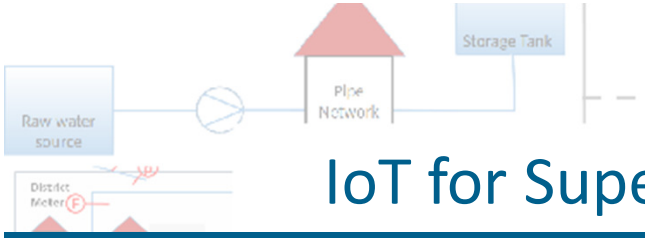
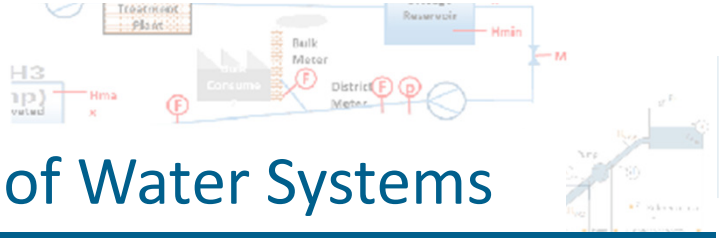


IoT.H2O

IoT for Supervision and Control of Water Systems



Low-cost sensor system based on LoraWAN for monitoring water distribution systems

Harald Roclawski, Martin Böhle, Thomas Krätzig, Benjamin Dewals, Laurent Vercouter, Aloysio Saliba, Anika Theis, Thomas Pirard, Henrique Donancio, Pierre Archambeau, and Sébastien Erpicum

Water JPI

2017 JOINT CALL

IoT.H2O

IoT for Supervision and Control of Water Systems

Introduction

- Water JPI project: IoT.H2O - IoT for Supervision and Control of Water Systems
- Objective: Explore the potential of the Internet of Things (IoT) model for monitoring and operating small water utilities
- In these slides the current status of the project since its start in April 2019 is presented
- Consortium
  - Technical University of Kaiserslautern (Germany), Institute for Fluid Mechanics and Fluid Machinery (SAM)
  - Dr. Krätzig Ingenieurgesellschaft mbH (KI), Aachen, Germany
  - Federal University of Minas Gerais, Brazil (CPH), Centro de Pesquisas Hidráulicas e Recursos Hídricos
  - Liege University, Research group Hydraulics in Environmental and Civil Engineering (HECE), Belgium
  - Institut national des sciences appliquées de Rouen, LITIS LAB, MIND Group, France

Motivation – SCADA systems

- SCADA (Supervisory Control and Data Acquisition) systems are used for data acquisition, process control and visualization of water systems
- Centralized, hierarchical structure
- Inclusion of additional sensors requires significant hard- and software upgrades in the central computer
- number of measuring devices is limited
- significant parts of the network remain “invisible”
- long term observation and big data analysis not possible
- mostly proprietary and manufacturer specific
- restricted communication and interaction with other systems
- high investment cost and technically complex

Motivation – IoT model in IoT.H2O project

- IoT model: decentralized interconnected field devices : additional sensors can „easily“ be added
- low-cost hard- and software
- manufacturer independent computer platforms
- sensors and actuators with digital interfaces
- free or open-source visualization technologies
- digital hydraulic water system modelling and artificial intelligence implementations
- digital twin technology for prototyping and testing and as an operational support tool

