

# **WIDE End-User Panel Meeting**

## **WP5: Barcelona Water Network Prototype**

**Honeywell Prague Laboratory**

**Honeywell**

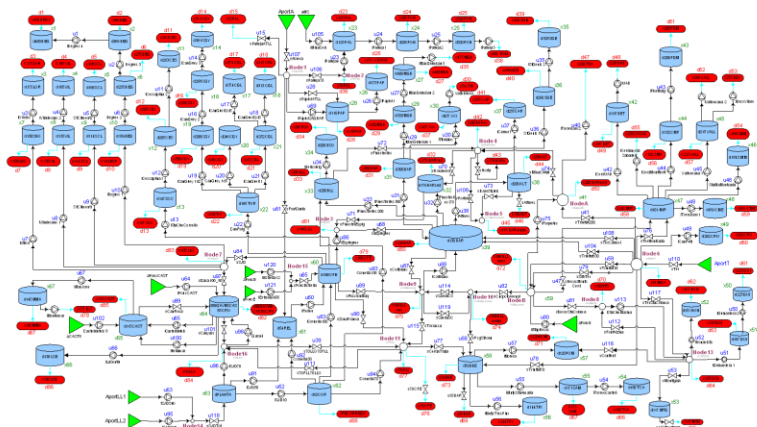
## Barcelona Demo Case: Objectives

### DEMO 1 – Matlab only

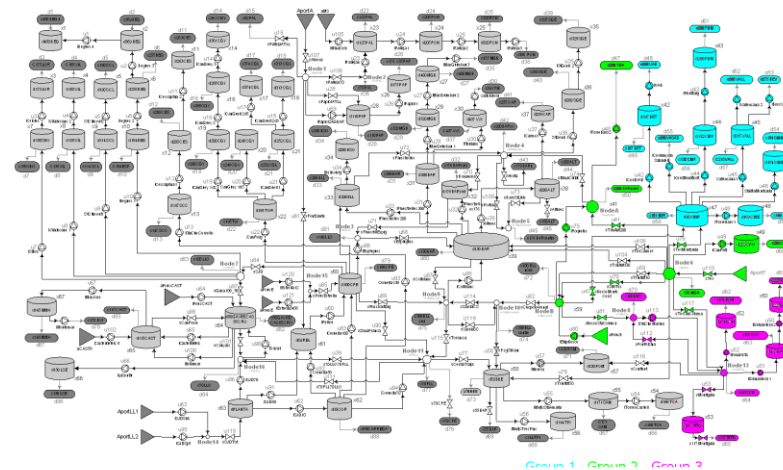
- Evaluate benefits of (distributed) MPC by comparing overall costs for legacy (historic data) and distributed MPC control strategies
- demo scale: whole network

### DEMO 2 – Real-time platform URT

- Demonstrate complete industrial solution (real-time platform, basic control layer, backup strategy)
- Demonstrate project life cycle - the ability of distributed MPC to replace legacy control in multiple steps for smooth transition between legacy and advanced control strategy
- demo scale: 3 network sub-groups (right figure)



