EIB/KNX BASED HVAC CONTROL SYSTEM IN A RESEARCH LABORATORY

Petr Polách
Doctoral Degree Programme (2), FEEC BUT
E-mail: polachpetr@phd.feec.vutbr.cz

Václav Sáblík
Doctoral Degree Programme (2), FEEC BUT
E-mail: xsabli00@stud.feec.vutbr.cz

Jan Pohl
Doctoral Degree Programme (1), FEEC BUT
E-mail: xpohlj00@stud.feec.vutbr.cz

Supervised by: Václav Jirsík
E-mail: jirsik@feec.vutbr.cz

ABSTRACT

A new multipurpose laboratory of HVAC-systems applications comprising renewable source of energy utilization and a recent control system based on KNX communication bus has been opened. This paper introduces the laboratory and briefs the reader on first experience made during its usage. It focuses on the control and visualisation software which was developed by the authors of this article.

1 INTRODUCTION

A new multipurpose laboratory has been built at the Faculty of Applied Informatics, Tomas Bata University in Zlín. The aim of the project was to build a multipurpose laboratory as an experimental educational, research and development base-ground for subjects dealing with applied control systems in advanced building technology systems (Intelligent buildings) enabling study and evaluation of specific parts of the system and/or the system as a whole, concerning its functions, control and communication.

In the above stated sense, the laboratory was designed for research and education in these fields: application of field bus communication in a real complex system; control and monitoring systems; application of HVAC technology with renewable sources of energy; modeling of heat transfer processes in advanced technologies and components.

2 HVAC SYSTEM

Briefly described, the system operates as follows: Incoming fresh air is sucked via external wall inlet, passing through an air filter, heat recovery section, heat exchangers (water cooler and heater) and is then distributed into the laboratory room by the fresh-air fan.

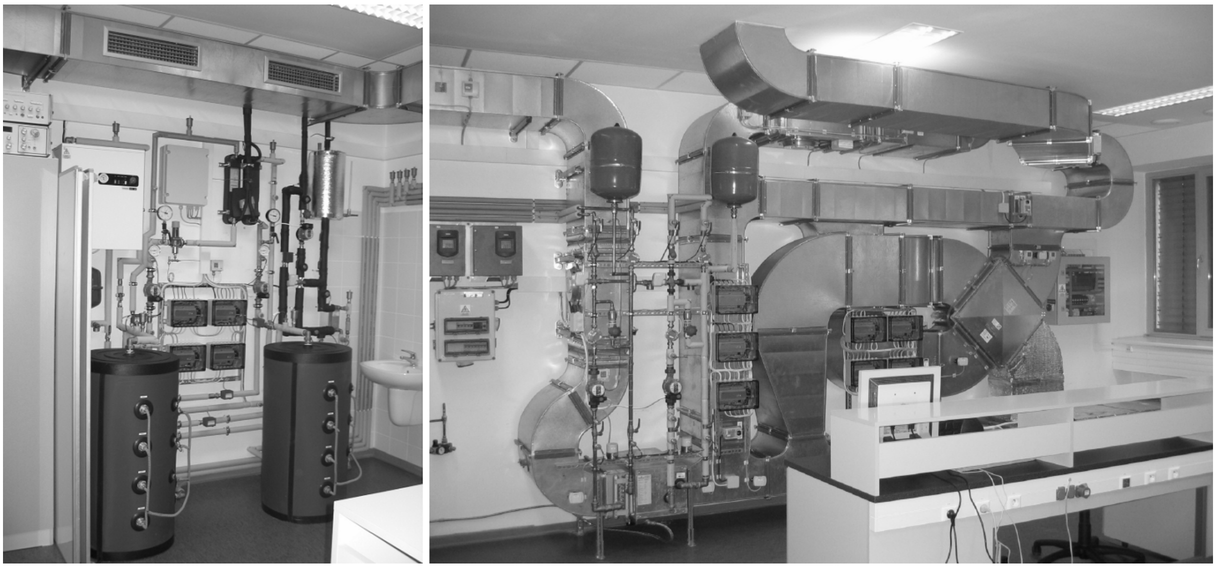

Figure 1: Partial view of the laboratory equipment

Exhausted air is sucked via outlets placed in laboratory's false ceiling, going the opposite way via the heat recovery section. The fan motors are equipped with transducers allowing for controlling the volume of ingoing and outgoing air individually.