➡ Cost efficient but powerful control and supervision system for water utilities

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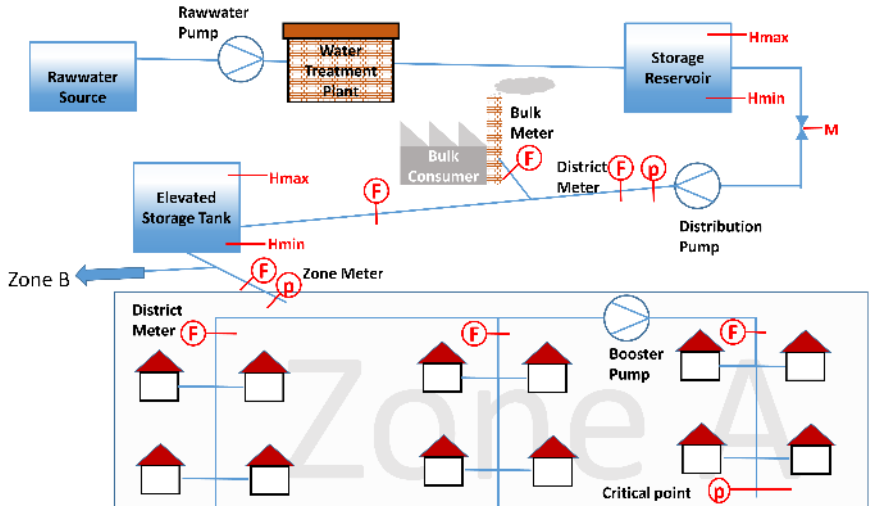
IoT system design

Field layer (Devices / Gateways)



Network layer

- Network service provider (Ethernet, cellular data networks (2G/3G/4G/5G), LoRaWAN, …)
- Gateway administration

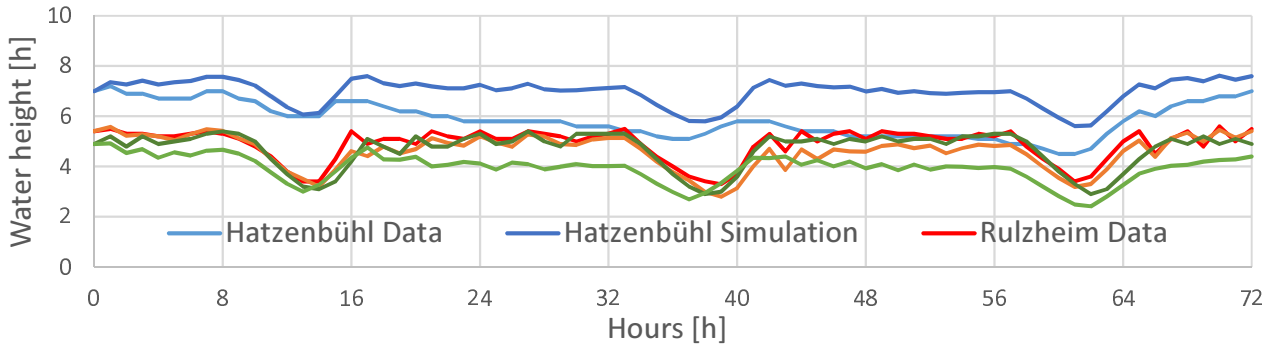
Application layer

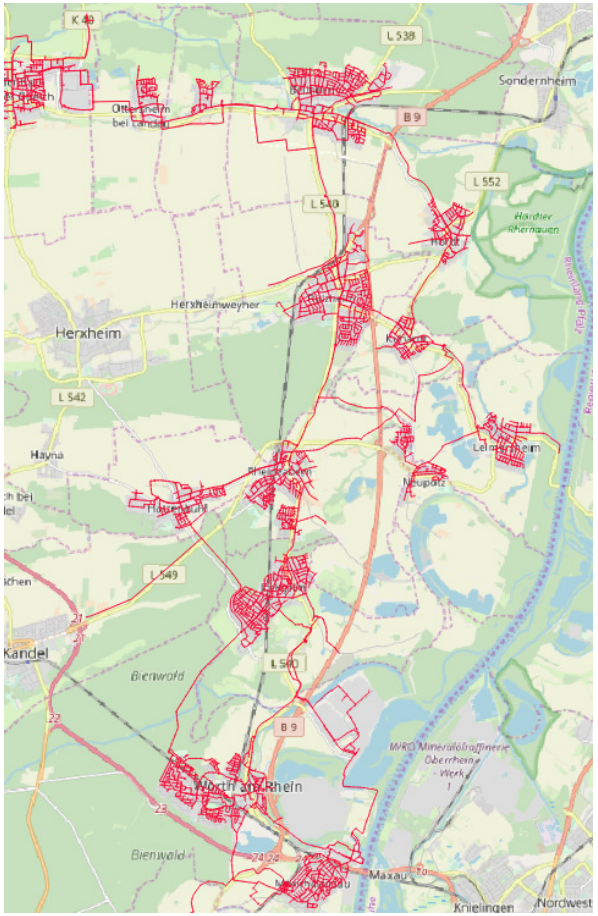
- Physical objects are mapped to objects in the information world
- User Front-End
- Applications for visualization of water network operation
- Big data analysis
- Time series processing
- Predictive maintenance for pumps and valves
- Operational optimization
- …

