KNX/EIB SYSTEM IN DIDACTIC PROCESS OF TECHNICAL UNIVERSITY – PRACTICAL ASPECTS

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Abstract **- The aim of this paper is to show the performance, design and commissioning of the KNX/EIB installations in the didactic process of technical university. The paper includes description of KNX/EIB laboratory stands which have been hitherto built at Institute of Electrical Power Engineering in Warsaw University of Technology and a short presentation of elaborated laboratory exercises. Those exercises enable students to investigate the communication and transmission technology and to knowledge the methods of designing and commissioning the KNX/EIB systems with the use of specialised software. The laboratory stands and exercises cover mainly those building automation issues, which at present are subject of significant interest: control of lighting, control of roller blinds and control of the temperature inside rooms. Special attention has been paid to modern communication techniques.**

Keywords: **KNX/EIB system, didactic process of technical university, signal transmission and modern communication techniques, teaching methodology**

1. INTRODUCTION

Requirements with respect to modern electric installations have considerably increased over the last years. Nowadays a large weight is attached to safety, convenience and flexibility of electric systems and a cost-saving use of energy. Traditional electrical building installations would not be able to fulfil all of these requirements and a necessity of developing new standards in electrical installations comes into being.

KNX/EIB system [1] represents a new approach to electrical installations. This system has several advantages comparing to a traditional electrical installation. Especially many new functions are possible to realise, for example: complex control of lighting, control of roller blinds and control of the temperature. Additionally, the system KNX/EIB can be controlled even via Internet (intranet) network.

As is known, several kinds of KNX/EIB installations can be distinguished in respect of medium used for communication [1]: EIB-TP (Twisted Pair), EIB-PL (Power Line) and EIB-RF (Radio Frequency).

In the paper there have been presented the circumstances of establishing and the history of development of KNX/EIB system in the Laboratory of Intelligent Installations at the Institute of Electrical Power Engineering in the Warsaw University of Technology.

There have been shortly described the lab stands designed to investigate EIB-TP and EIB-PL systems, which have been hitherto built. In the paper there have been also presented typical laboratory exercises, realised by students of electrical faculty within obligatory studies course.

In the paper there have been also shown some conceptions of future development of our laboratory. Those conceptions concern extension of the EIB-TP laboratory stand. Internet network will be connected to that stand. Use of different communication media, possible software and hardware solutions and mobile phones have been presented. Additional bus devices working with EIB-RF technology will be also installed there.

2. EIB-TP SYSTEM

EIB-TP installation is the classical and the most often used approach in the KNX/EIB system technology. This system has been implemented in our Laboratory of Intelligent Installations several years ago.

2.1. EIB-TP laboratory stand

In Fig. 1 laboratory Instabus EIB-TP installation has been shown.