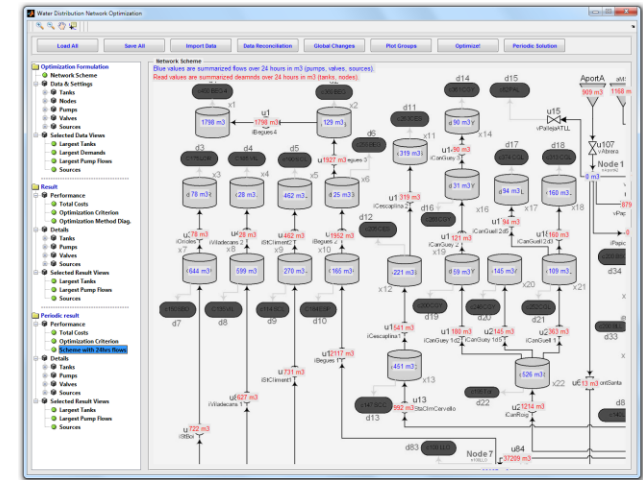
DEMO1: whole network optimization



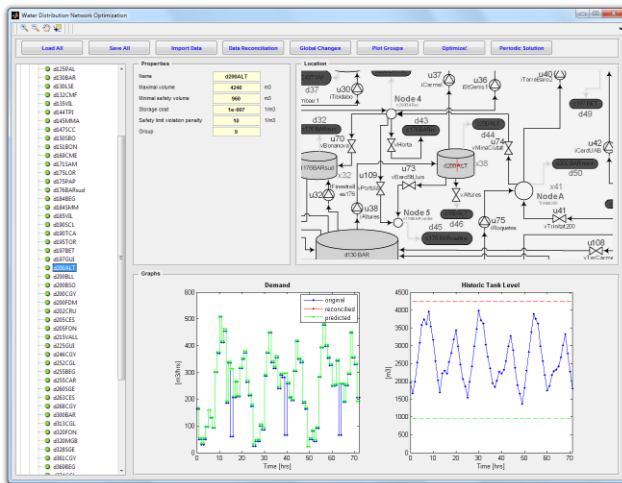
DEMO2: 3 groups optimization

## Barcelona Demo Case: Benefits Evaluation

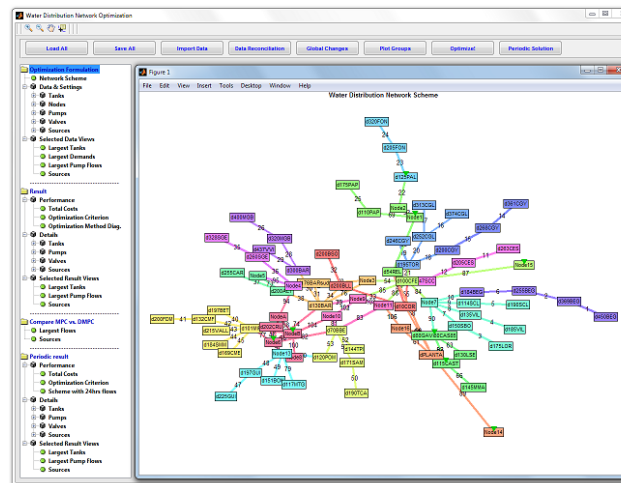
- Matlab tool with GUI for:
  - Building network description (topology, limits, prices)
  - Decomposing network to groups
  - Performing optimization
  - Comparing flow and tank level trajectories for legacy and MPC control strategies
  - evaluating benefits (pumping and water costs)
- Developed for water networks, directly applicable also to gas distribution networks



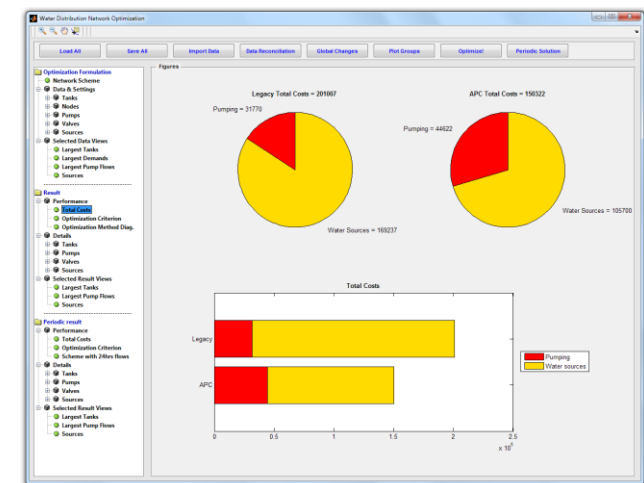
Network topology



Network object details view.