3 ENERGY SYSTEM

The basic energy source for the laboratory equipment is a heat pump utilizing superheated coolant gas, capable of operating in either heating or cooling mode. An additional electrical heater in combination with a roof-placed solar collector is used for heating. In case of both cooling and heating being required within one day (occurs during certain period of year), two vessels for hot and cold water accumulation are supplied. Figure 2 shows the diagram of the energy system.

4 CONTROL AND MONITORING SYSTEM

The Konnex (KNX) field bus system was decided to be employed as the communication means in the control and monitoring system. It was proved during the initial phase of the system design, that a *fully distributed system* based on the KNX standard could not manage the communication in the desired way. Therefore, the control system is now based on a set of controllers and accessories forming a system with distributed inputs and outputs. It comprises a main controller running the regulation task and ten *satellite* controllers linked together with the KNX bus. The hardware topology is shown in Figure 3.

All satellite controllers together with their respective sensors and control members stand for the lowest control level. Each satellite and its associated sensors/actuators form an *intelligent node*. The system does not utilize intelligent sensors and actuators connected directly to the bus. It uses standard sensors and actuators (i.e. 0 – 10 V in most cases) wired to the satellite controllers instead. The "intelligence" is then taken over by the associated controller. One of the reasons

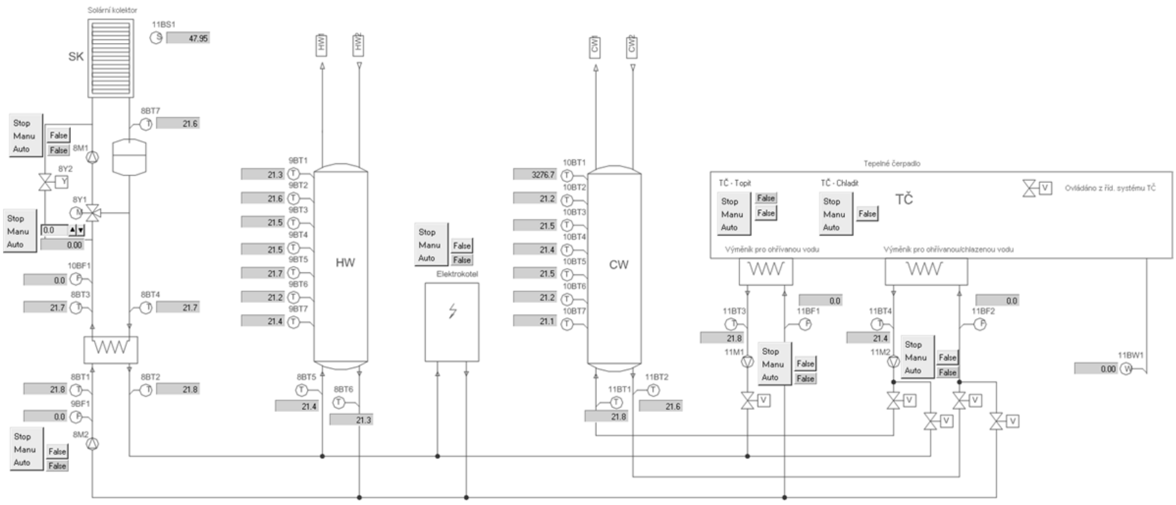

Figure 2: Diagram of the laboratory energy system

for the system to be formed of these intelligent nodes instead of being completely distributed is that the implemented solution comes significantly less financially demanding (some 200 sensors and actuators are included in the system).