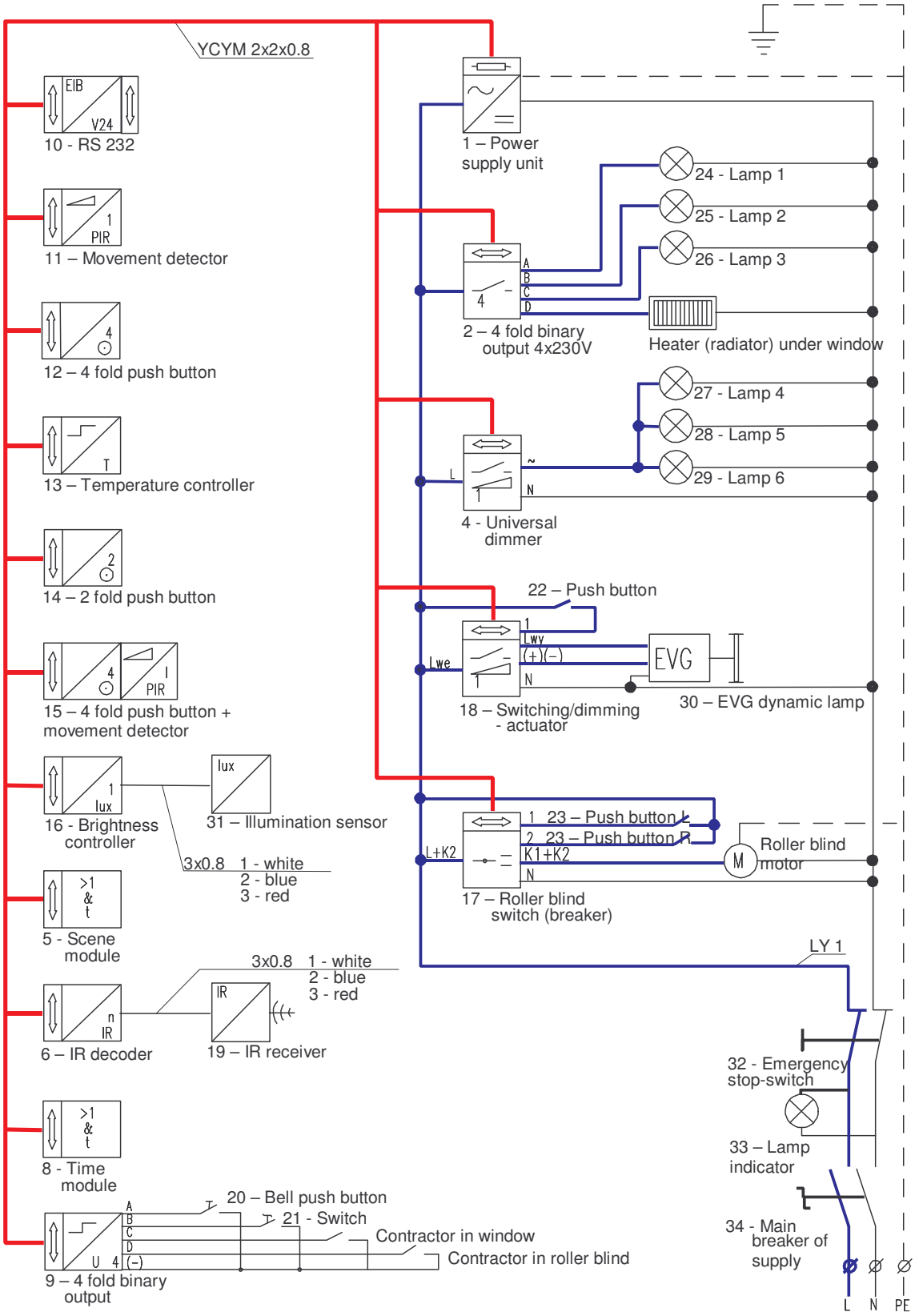

Fig. 1. Connection diagram for the laboratory Instabus EIB-TP installation [2].

This project has been realised at the Institute of Electrical Power Engineering, Warsaw University of Technology in 1998 [2]. Two very known companies - Siemens A.G. and ABB Industrial Components A. G. (Busch-Jaeger Electro GmbH) - founded all bus devices to build this installation.

Fig. 2. View of the EIB-TP lab stand.

2.2. EIB-TP students' exercises

Set of 12 laboratory exercises (tasks) has been elaborated [2]. The tasks allow students to learn basic design and commissioning techniques of the EIB-TP installations. Elaborated exercises have been presented and characterised in tab. 1.

From the perspective of several years it is possible to formulate the most interesting issues for the students and to point difficult ones.

There are the most interesting subjects:

- possibility to easy programming and changing of functionality of EIB devices by means of computer program,
- possibility to simple programming even the most complex control logic of EIB installation,
- way, how the laboratory stand has been assembled (mounted) from the electric point of view,
- principle of construction (assembly) of EIB system – technological aspects.

The most difficult issue is to choose correct program name of EIB device (selected from product data base) and to assign proper communication objects of the EIB device to respective group addresses defined.

Table 1. EIB-TP laboratory exercises [2].

Task no.	Task name	Description of task
1	simple lighting control	the simplest project – three separate lamps (24, 25, 26) are turned on or off by means of 4 fold push button
2	switching/dimming incandescent lamps	group of lamps (27, 28, 29) is switched/dimmed
3	switching/dimming discharged lamp	EVG dynamic lamp (30) is switched/dimmed
4	turning off lighting using central function	all lamps in the installation are turned off in central manner
5	roller blind control	roller blind is automatically controlled (up and down moved). The control is step-by-step or continuously until limit position of roller is reached
6	heating control	heater (radiator) under window is turned on or off in function of ambient temperature. During the window is opened the heater is turned off. It is possible to set up in controller two specific options: “standby” and “comfort”
7	controlling by means of movement detector	movement detector is used to turn on lamp (24) and automatic switch-over temperature controller from option “standby” to option “comfort”. When nobody is in detector movement zone, automatic change of the temperature controller state is executed from “comfort” to “standby” and lamp is turned off
8	satisfying requirements of constant illuminance	when outdoor illumination changes, constant fixed illuminance by means of EVG dynamic lamp (30) is satisfied in the room
9	time control	lamp (25) is turned off with delay
10	setting up scenes	typical light scenes are set up in a room: to watch TV, to read, to receive visitors and others
11	infrared control	devices are controlled by means of IR hand-held transmitter (pilot). IR hand-held transmitter has set up different channels with commands to execute
12	unloading applications from bus devices	unloading physical addresses and application programs from bus devices

3. EIB-PL SYSTEM

EIB-PL (Powernet EIB) installation is one of the KNX/EIB systems. This system does not require conducting additional bus controlling cables. The entire communication is run via the 230/400V electric power supplying network. This type of transmission is conformant with current European standards, in particular [3].

