Intelligent Buildings Remote Monitoring Using PI System at the VSB - Technical University of Ostrava

Jan Vanus

Presentation Agenda:

- About VŠB TU Ostrava
- OSIsoft and Intelligent Building monitoring – how did it start?
- PI System in Intelligent Systems and Technologies for Smart Buildings courses?
- Educational process – Engineering thesis – Work with real data
- Conclusion

VŠB-TU Ostrava

More than 20,000 students

- The university consists of seven faculties:
  - FMG (since 1849) - Faculty of Mining and Geology
  - FMME (since 1849) - Faculty of Metallurgy and Material Engineering
  - FME (since 1951) - Faculty of Mechanical Engineering
  - FE (since 1977) - Faculty of Economics
  - FEECS (since 1991) - Faculty of Electrical Engineering and Computer Science
  - FCE (since 1997) - Faculty of Civil Engineering
  - FSE (since 2002) - Faculty of Safety Engineering

Faculty of Electrical Engineering and Computer Science

With approximately 3000 students, the Faculty of Electrical Engineering and Computer Science is one of the lar-gest faculties within the VSB - Technical University of Ostrava today (8 Departments).

- Department of Cybernetics and Biomedical Engineering

Education:

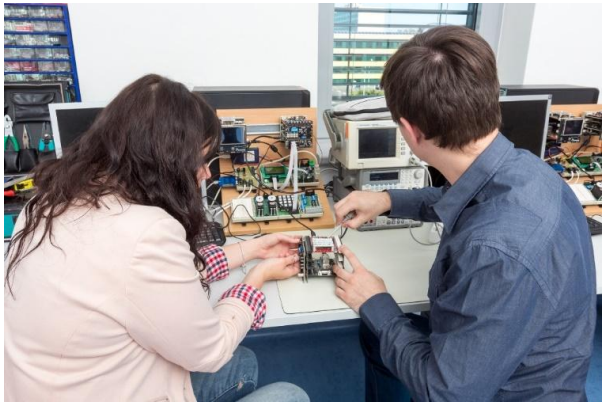
BC (3 years):	- Control and Information Systems
	- Biomedical Technician
MGR (2 years):	- Control and Information Systems
	- Biomedical Engineering
Ph.D. (4 years):	- Technical Cybernetics

Department of Cybernetics and Biomedical Engineering

Laboratories

- Laboratory of Signal and Systems Theory
- Laboratory of Virtual Instrumentation
- Laboratory of Sensors and Measurement
- Laboratory of Control Systems
- Laboratory of Embedded Systems and Microcontrollers
- Laboratory of Biomedical Engineering
- Laboratory of Biomedical Instrumentation
- Laboratory of Biomedical Sensors and Measurement
- Laboratory of Building Control
- Laboratory of Machine Vision
- Laboratory of Programmable Controllers and Distributed Control Systems
- Laboratory of Electrical Measurement

Laboratories - photos



Department of Cybernetics and Biomedical Engineering

Research groups at department:

- Industrial automation and embedded systems.
- Sensors, measurement and testing.
- Control of appliances with alternative energy sources.
- Biomedical engineering.

Department of Cybernetics and Biomedical Engineering

Research area at the department:

- Design of embedded systems based on microprocessors and FPGA.
- Design of industrial control systems (PLC, HMI/SCADA), implementation of complex control algorithms.
- Signal measurement and processing, image processing.
- Industrial communication systems (wired or wireless).
- Automated measurement systems, sensors and testing.
- Biomedical engineering, telemetry, Smart Home Care.
- Measurement and control in systems with renewable energy sources.
- Industry 4.0., IoT, IoTT, Intelligent Buildings, Smart Cities, Smart Grids …

Department of Cybernetics and Biomedical Engineering

KNX training centre

- VSB - TU, Faculty of Electrical Engineering and Computer Science, Department of Cybernetics and Biomedical Engineering **has set up a KNX training centre** in Ostrava in Czech Republic.
- The training centre **offers KNX Basic training courses**, concluded **with a Partner KNX certificate** after successful completion of the course.
- The training lab equipment is carefully designed to familiarize **electricians, installers, developers, teachers, architects** and designers with the KNX technology.
- The KNX Basic course is the first course that one must attend in order to become a KNX Partner and in order to be listed as a KNX Partner on the KNX website (**knx.org**).