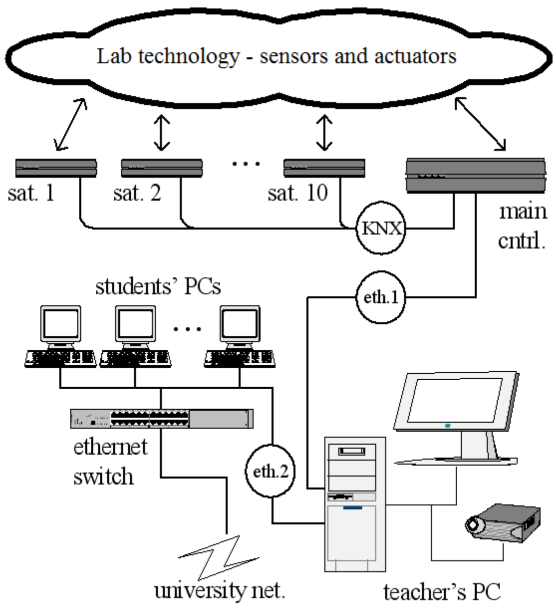

Figure 3: Hardware topology of the control system

The main controller, placed in the main distribution frame, stands at the mid-level of the system's hierarchy. Through coupled relays it controls several actuators. Main controller's primary task, nevertheless, is to process the control algorithms and to communicate with lower and higher system levels. Its firmware has a modular architecture and is configurable via the teacher's PC which can enable or disable the functionality of certain control blocks, thus certain technology blocks. Controller set-points or even individual PID component constants as well

as sensor offsets and other values can be adjusted for research- and educational purposes.
The teacher's PC (as shown in Figure 3) represents the highest control level in the system. It runs a SCADA system that allows for data monitoring, archiving and visual representation, as well as *control parameters setting* and *operational mode selection*. The software also contains communication modules that feed data to the students' workstations (see example in Figure 5) allowing them to see and set only those values necessary and suitable for tuition (see Figure 4). A web server for on-line data presentation is also installed. The teacher's workstation allows for password-protected remote connection from other PCs. There is also a secondary RS232 line (not shown in the figure above). These features allow for remote low-level servicing and diagnostics performed by the technology service engineer, as well as for remote SCADA application or main controller firmware update.

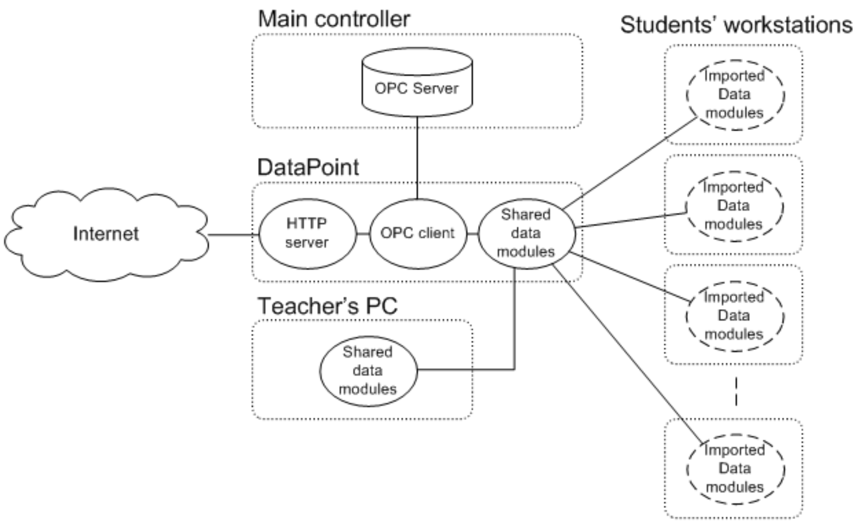

Figure 4: Data topology of the control system

The control system uses the KNX bus in its S-Mode for controller interconnection. Unlike other KNX intelligent building applications that use the KNX ETS3 configuration tool, this system uses proprietary configuration blocks provided by the controller manufacturer, accessible in the controllers' IDE instead. The utilization of KNX in this system is partially experimental and even the KNX interoperability was new to the control system components manufacturer. Therefore, some tune-up measures had to be adopted prior to deploying the control system.

