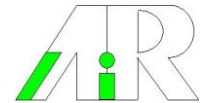




Institute of System Research
Polish Academy of Science



Institute of Automatic Control and Robotics
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Numerical algorithms and mathematical models supporting the management of communal water networks

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Introduction

Institute, Department, University

Goals of the algorithms

Hard management

Soft management

Summary

One of the **leading institutes** of technology in Poland, and one of the **largest in Central Europe**. It employs 2,453 teaching faculty, with 357 professors (including 145 titular professors).

R&D at WUT is:

- Participation in national and European research projects.
- Well-functioning Centre for Technology Transfer and Entrepreneurship Development.
- Coordination and activity within the framework of 8 research centres:
 - Academic Research Centre for Power Engineering and Environment Protection,
 - Academic Research Centre for Sustainable Energy Systems,
 - Research Centre for Business of the Faculty of Mathematics and Information Science.

Scientific profile

- Research and development of new automatic control, decision support and diagnostic systems;
- Application of artificial intelligence and neural networks in automation, robotics and diagnostics;
- Control engineering theory: optimal and predictive control;
- Construction and development of electric and hydraulic drives;
- Construction and development of mobile robots;

Important projects funded by NCBiR

- Intelligent system of diagnostics and industrial process control "DIASTER"
- Interactive environment for solving optimal control problems – IDOS
- Research on detection and location of leaks in pipelines

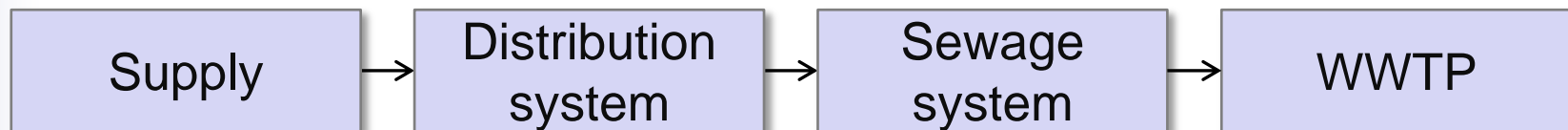
Experience with EU projects

- Advanced Decision Support System for Chemical/Petrochemical Manufacturing Processes – **CHEM 5FP**
- Development and Application of Methods for Actuator Diagnosis in Industrial Control Systems – **DAMADICS 5FP**
- Intelligent Controls for High Speed Injection Moulding Machines – **ICON HiSim 6FP.**

Introduction – Goals of our activities

Goals of a waste and waste water companies

- Modern water and waste water company has a number of goals. The main aspects of its activity are:
 - Serving to the local community
 - Taking care about natural environment, water resources etc.
- Such companies can use integrated technical and computer aided tools to meet these requirements.



Our goals

- **The main goal** of our activities is an integrated approach to **improve the complex management** of municipal water supply and distribution systems.
- To realize this goal an **integrated IT** system is under development. The system will support the complex management, planning and operational control of communal water networks.
- The **IT system** is destined to computer aided and automated management of communal waterworks, **based on the numerical algorithms and mathematical models.**

State of art

- The IT system planned in frame of our activities **is not used** in Poland.
- The **innovative feature** of the IT system are the simultaneous solutions of problems concerning the soft and hard management of communal water supply systems.
- The **soft management** means the solution of the tasks like financial planning of the water net expansion or revitalization or the human capital development.
- The **hard management** means the solution of the tasks like modelling, optimization and control of water nets.

The results in general

- The implementation of the IT system will **help** to solve the problems concerning the **production and distribution of drink water** and the **improvement of water quality**.
- The implementation of the IT system in waterworks will lead to the **better management and utilization of available water resources** and to **energy saving water net operation**.