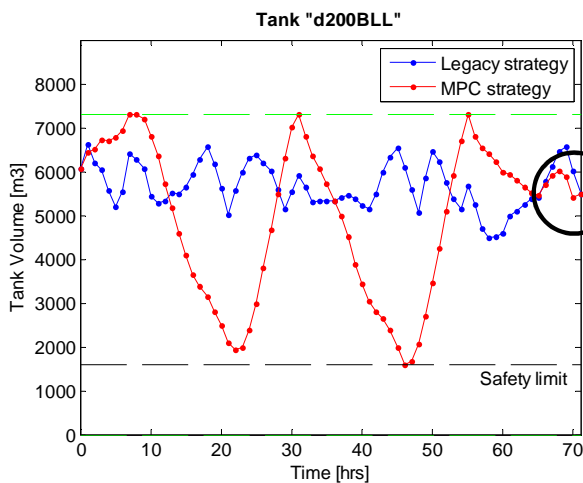
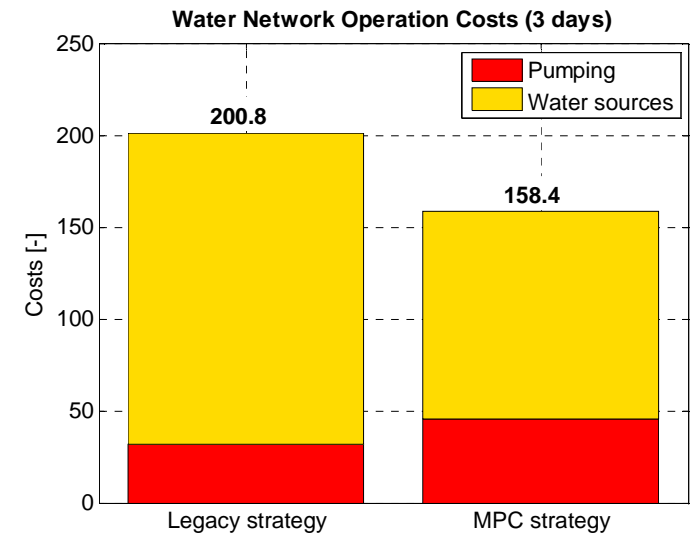
Network separation to groups



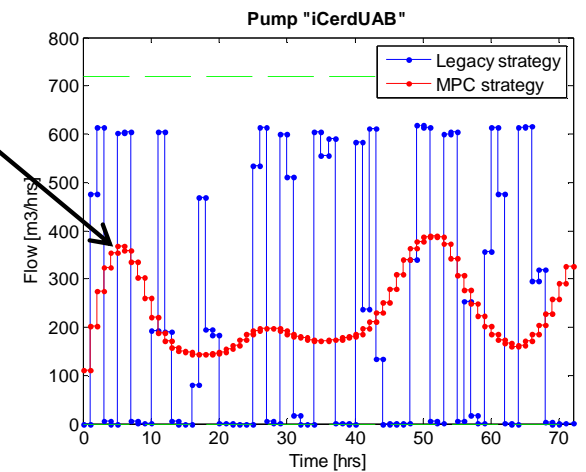
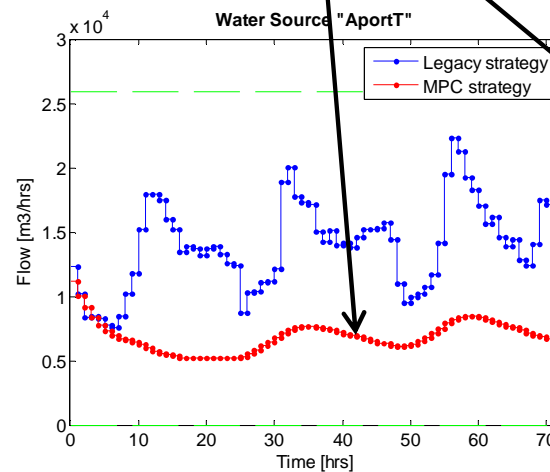
Costs evaluation

## Barcelona Demo Case: Benefits Evaluation

- Benefits evaluated on 3 days historic data set
- Benefits evaluation is complicated by water accumulation (different final accumulation for different control strategies)
- To get comparable data MPC was forced to fill tanks to the same final levels as in historical data (sub-optimal)
- ~20% direct cost savings (pumping and water sources)
- Indirect savings by smooth MV's operation -> leakage prevention by small pressure surges and reduced equipment tear & wear