LoRa radio and LoRaWAN network protocol were selected as technology for sensor to gateway / server communication

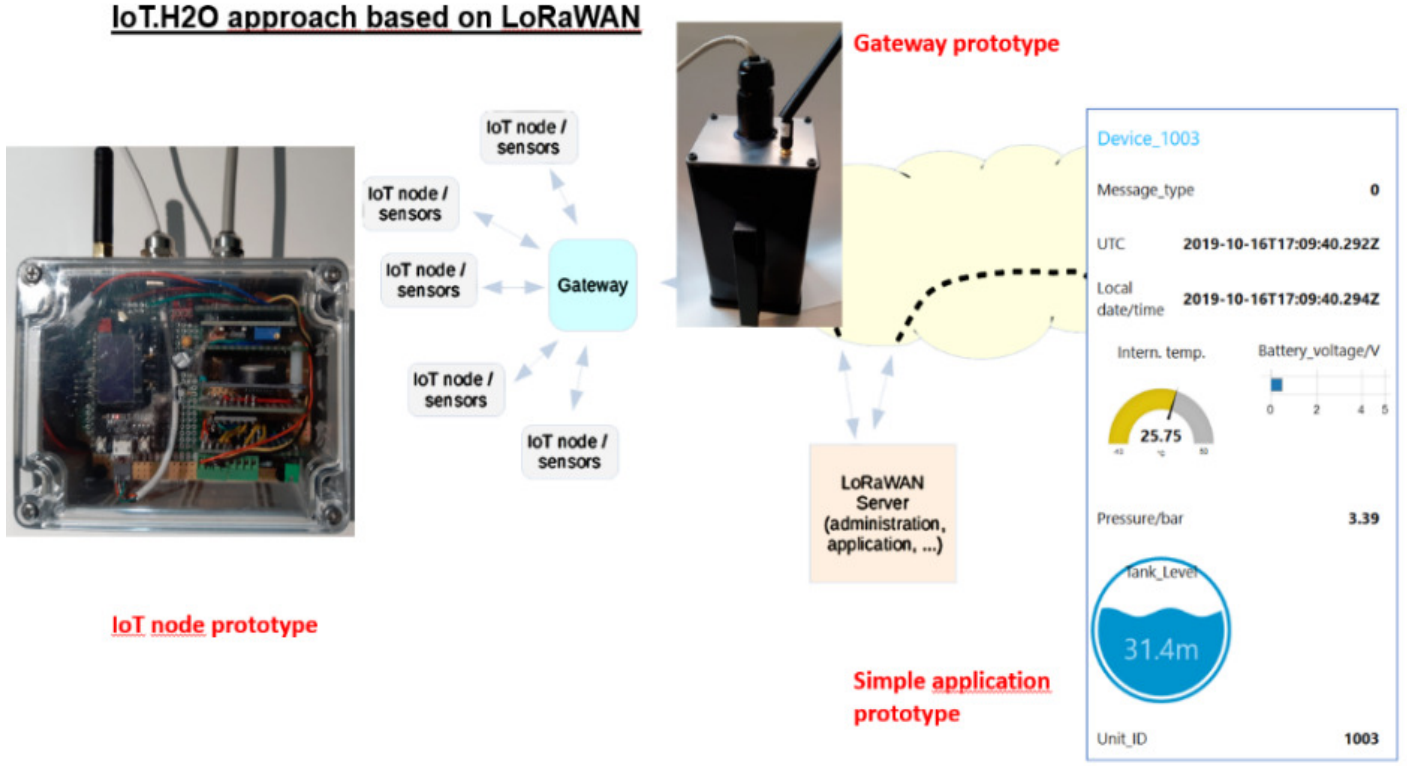
Application layer: data valorization through modelling and optimization of water networks