Powernet EIB devices connected to different phases can communicate with each other. For this purpose a capacitive phase coupler is required. Additionally, the installation must be equipped with band stop filters installed on all three phases in front of the circuits for signal transmission. Detailed description of the Powernet EIB system can be found in [1, 4, 5].

3.1. EIB-PL laboratory stand

In the Laboratory of Intelligent Installations at the Institute of Electric Power Engineering, Warsaw University of Technology, a laboratory stand for investigation of the Powernet EIB installation (see Fig. 3) has been established in 2001. Installed devices enable realisation of the following functions [4, 5]:

- control (switching, dimming) of lighting installations,
- realisation of lighting scenes,
- control of roller blinds (shutters),
- control of temperature (heating, cooling),
- central switching function.

Installations and devices present in the students laboratories are destined for teaching. Therefore they usually require mounting in a different manner than in practice. It is firstly caused by safety and flexibility considerations and secondly it should be easy for students to carry out commissioning, measurements and observations. Thus additional elements have been added, for instance a digital oscilloscope, safety cut-out switch, auxiliary terminals or outlet plugs.

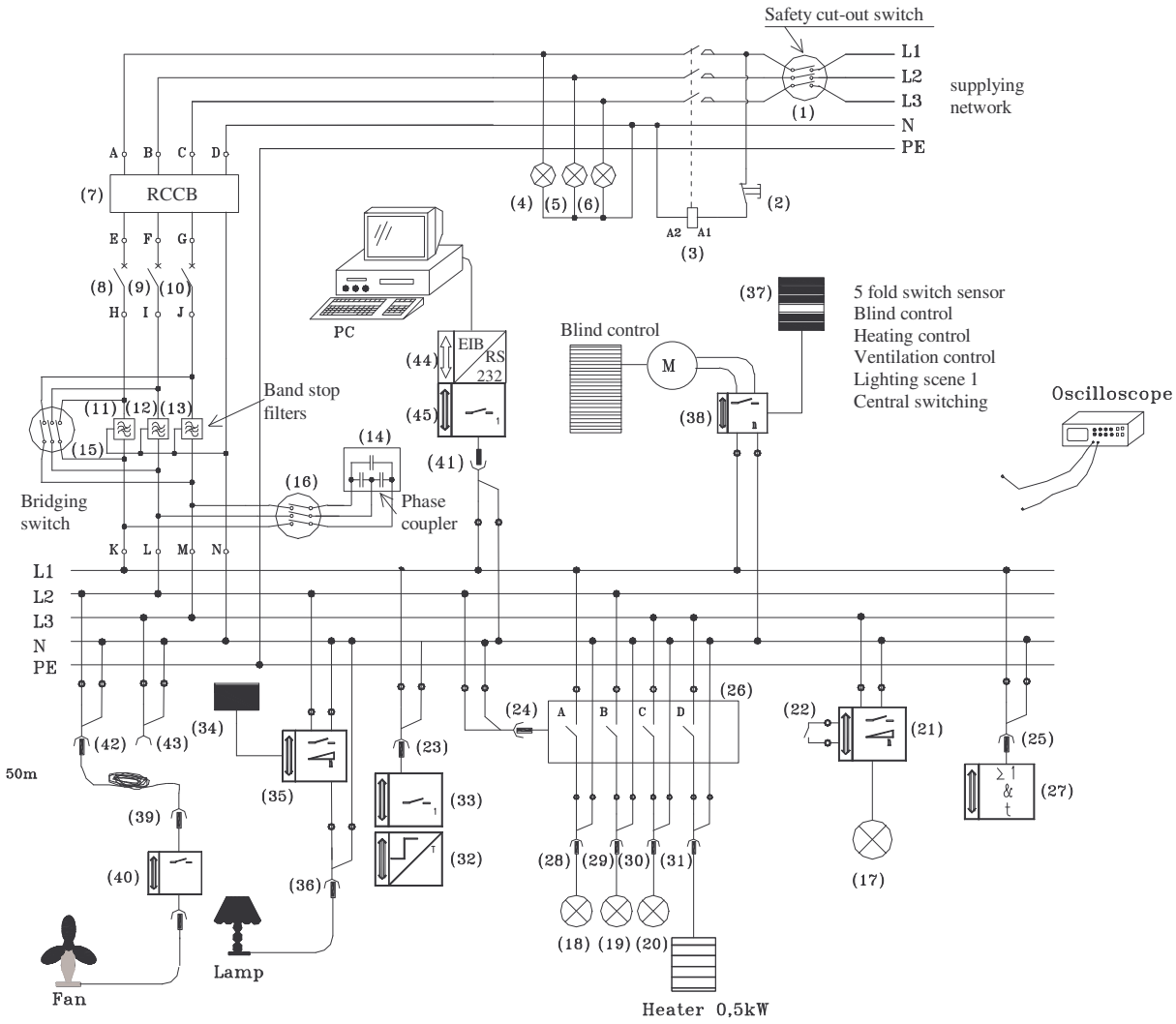

Fig. 3. Connection diagram of the EIB-PL laboratory stand [4, 5].

One of the aims, which had been established for ourselves was to prepare exercises that a student would perform eagerly. This lab stand, besides being a typical educational tool is supposed to stir students imagination and to show real possibilities of applying the system in one's closest