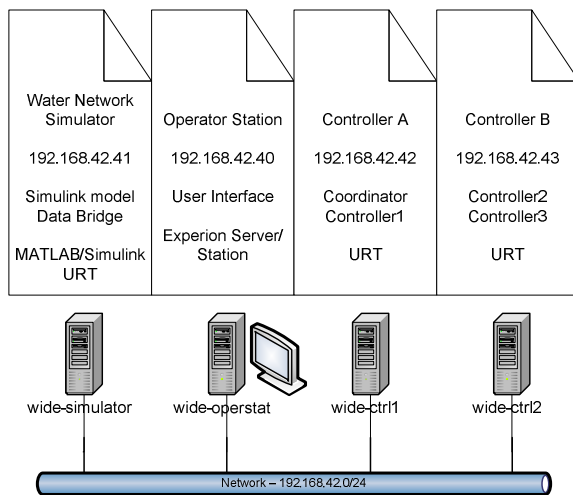


Same final tank levels

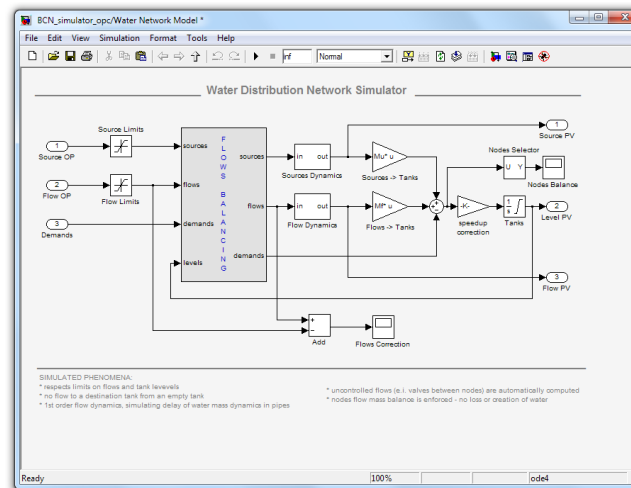


## Barcelona Demo Case: Real-time Demo

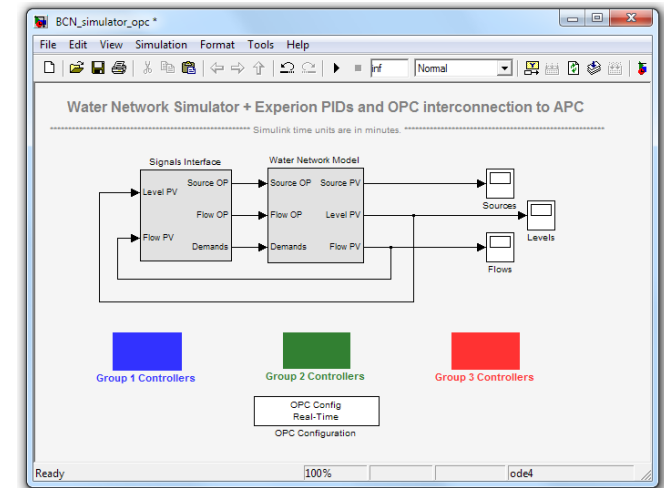
- Demonstration of a complete solution on a selected part of Barcelona network
- 3 distributed MPC controllers with coordinator (runs on 4 computers)
- Algorithms implemented in C++ for Honeywell Unified Real Time (URT) platform – an infrastructure for implementing real-time advanced process control applications (used for example for power plants advanced control)
- Water network is simulated in Matlab Simulink (Barcelona operator was not willing to allow test on their network)
- Simulation is hidden to URT by standard OPC connectivity of the simulator