- Modelling of the network at Jockgrim
- Hydraulic model developed inhouse at ULiège
- Optimization tools based on IPOPT
- Standard data currently available are insufficient for a complete modelling of the network → **need for extra data from IoT**



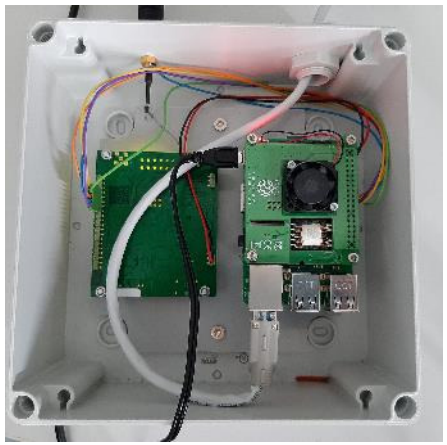


IoT system design based on LoRaWAN



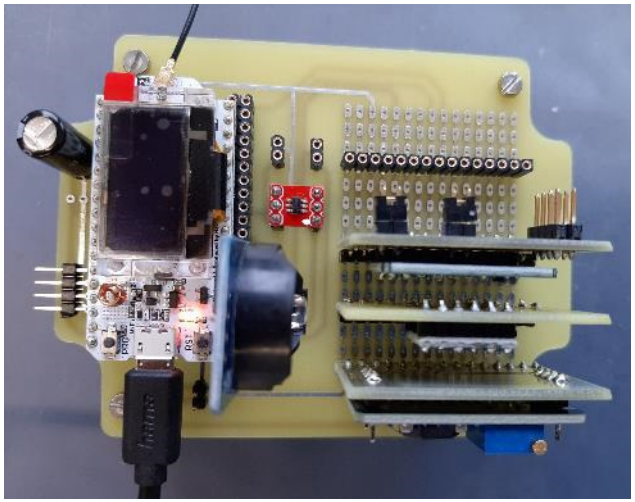
LoRaWAN -Gateway

- iC880A - LoRaWAN® Concentrator 868MHz IMST GmbH and RAK831 Concentrator (RAK) are used in connection with a Raspberry Pi.
- Currently „The Things Network (TTN)" server is used.
- Operation of an own LoRaWAN network server is under development