Planned results

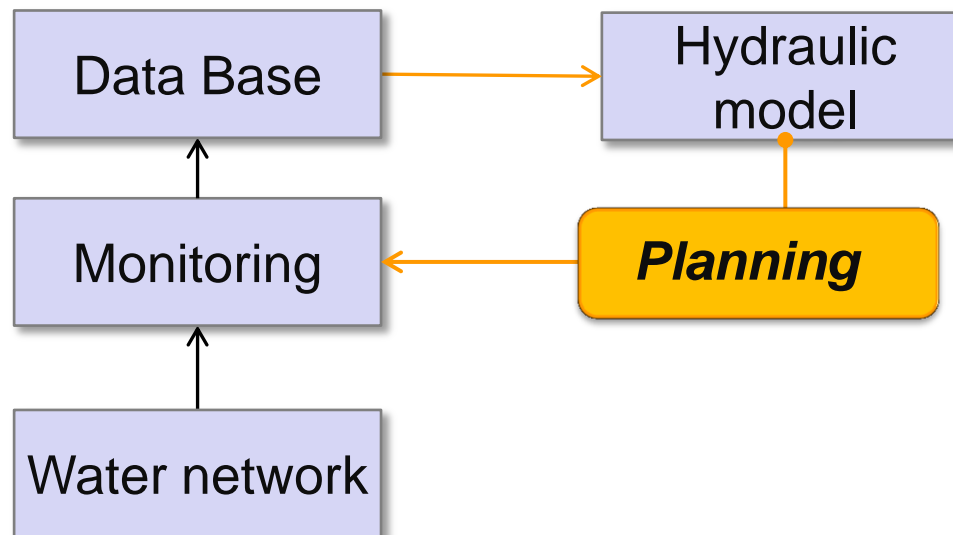
The results in details

- reduction of the **water losses** in the water networks
- **energy saving** control of the water nets
- improvement of **the drink water quality** supplied for the city
- increase of the **quality of servises** executed for local communities
- reduction of the **money costs** while operating the water nets

Planning a monitoring system

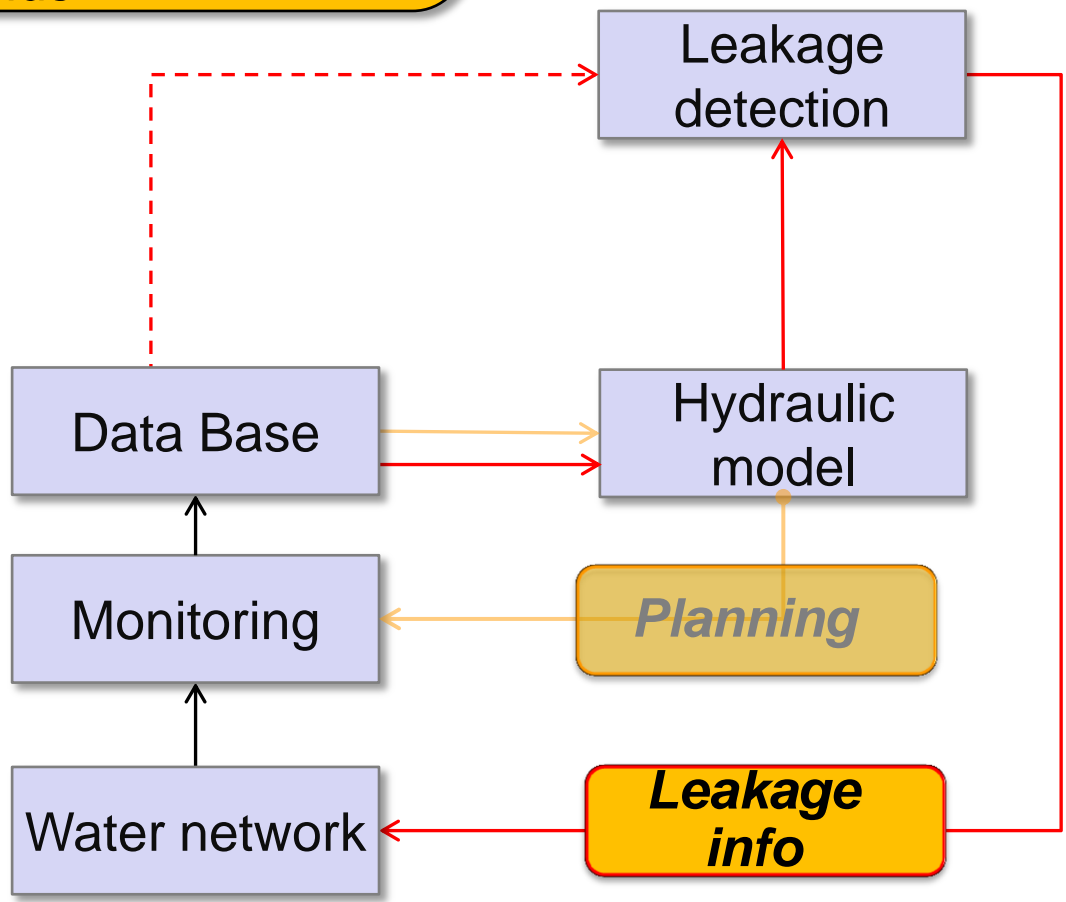
Planning a monitoring system:

1. Planning algorithm is based on a mathematical model.
2. Mathematical model is based on a monitoring system.
3. Thus, process is iterative.

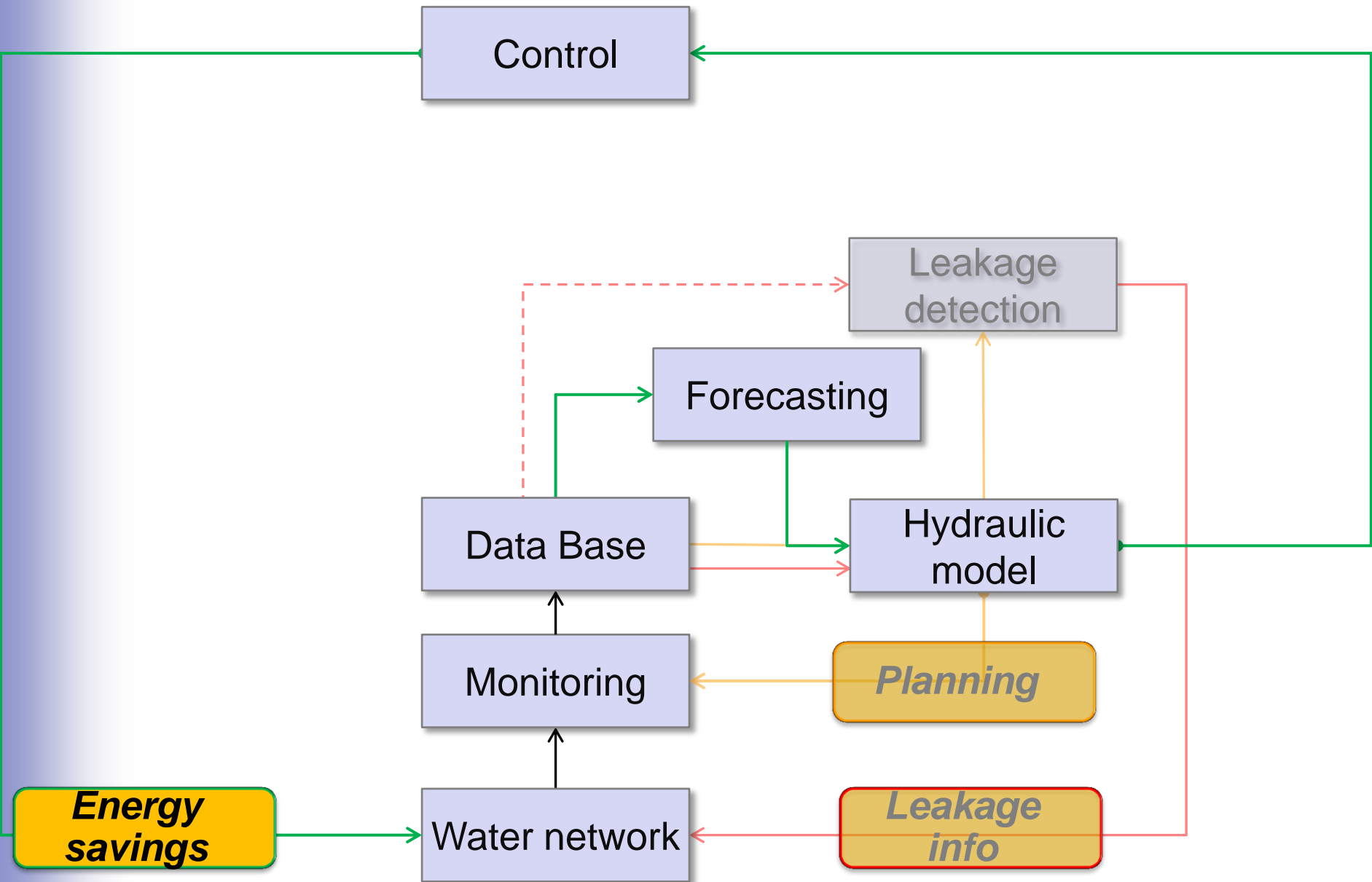