VŠB-TU Ostrava - cooperation with business and industry

Cooperating agreements (teaching, research and development)

SIEMENS Ingenuity for life
Schneider Electric
ABB
WAGO
OSIsoft.
NATIONAL INSTRUMENTS
MICROSYS computers automation

Licensed software used in teaching and research (among others)

MATLAB SIMULINK
Wonderware by Schneider Electric
PROMOTIC
OPC UA

Technologies for building automation

ASHRAE BACnet
DALI
LonWorks
SCIENTIFIC KNX
TRAINING KNX
xComfort
EtherNet/IP

Department of Cybernetics and Biomedical Engineering

Education – PI System used in Subjects

- Building Control (2017/2018),
- Intelligent Building Control (2018/2019),
- Sensors for Safety Applications (2017/2018),
- Intelligent Systems and Technologies for Smart Buildings (2018/2019).
- 4 x Master Thesis
- 2 x Bachelor Thesis

Topics of my interests:

- Design and implementation of remote comfort control of operational and technical functions in Smart Home and Smart Home Care with fieldbus (KNX, BACnet, LonWorks) and wireless systems.
- Voice communication with control system in Smart Home and Smart Home Care.
- Use of modern methods (Data Mining, Big Data processing, Soft Computing methods) for measurement data processing in Smart Home and in Smart Home Care.
- Smart Light control in Smart Home and in Smart Home Care.
- Energy management in Smart Home and in Smart Home Care.
- Verification, clasification, recognition, preprocessing, prediction of operational and technical measurement values (data) in Intelligent Buildings, Smart Home, Smart Cities

VŠB – TU Ostrava

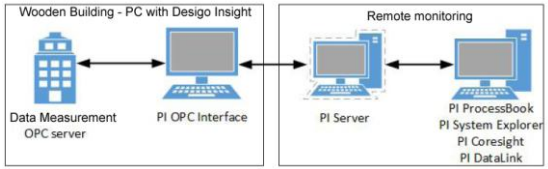
Smart Home, Smart Home Care

CHALLENGE

Smart Home Remote Monitoring Using PI System Management Tools

• **PI System** implementation for remote monitoring of operational and technical functions in the Smart Home used for the collection and processing of measured operating data.

SOLUTION



The following tools were used to process and analyze the data further measured by the sensor described above:

- Visualisation sw Desigo Insight (data trends).
- PI Process Book.
- PI Vision.
- PI Datalink (MS Excel).

RESULTS

The PI Process Book came out on top for the following reasons:

- Real time display speed.
- Capability of displaying multiple progressions for any time period.
- Displaying of basic statistical data at precisely specified time within any time period, (Average, Minimum, Maximum, Range, Standard deviation, Time interval, Time Range).
- Quick storage of measured data within any, precisely specified time period.

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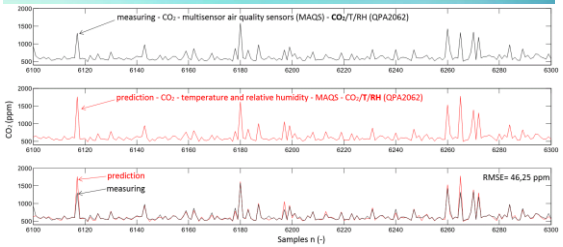
Smart Home, Smart Home Care

CHALLENGE

New Method for Accurate Prediction of CO2 in the Smart Home

The measured data are loaded from the individual BACnet technology sensors by means of the Desigo Insight visualization tool.

SOLUTION



To analyse the measured data for prediction of the Smart Home's internal environment quality at VSB TU Ostrava built within the Moravian-Silesian Wood Cluster (MSDK), we used the Random Forest method (RF).

RESULTS

- The new approaches method to calculate of predicted CO_2 values in implementation of the decision tree regression method from measured temperature (T) and relative humidity (rH) values.
- It is possible to use the RF with sufficient accuracy for estimate of the CO_2 content in the air on the basis of the internal and external temperature (*T*), internal relative humidity (rH), the date and the time as the input parameters.
- As the RF method provided estimates with sufficient accuracy, it is possible to focus on potential elimination of CO_2 sensors in the Smart Home.

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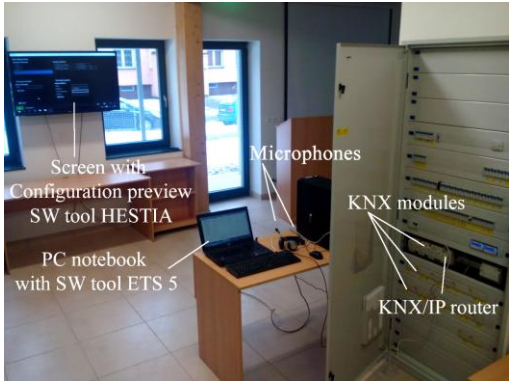
Smart Home (SH), Smart Home Care (SHC)