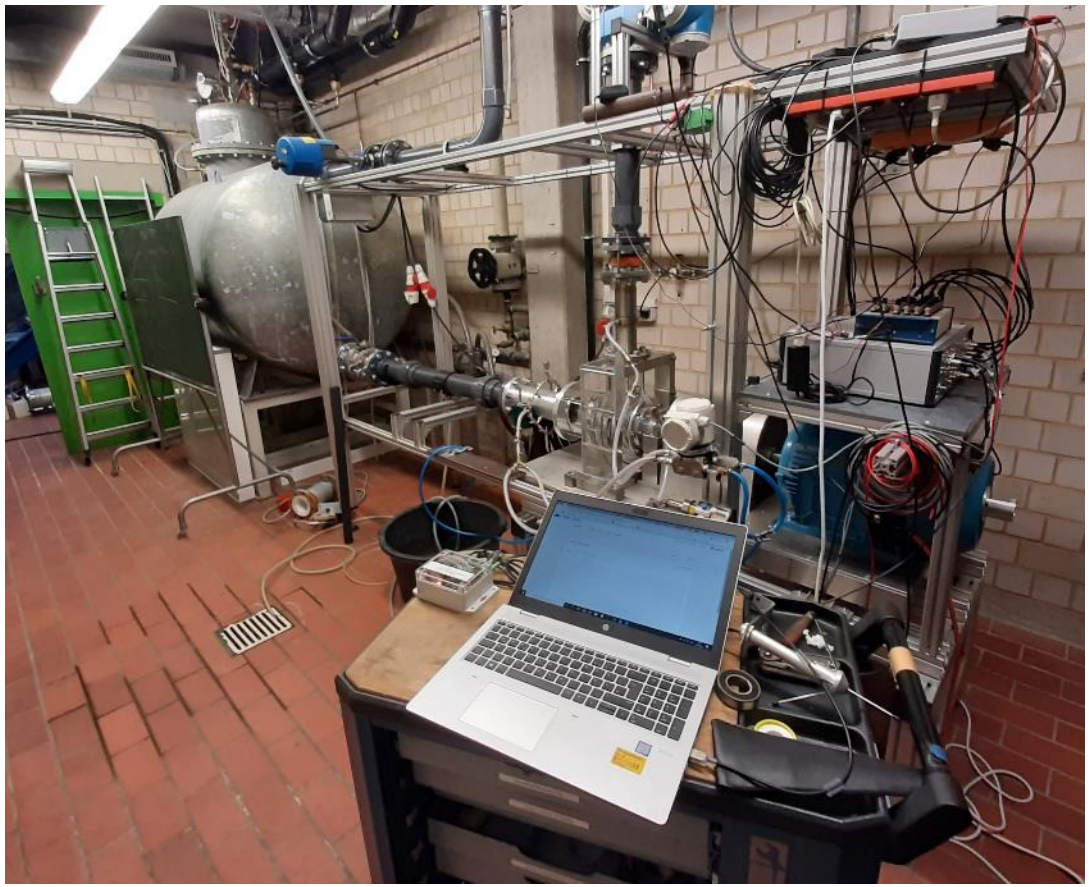
Design of IoT-node

- GOAL: modular design based on self-developed PCB boards
- Different sensors can be connected to IoT-node
  - currently: pressure sensor and flow meter
  - Future: water level sensor and acceleration sensor
- Microprocessor: ESP32 / Heltec WiFi LoRa 32 (V2) board



IoT system test at pump test rig

- Currently: measurement of flow rate by MID and hydraulic head by pressure sensors
- Alternative: pump monitoring based on vibration measurement and neural network (flow rate, hydraulic head, speed, power, efficiency)
- Range tests:
  - signal transmission through a single building is possible
  - Distance ~1km