vicinity. Therefore it is equipped with commonly used authentic loads like convection-type heater, desk fan, small lamp with a lampshade, lamp bracket and other type of light fitting. Additionally a digital oscilloscope enables to carry out observations and measurements of the telegram signals.

Fig. 4. View of the EIB-PL laboratory stand.

3.2. EIB-PL students' exercises

Two different types of students' exercises have been planned and prepared [4, 5]: analysis of transmission technology and design and commissioning of the EIB-PL system.

Analysis of transmission technology

One type of prepared exercises has the purpose of acquaint students with transmission technology applied in the EIB-PL system. These exercises contain a set of questions that are prepared in the manner, which firstly forces students to choose a proper measuring technique and secondly to draw conclusions from carried out examinations. The most important questions and connected with them conclusions are presented below:

- what is the voltage amplitude of the transmitted telegram with system elements correctly connected?
- what influence on the transmission reliability would have installation of the system without band stop filters?
- what influence on the telegram voltage has the capacitive phase coupler?
- what is the attenuation characteristics of the band stop filters?

For example to measure the voltage amplitude of the transmitted telegram, a probe of the oscilloscope should be connected to respective terminals located at the lab stand during sending a telegram.

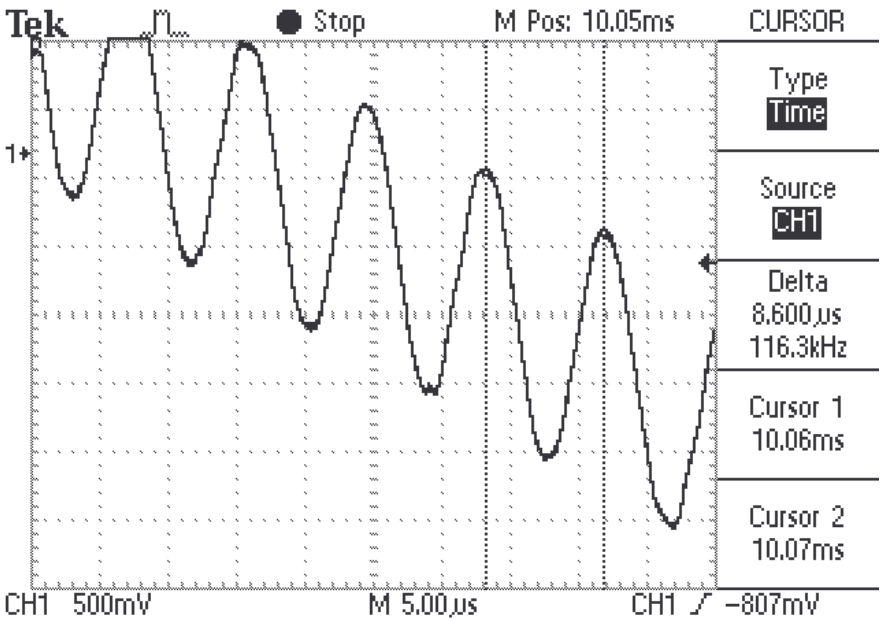

Fig. 5. Logical “1” superimposed with the supplying voltage [4, 5].

In Fig. 5 a telegram voltage superimposed with the supplying voltage can be seen. The amplitude of the telegram signal is U_m = 1,6 V.