Hard management – leakage detection

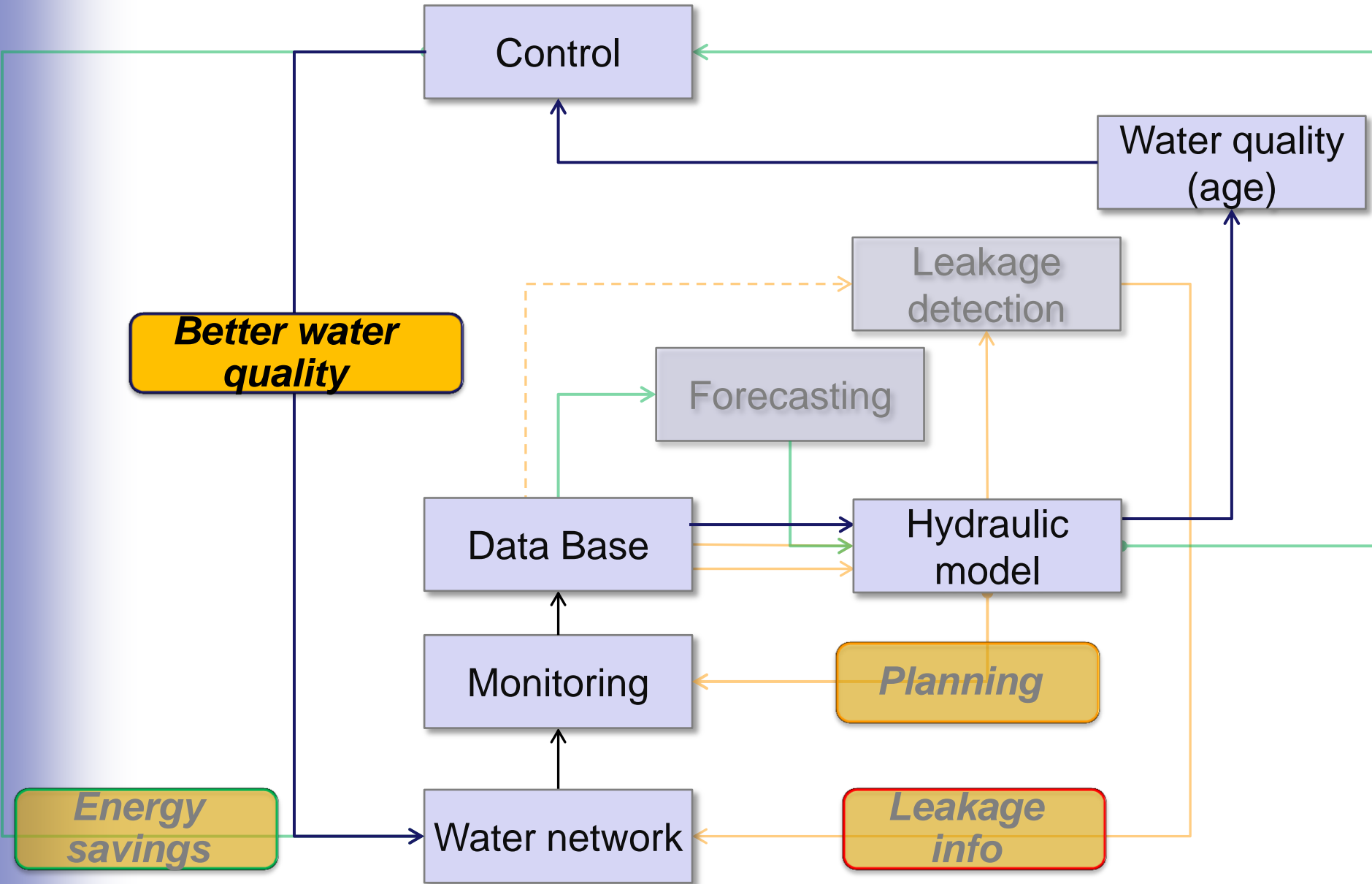
- Leakage detection:
- 1. Off-line: comparing measured flows with registered demands
 - 2. On-line compare model output with measured demands