Control configuration



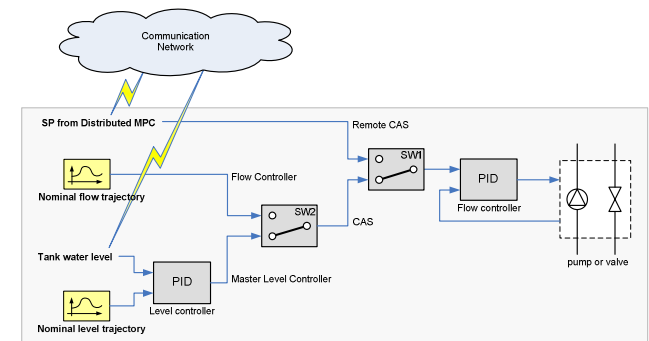
Simulink Water Network Simulator



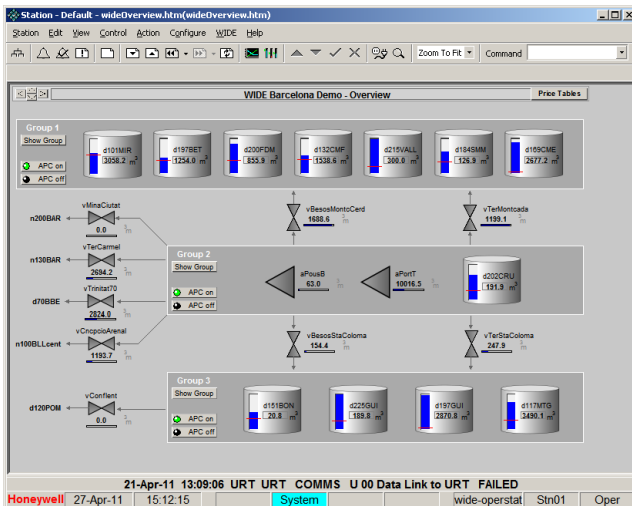
Simulator OPC Interface

## Barcelona Demo Case: Real-time Demo

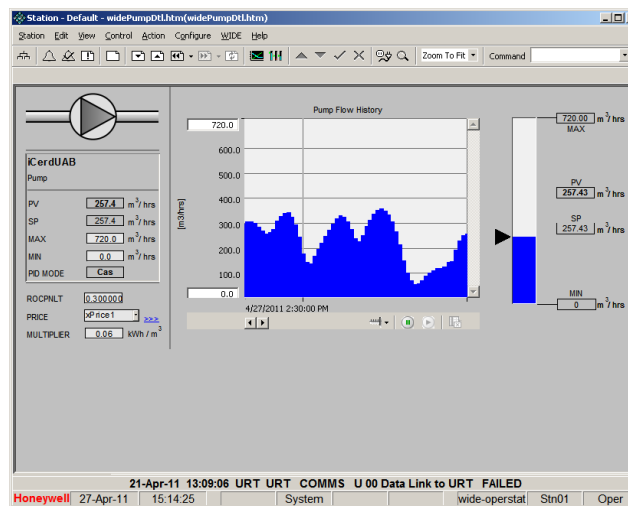
- Demo solves cooperation of MPC with legacy control for sequential implementation of MPC to the network groups (project life cycle) to allow network operator to evaluate MPC operation before implementing it to the whole network
- Includes backup control strategies for the case of MPC failure
- Basic control layer implemented in Simulink using industrial Experion PID blocks
- Operator panels implemented in Experion HMIweb