Design and commissioning of the EIB-PL system

This group of exercises explains the method of designing and commissioning of the EIB-PL system with the use of ETS2 software. Several different configurations of the installed devices are scheduled. Designing and commissioning of EIB-PL installation by means of ETS2 program is very similar to designing and commissioning of EIB-TP system. Therefore only distinctive features between programming of EIB-TP and EIB-PL systems will be more precisely pointed out. Special attention is paid to generating System ID of the EIB-PL installation and to scanning assigned ID number.

4. REMOTE CONTROL AND VISUALISATION OF LABORATORY EIB-TP SYSTEM VIA INTERNET

In current year a new specialised software for visualisation and remote control of the laboratory EIB-TP installation via Internet network has been developed [6]. This software utilises ABB i-bus EIB IP gateway IG/S 1.1 [7].

The gateway IG/S can act as an interface between Internet network and any KNX/EIB installation. It can also be used as a line or area coupler and can utilise LAN network for fast exchange of telegrams between lines/areas. The gateway IG/S connected with iETS program or OPC Server can serve for programming EIB devices via LAN network.

The way, how to connect a gateway IG/S to EIB-TP bus and to LAN network has been presented in Fig. 6.

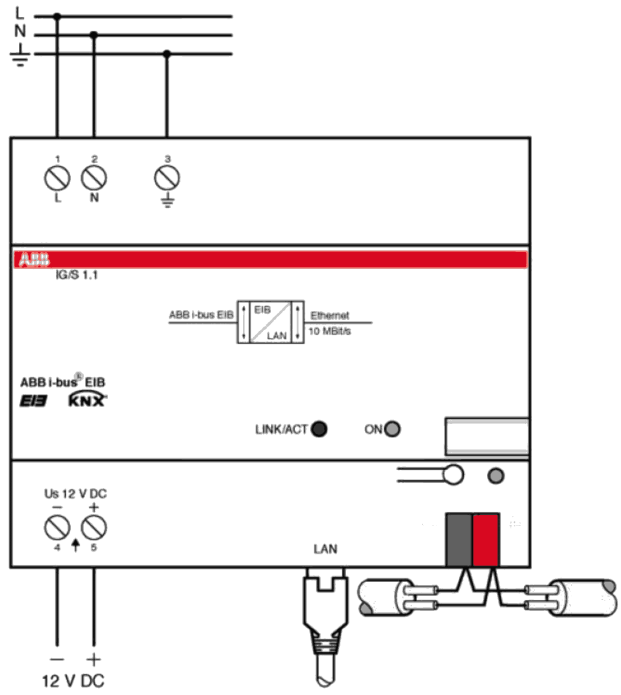

Fig. 6. Connecting manner of gateway IG/S to power supply network, to EIB-TP installation bus and to LAN network [7].

Data conversion was the essential problem during creation of visualisation and remote control application.

Visualisation

The laboratory EIB-TP installation is in this case source of data. Main role play sensors which control the EIB-TP installation. As is known, communication between sensors and actuators is realised via EIB telegrams. Role of the gateway IG/S is to catch all these telegrams and to convert them into so called UDP telegrams (telegrams interpreted in UDP - User Datagram Protocol). Then the UDP telegrams are transmitted to Ethernet network. Special tool program CommView for catching the EIB telegrams (see Fig. 7) has been utilised. This program shown exactly what type of telegram the IG/S generates and what data are via it transmitted.

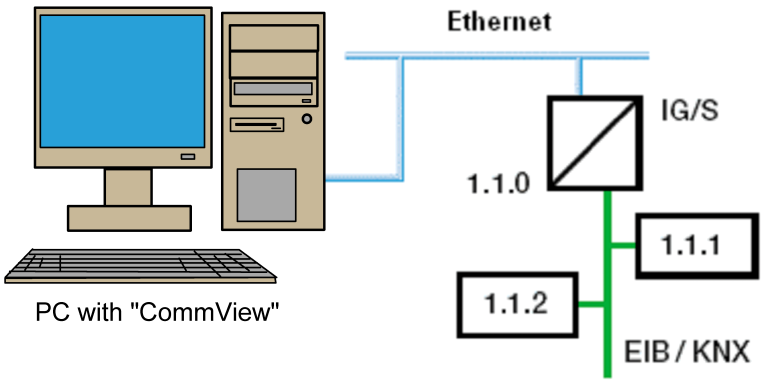

Fig. 7. Use of CommView program during communication [6].

Then special software tool to catch the UDP telegrams and to get out necessary data of them has been developed. Respective application in Java has been written for that purpose. Separate array for holding (storing) data and addresses was also necessary. Server application executes whole visualisation operation. It non stop listens to the Ethernet network. If any telegram from EIB bus runs, i.e. from EIB device with given group address, Server saves its data in the array and simultaneous changes state of device in visualisation panel created, which is image of the physical device in the laboratory EIB-TP system installed.

