A Survey of KNX Implementation in Building Automation

Fatima Sapundzhi

South-West University "Neofit Rilski", 2700 Blagoevgrad, Bulgaria

Abstract **– The smart technologies are becoming more important in many applicative scenarios such as healthcare, environmental monitoring and building automation. The main goal of this work is to investigate a KNX-based home automation system. Such technical systems can be remotely monitored and controlled. By the use of KNX, technical data can be collected and made available at desired location.**

Keywords **– Computer modelling, KNX, Smart Home, Network, Energy Efficiency.**

1. Introduction

Over the last few years, the trend in office automation is to use remote reading systems. A widely used protocol is the Konnex (KNX) protocol for wireless data transmission [1], [2], [3]. It is a communication protocol developed to be used in home and building automation, that is standardized EN 50090, ISO/IEC 14543, OSI-based network communications protocol and it is administered by the KNX Association. LAN networks, as well as a range of wireless connectivity technologies such as Wi-Fi, Bluetooth, ZigBee, KNX and others, are used as a base. The complete KNX description is presented in the KNX handbook which contains several thousands of pages of documentation [3].

KNX applications play a basic role in converting theoretical knowledge about Smart Grid into practical awareness.

DOI: 10.18421/TEM91-20
https://doi.org/10.18421/TEM91-20

Corresponding author: Fatima Sapundzhi,
South-West University "Neofit Rilski", 2700 Blagoevgrad, Bulgaria
Email: sapundzhi@swu.bg

Received: 19 September 2019.
Revised: 24 January 2020.
Accepted: 30 January 2020.
Published: 28 February 2020.

Users of this technology can access typical functions of building automation - lighting systems, heating and blinds, audio and video controls via wall-mounted controls and mobile devices. The wireless integration offers maximum flexibility and functionality.

The purpose of this article is to present a KNX implementation and design of atelier automation through Cisco Packet Tracer.

2. Computer Simulations and System Implementation

The two types of bus coupling unit are completely compatible. If we want to take advantage of the new topology and need to have a mix of TP1-64 and TP1-256 devices, then we can use the following formula:

$$(4 \times M \times TP1 - 64) + (N \times TP1 - 256) < 257$$

in which M and N are the number of each device type. This allows for a maximum of 64 x TP1-64 or 256 x TP1-256 devices.

The software used to perform the computer simulations for current investigation is:

Cisco Packet Tracer was used for network design by connecting different devices in order to allow various troubleshooting tests, connectivity and communication testing [4], [5].

DIALux evo is a free software for professional lighting design, and it was used for computer modeling of the interior, the lighting and 3D visualization of the building [6], [7]. The 3D design of the investigated atelier is presented in Figure 1.

KNX technology provides all necessary functions required for home and building automation. It provides an OSI-based communication environment for nodes connected to the KNX network. KNX allows different physical transmission mediums such as twisted pair (KNX.TP), power line (KNX.PL), radio frequency (KNX.RF), and Ethernet (KNX net/IP), as described in [8]. The most commonly used medium for KNX implementation is KNX.TP by which a serial differential connection is made to each node. The Berg Insight finds the number of smart homes in Europe and North America for period 2013-2019. The results of the study are presented in Figure 1 [9].

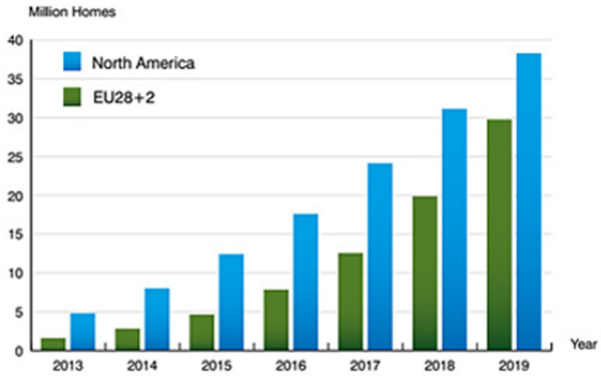

Figure 1. Numbers of Smart Homes for 2013-2019

The atelier automation system, located in the municipality of Blagoevgrad, Bulgaria is designed in AutoCAD. The designed system consists of three main components: *software application* through which the user can control the system via PC, smartphone or tablet; *transmitter device* that connects the software to other devices; *peripherals* used to execute specified commands.

3D visualization and lightning design of the atelier realized on DIAlux Evo program is presented in Figure 2.