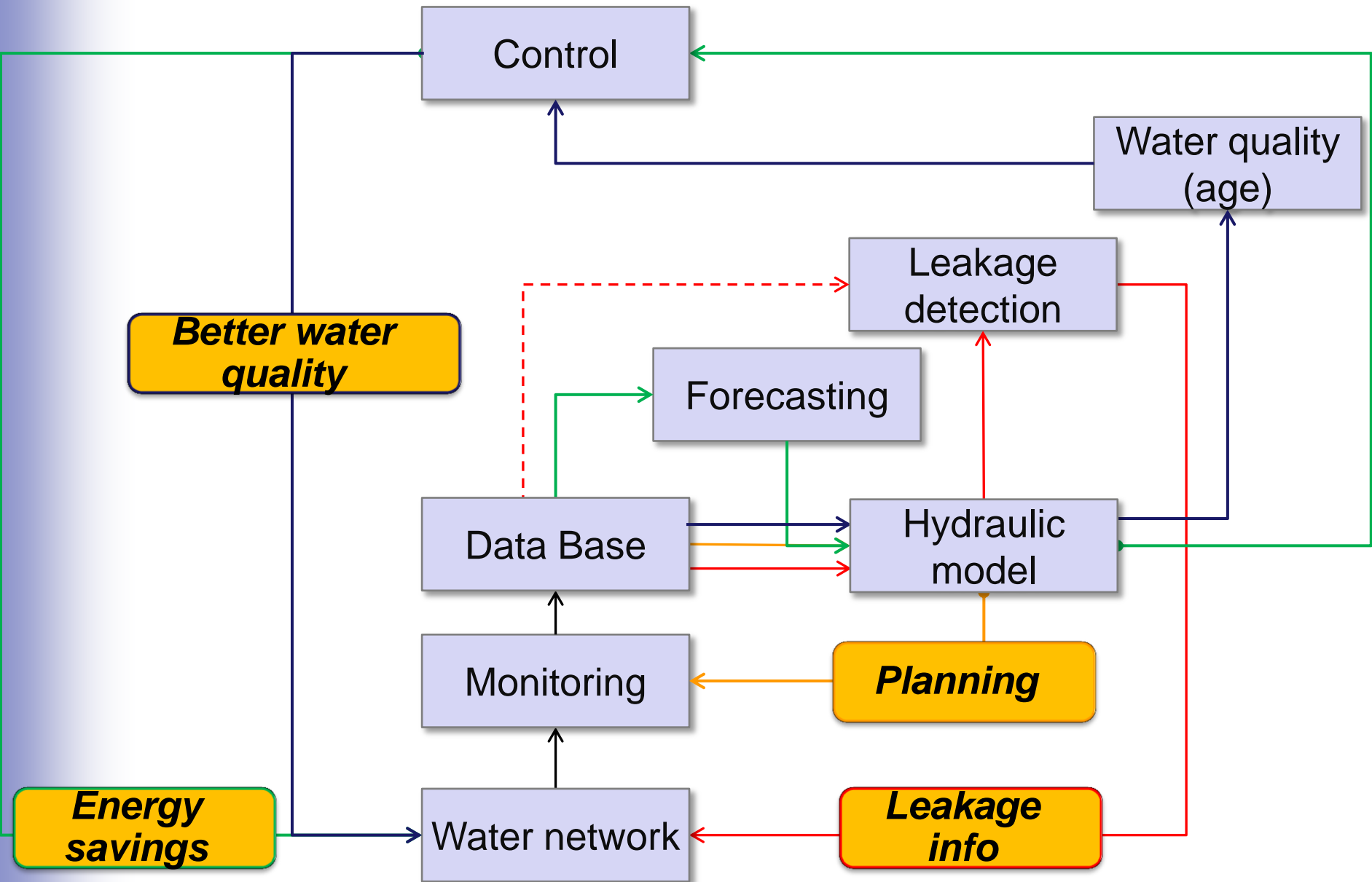
Hard management – Forecasting a net load