Remote control

For remote control special application has been also developed. This application serves to control state of the EIB devices model on the visualisation panel and, if any change of state occurred, to generate a telegram to respective physical device in the lab EIB-TP system. For that purpose Client application has been created. Because telegrams caught by Server

application had inside many needless information, therefore respective software Filter has been constructed. Task of the Filter is to catch only useful data. These data are sent to the Ethernet network and then change states of actuators. The gateway IG/S catches control commands, converts them into the EIB telegrams and introduces (pushes) them into EIB bus (see Fig. 8)

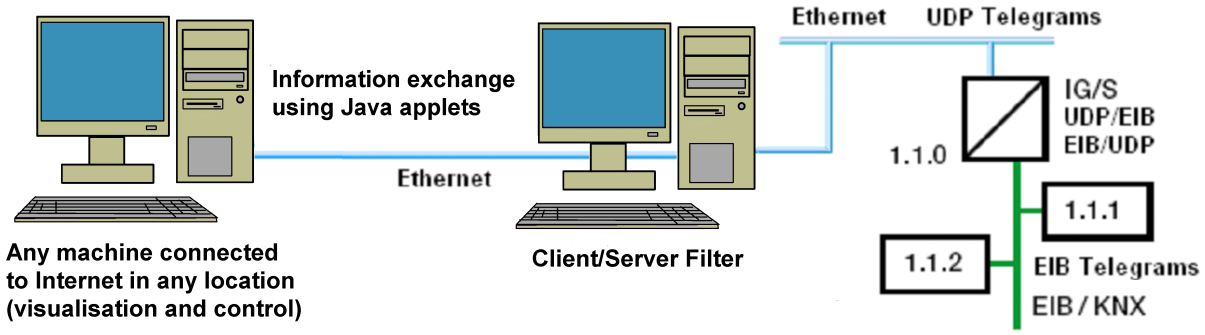

Fig. 8. Flow chart of application for visualisation and remote control via Internet [6].

Inside Client/Server – Filter machine server of web page with the visualisation application together with data base has been also installed.

Two Java packets: java.io.* and java.net.* and included inside them classes have been utilised during creating of the visualisation application.

Web page for remote control and visualisation of lab EIB-TP installation

Developed software application enables visualisation and remote control of the laboratory EIB-TP installation via Internet network.

The application consists of two parts [6]: administrator part and user part. The administrator part manages users' accounts, which have a right to use software application, taking into consideration their access rights. In turn the user part of application allows to remote control and visualisation of EIB devices installed in the lab EIB-TP system.

In Fig. 9. web page with visualisation application of the lab EIB-TP installation has been presented.

Function software push buttons are located at top of the control panel. These push buttons allow to control EIB devices. Push buttons "All ON" and "All OFF" serve to central on or off all devices within the EIB-TP installation respectively. Besides them other push buttons are located there.

They allow to realise the following control functions:

- "On-Off" - to turn on / to turn off any lamp and to raise / to let a roller down (continuously),
- " Dimming" – to dim any lamp in the living room or lamp in the kitchen,
- "Brightening" – to brighten any lamp in the living room or lamp in the kitchen,
- "Up" – to raise a roller step by step,
- "Down" – to let a roller down step by step.

In order to control (change of state) any EIB device installed in the lab EIB-TP system, it is necessary to click on selective function push button and then to click on respective EIB device graphical symbol.