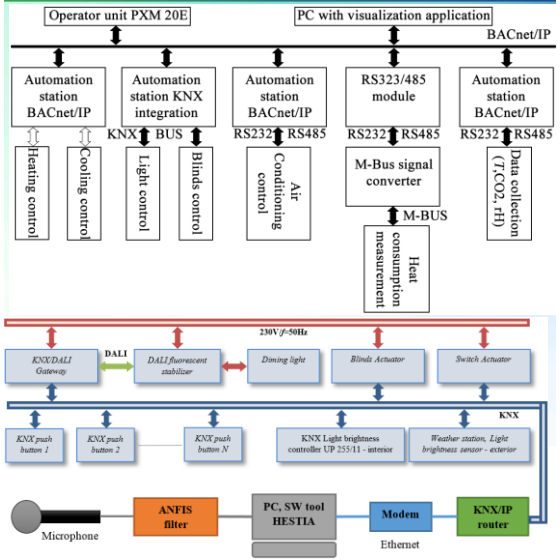


CHALLENGE

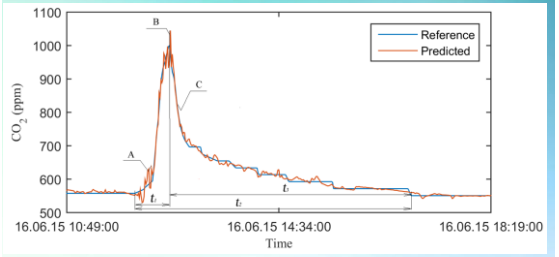
MONITORING OF THE DAILY LIVING ACTIVITIES (ADL) IN SHC

- The aim is the use and processing of information from operationally measured non-electrical quantities determining the indoor environment in the SHC using operational technological units for the determination of the ADL in a real-world SHC environment.

SOLUTION



RESULTS



- The monitoring the presence of persons of the SHC to determine the occupancy of the monitored spaces with the possibility of using the obtained information to determine the ADL using existing technological systems that can be employed in the SHC.

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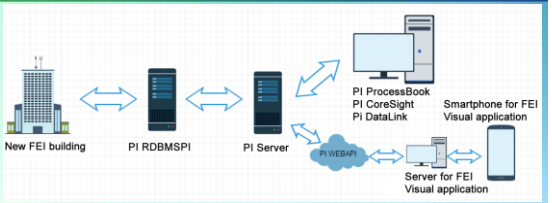
New FEI Building

CHALLENGE

Energy Management Strategies in Intelligent Office Building Using PI System

• **Implementation** of a the PI System Management Tools by OSIsoft for **remote comfortable monitoring** of HVAC in the intelligent building for **statistical analysis** of the measured data.

SOLUTION



• **Data** from sensors HVAC control (LonWorks) , Light control (KNX)
• **RDBMSPI** interface.
• **PI server**.
• Use **PI SDK** (Software Development Kit), **PI API** (Application Programming Integration) libraries or a combination of both.

RESULTS

• Acquired data
• Application of Soft Computing methods

• Long-term monitoring
• Target - optimal control of operational and technical functions in Intelligent Building
• BMS (Building Management System).

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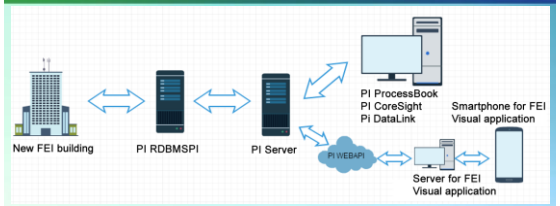
New FEI Building

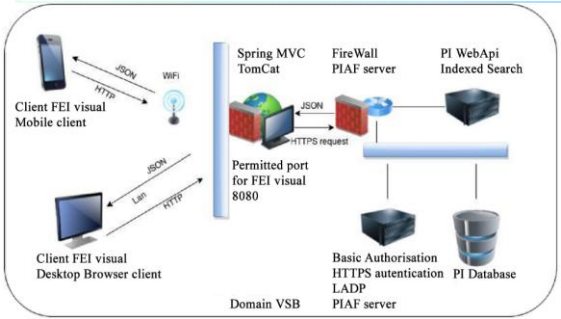
CHALLENGE

Design of an Application for the Monitoring and Visualization of Technological Processes with PI System in an Intelligent Building for Mobile Application

- The application has been developed using the Sencha Touch JavaScript framework and the PhoneGap wrapper.
- The application is optimized for Android devices.

SOLUTION





RESULTS

- The work describes the various tools and custom design of the user interface for the monitoring of technological processes in an intelligent building.
- The main feature of the development and implementation of a hybrid mobile application is that it is a platform independent application.
- The application is programmed using JavaScript Sencha Touch Framework 2.
- The application is deployed together with the server components on a PC, which is located in the VSB domain.