Hard management – water quality

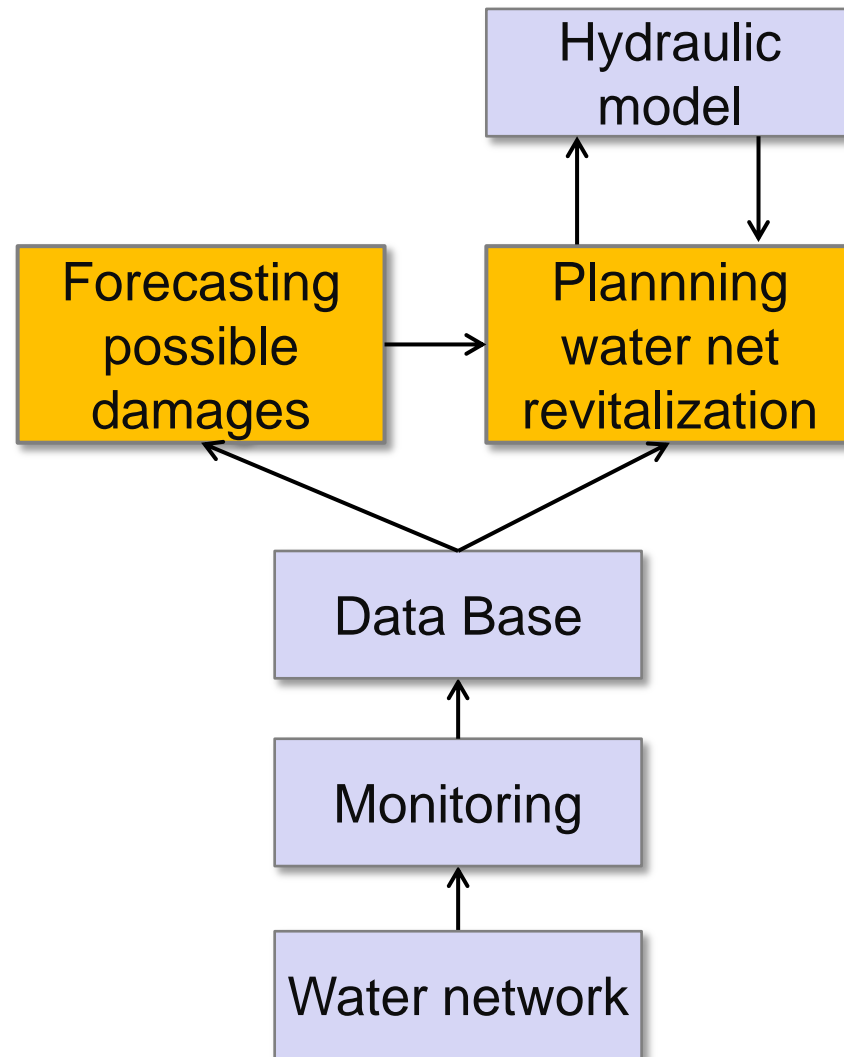


Hard management



Soft management

- Forecasting the possible damages
- Planning the water net revitalization
- Planning water price for the network



Summary

Future plans

- Development of presented algorithms
- Integration of all algorithms into united IT System
- Testing the system under real conditions

Future plans

- The diversity of problems to be solved makes the project complicated and very interesting from the scientific point of view.
- This will have an essential and positive impact on the environment regarding the reduction of water losses
- This will also influence positively the standard of life of human communities in the cities in which the system will be implemented.

Thank you for your attention