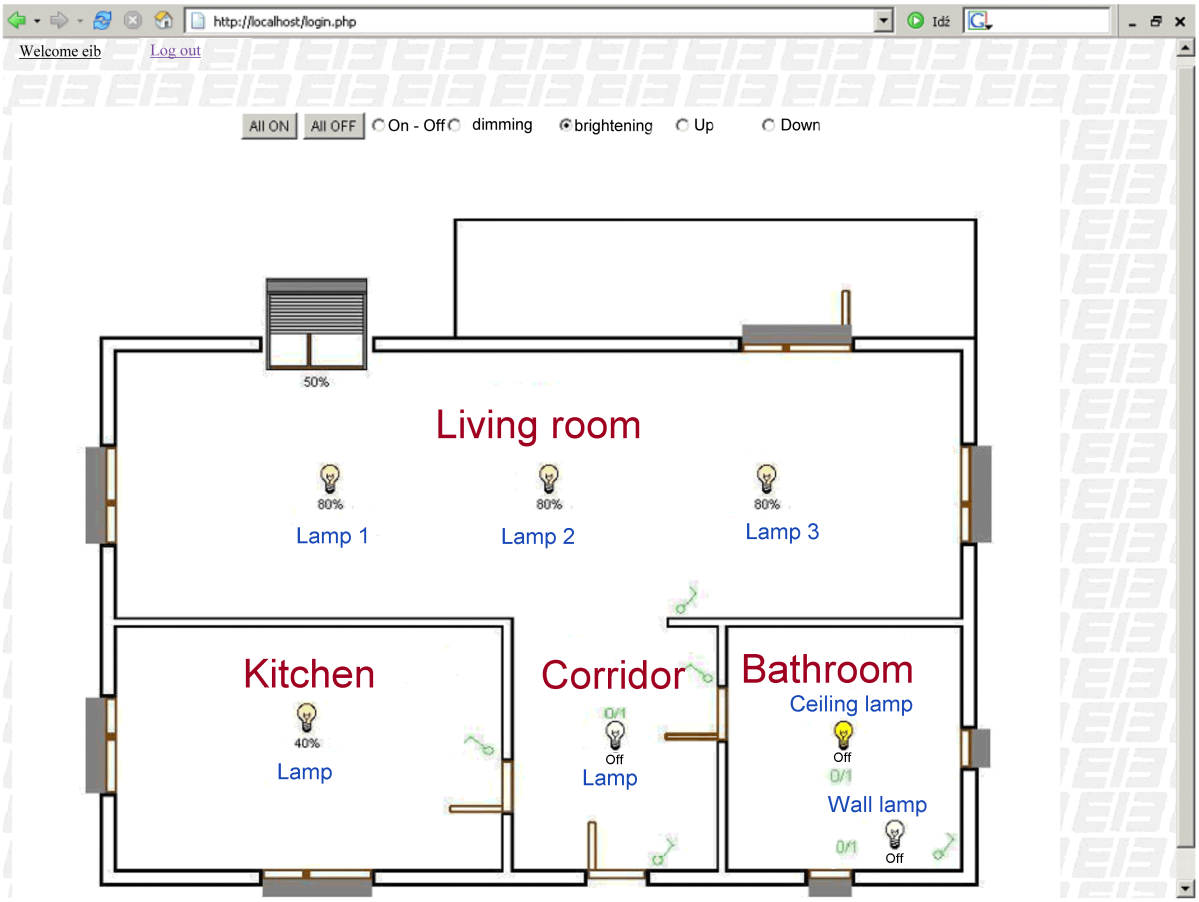

Fig. 9. Web page for remote control and visualisation of the lab EIB-TP installation [6].

During laboratory exercises students can test designed web page for remote control and visualisation of the EIB-TP installation. They may execute respective control operations by means of push buttons located on the visualisation panel and observe behaviour of devices

installed in the lab stand. On the other hand students may push buttons located in the lab EIB-TP stand (change state of sensors) and observe behaviour (states) of graphical models of devices installed on the visualisation panel.

It is possible to carry out first five laboratory exercises, which are described at point 2.2 in detail.

Students may also utilise the visualisation application designed into their own visualisation projects. In that case the same group addresses and IP address of gateway IG/S, as in the visualisation application developed, must be used. All necessary information about it can be found with the use of ETS program in respective EIB-TP project.

During laboratory exercises action of developed the visualisation application can be also compared with action of the specialised visualisation panel designed by BusBaer enterprise and with action of the specialised OPC Server – NETxEIB MP Open OPC Studio and with OPC Client – NETxEIB OPC Client2 Demo.

5. DEVELOPMENT OF EIB-TP LABORATORY STAND

At present time two conceptions of development of the EIB-TP lab stand are realised. First idea is connected with integration EIB-RF technology with existing EIB-TP system. In the second conception remote control and visualisation of the lab EIB-TP installation is executed by means of mobile phone.

Integration EIB-RF technology

Communication via radio is a very promising and more and more often used in different signal transmission systems. It is also possible to integrate EIB-RF technology with the EIB-TP lab stand. In that purpose three devices, belonging to GIRA radio bus system [8], will be utilised (see Fig. 10).

Main aim of the converter is to integrate radio bus sensors into EIB-TP system. The converter transforms radio data telegrams into corresponding EIB-TP telegrams. The wall-mounted transmitter and the hand-held transmitter serve to wireless remote control of receivers of the radio control system. After a press on a key (push button) transmitter sends a radio data telegram. This telegram can be received, interpreted and proceeded by all receivers in the radio bus system.