5 FIRST RESULTS

As the KNX bus utilization in intelligent buildings applications is concerned, the experience during installation indicates certain problems. It was clearly shown that the application of a fully open system using KNX components would be excessively expensive and there even are not enough sensor-types available to serve more complex system. The possible way forward therefore may be the utilization of a semi-distributed system based on field controllers that enable for both signal processing and basic control as it was done in this case. The communication speed, that is limited to 9600 kilobits per second, can be accepted for smaller applications only and without any requirement for hard real-time behavior.

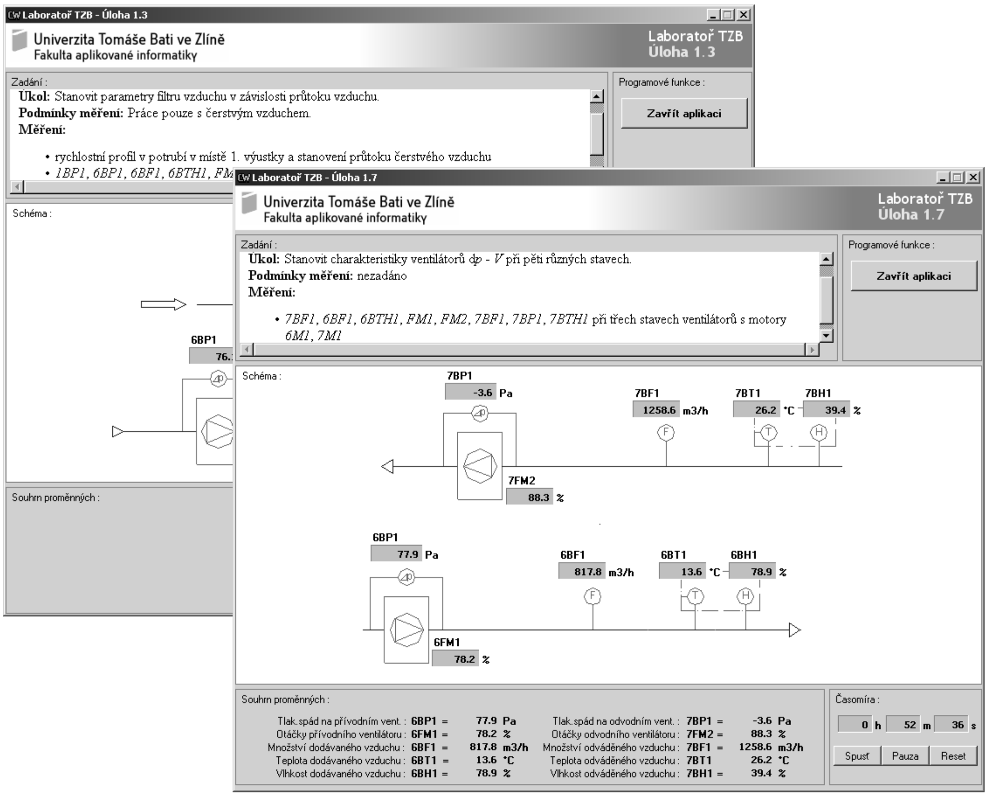

Figure 5: An example of tuition application for students' workstations

6 CONCLUSION

The laboratory is now fresh-installed, thus a complex evaluation of the technology and its control system operation would be quite preliminary. Nevertheless, the first experience indicate that the system fulfils the original requirements and is suitable to run experimental research in the intended fields.

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