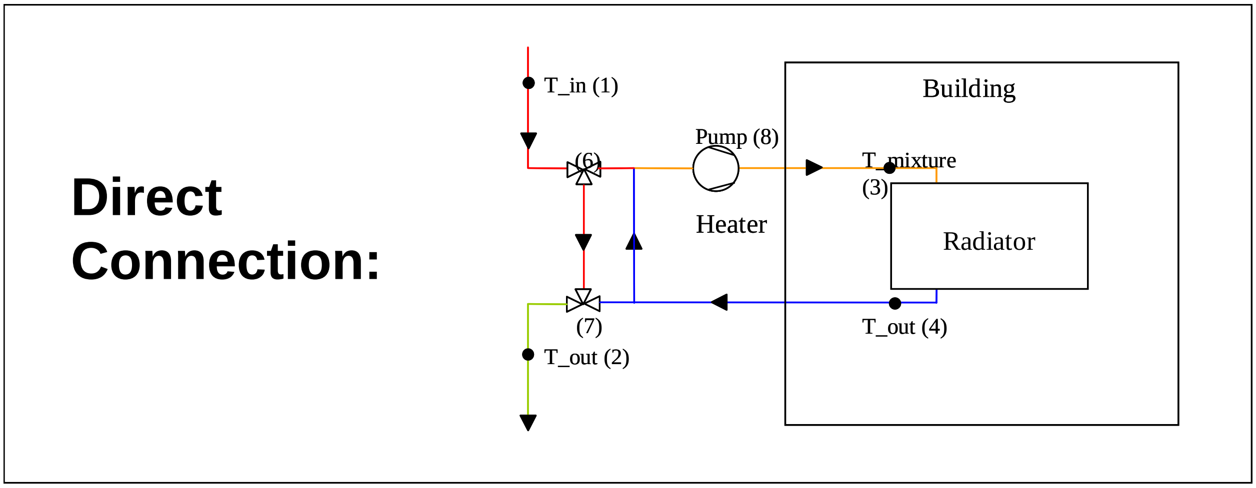

Figure 4: Direct connection structure

CONCLUSIONS

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

This approach, directly resulting from urbistic, leads the technical urban management on a more sustainable way.

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