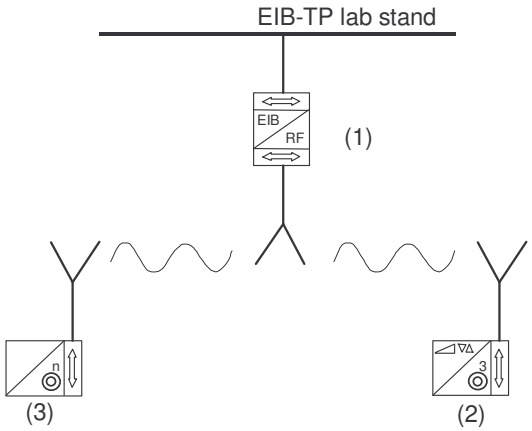

Fig. 10. EIB-RF devices integrated with existing EIB-TP lab installation (1 – radio control converter, 2 – wall-mounted radio control transmitter, 3 – hand-held radio control transmitter)

It is assumed that, similarly as during remote control via Internet network, radio control transmitters will be utilised for carrying out first five laboratory exercises, which are described at point 2.2 in detail. Special attention will be paid to distinctive features between designing, commissioning and programming of EIB-TP and EIB-RF systems.

We hope that communication via radio in EIB systems will be interesting and useful issue for our students.

Use of mobile phone for remote control and visualisation of lab EIB-TP installation

Very interesting approach is to use mobile phone for remote control and visualisation of the lab EIB-TP installation.

In this conception (see Fig. 11) communication between Client application and the lab EIB-TP system is realised via RS232/EIB interface. None gateway EIB/IP is necessary for the communication. For that purpose specialised software application will be utilised.

It is assumed that mobile phone application will be written in Java2 Micro Edition technology (it will be a midlet). The mobile phone should be equipped with KVM – Java virtual machine. Additionally the phone should be properly set up and has access to GSM communication network.

Information about user (client), the lab EIB-TP installation and its URL address will be stored in data base.

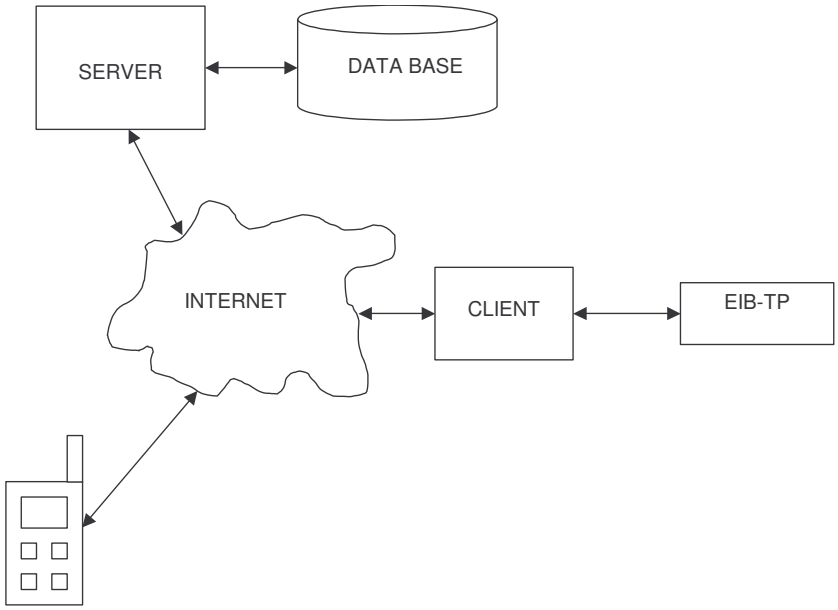

Fig. 11. Connection diagram for visualisation and remote control of EIB installation by means of mobile phone

6. CONCLUSIONS

Building automation systems and applied in these systems different communication media (twisted pair, power line, radio waves, infra red, Internet network) will in parallel develop and find many supporters each year to come. Therefore we are probably doomed to such systems and lots of engineers will be needed for development, design and maintenance of this kind of electrical installations. For that reason it is of great importance for today's students and future engineers to acquire solid knowledge of this relatively young and still not very well known and popularised area of electrical engineering.

The lab stands developed at the Institute of Electrical Power Engineering in the Warsaw University of Technology to investigate EIB-TP and EIB-PL systems and designed specialised software visualisation application, have been described. Typical laboratory exercises, realised by students of electrical faculty have been also presented in the paper. The most interesting and difficult issues for the students have been pointed.

In the paper there have been also shown some conceptions of development of our Laboratory. Presented conceptions concern extension of the EIB-TP lab stand and take in integration EIB-RF technology with existing EIB-TP system and remote control and visualisation of the lab EIB-TP installation by means of mobile phone.

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