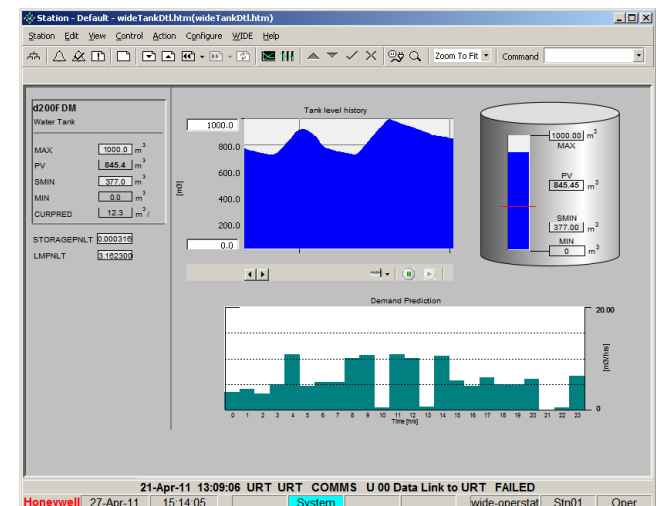
Flow controller with backup control



3 groups overview



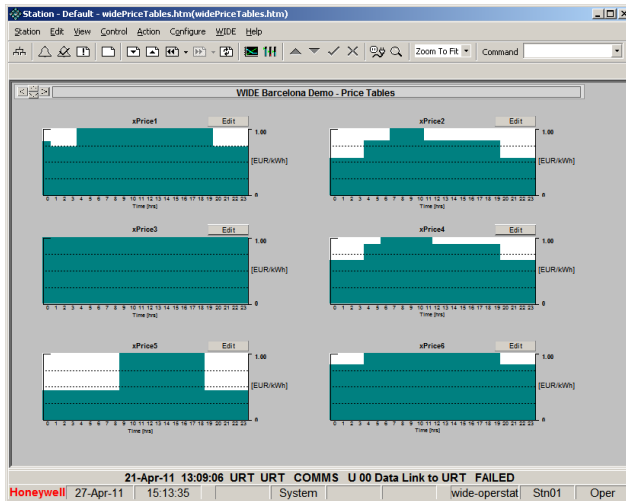
Pump detail operator panel



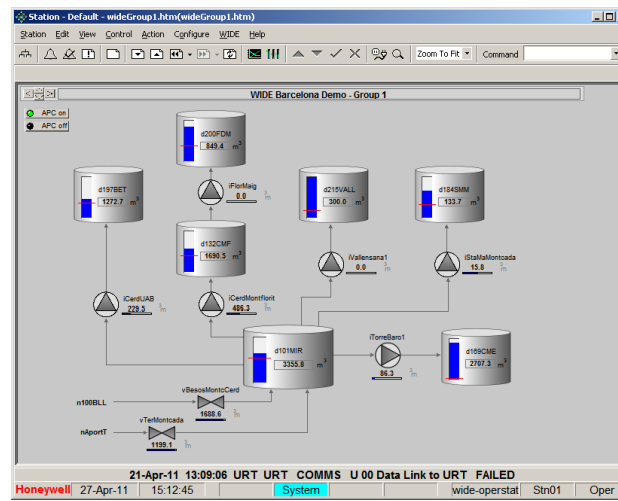
Tank detail operator panel

## Barcelona Demo Case: Real-time Demo Summary

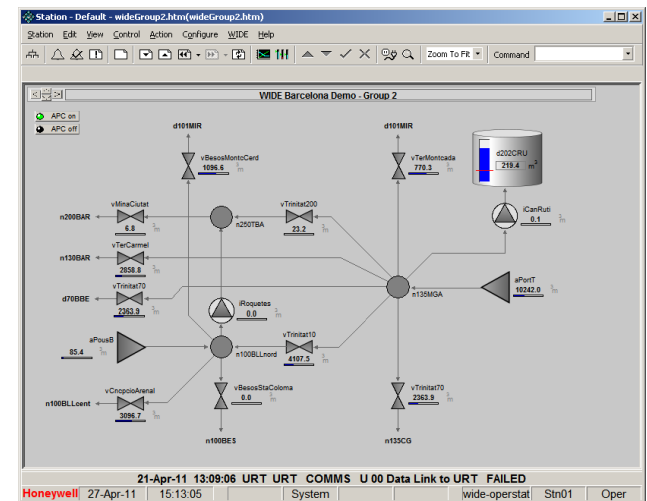
- Real-time demo uses distributed MPC with parametric coordination
- The consensus is reached in average in 15 iterations
- URT demo is now installed in Agbar (Barcelona water network operator) for evaluation



Price patterns definition



Group 1 detail



Group 2 detail