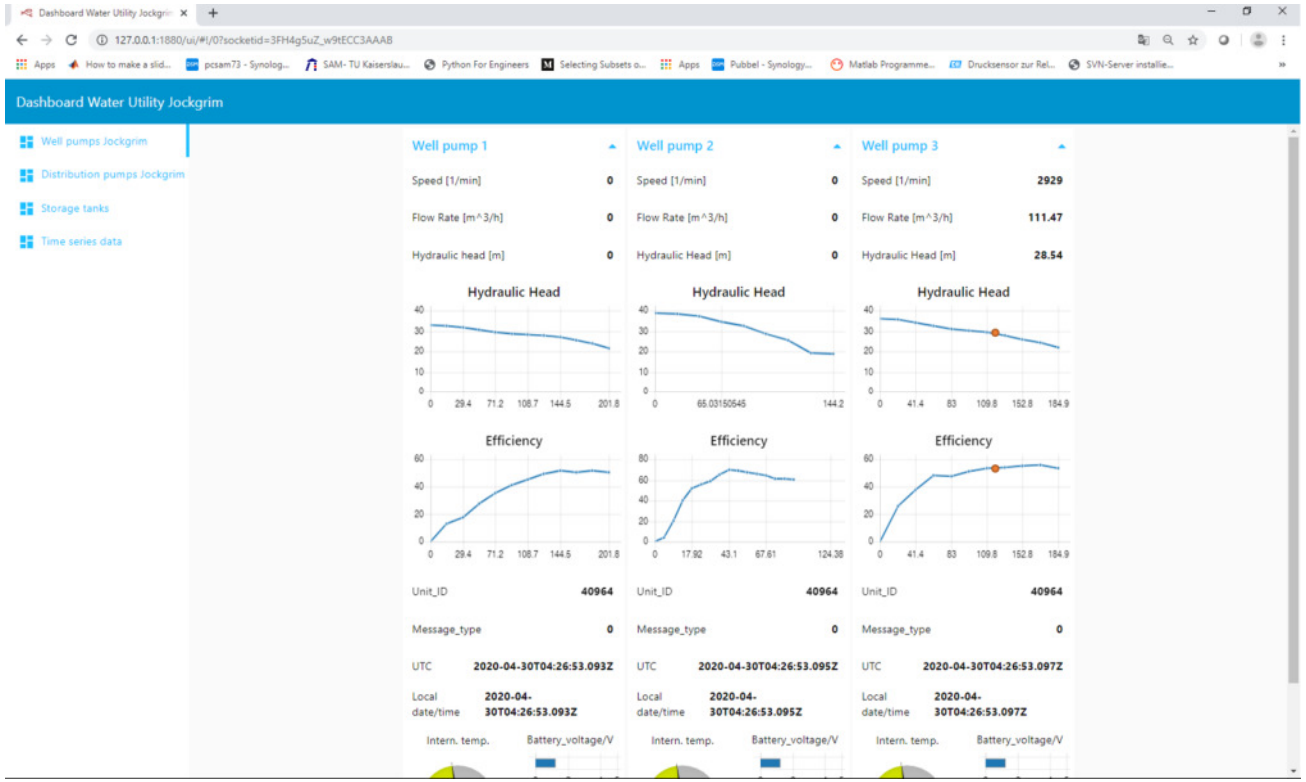


Field Test at water utility Jockgrim, Germany

- Installation of a gateway in administration building
- Currently monitoring:
  - pressure of two well pumps
  - and a distribution pump
- Water level in wells and storage tanks are under development

First results - Field Test at water utility Jockgrim, Germany

- Graphical visualization currently based on Node-RED
- Data storage in database is under development



First results - Field Test at water utility Jockgrim, Germany

- Quality of signal transmission:
  - Depends on location of sensor
  - Well pump 3 with cover plastic cover – no problems
  - Well pump 4 in building with metal walls – signal transmission is very weak
  - Distribution pump 2 in basement with thick concrete walls – from time to time no signals are received by gateway
- Improvement of signal transmission (next steps):
  - Improved antennas for IoT-nodes
  - Optimized gateway arrangement
- IoT nodes in network and storage tanks will be added in the future

Conclusion & future work

- First prototypes have been built and tested successfully in laboratory and field test
- Workflow from sensor to gateway and Node-RED has been implemented
- Improvement of signal transmission and gateway locations
- Optimization of IoT node hardware
- Extend field tests in Germany and to systems in Brazil and Belgium
- Improve big data analysis and visualization of operating data

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- Fund for Scientific Research (F.R.S.–FNRS), Belgium

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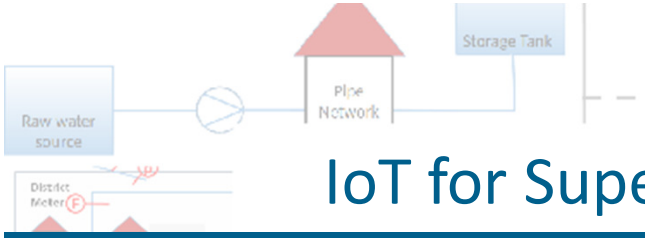

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Thank you very much for your attention!

https://www.mv.uni-kl.de/IoTDotH2O