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New FEI Building

CHALLENGE

The Design of an Indirect Method for the Human Presence Monitoring in the Intelligent Building

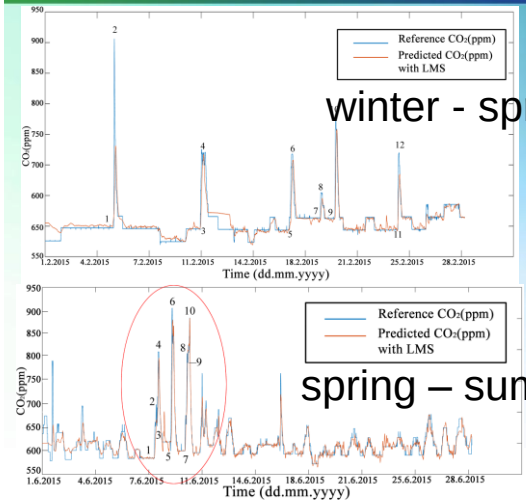
• Artificial Neural Network (ANN) with the Bayesian Regulation Method (BRM) for monitoring the presence of persons in the individual premises in the Intelligent Administrative Building (IAB) using the PI System SW Tool (PI - Plant Information enterprise information system).

SOLUTION

• Verification of the indirect method of predicting the course of CO_2 concentration (ppm) from the measured temperature variables T_{indoor} (°C) and the relative humidity rH_{indoor} (%) and the temperature $T_{outdoor}$ (°C) using the ANN.

• The CA (Correlation Analysis), the MSE (Root Mean Squared Error) and the DTW (Dynamic Time Warping) criteria were used to verify and classify the results obtained.

RESULTS



winter - spring

spring – summer

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New FEI Building
future

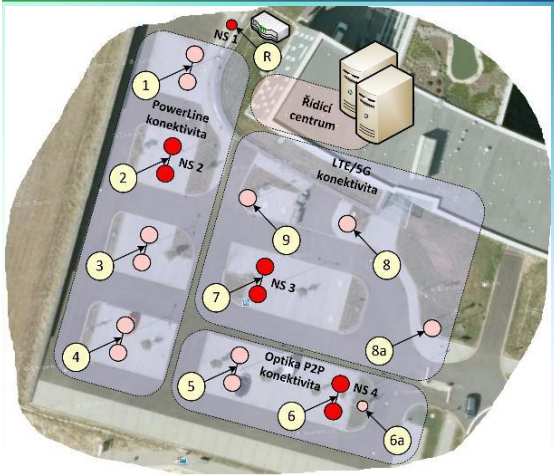
CHALLENGE

Smart cities -

Broadband^{LIGHT} polygon test model

• The aim of the project is to verify the usability of the VO infrastructure in the real-life operation of the Broadband^{LIGHT} test polygon to cover the city of SMART technologies.

SOLUTION



RESULTS

• **charging stations** for small electronics (mobile phones, notebooks, etc.), electro, electric, electric cars, including security and tariffs.

• Integration of **CCTV systems** directly into public lighting lamps.

• **SMART Sensors**, environmental sensors (temperature, precipitation, air pollution including salinity of the road surface in the winter, leakage of dangerous gases, etc.), traffic sensors (vehicle weighing, speed measurement, noise, vibration, etc.).

• **Cloud computing** - IoT ideology (IIoT).

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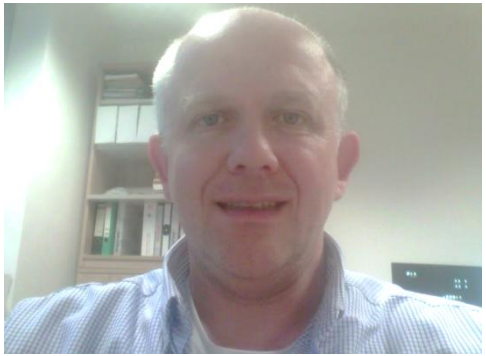
New Platform of modern technology at FEI CPIT TL3 - future

CHALLENGE	SOLUTION	RESULTS
• Smart Factory – Industry 4.0 • Smart Home Care • Smart Grids • Automotive electronic systems and electromobility	Start of construction of New Building CPIT TL3 24 September 2018 12:00	Project completion date: 30 June 2021

Next steps:

- Prepare courses for student basis on PI System software
- Workshops for students and teachers
- Grants, projects
  - internships program
  - additional courses
- Cooperation with companies using PI System



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Questions?

Please wait for the **microphone**

State your **name & company**

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