Figure 2. 3D Lightning Design of the building realized on DIAlux Evo: A) with lighting off; B) with lightening on.

The automation of the atelier, located in the municipality of Blagoevgrad, Bulgaria is designed in AutoCad. The implementation of KNX technology with DALI protocol and their connection diagrams are presented in Figure 4.

The building automation is realized using different modules: Input/ Output Expansion Module, Room Module, Convector Control Module, Temperature Module, Electronic Shutter, Presence Sensor and Illumination [10], [11].

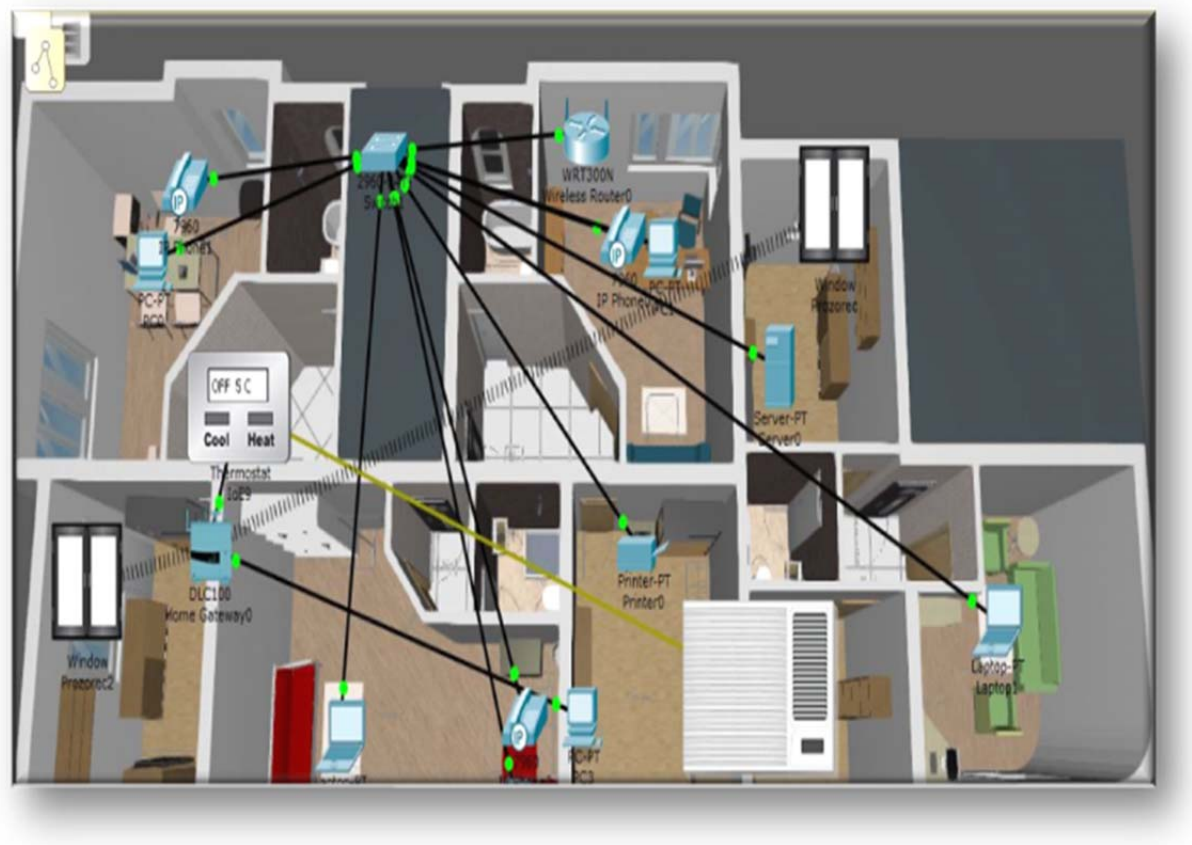

Figure 3. 3D visualization of the building automation implemented on the Cisco Packet Tracer program.

A LAN network with IP phones is built on the automation of the atelier implemented on Cisco Packet Tracer program. A Wi-Fi network for clients who do not have access to the employee server is built.

When the room temperature rises to 26˚C, the system installed in the rooms via the KNX technology opens the windows automatically. When the room temperature drops below 21˚C, the system closes the windows automatically. The results are presented in Table 1.

The following equipment was used in the automation of the building using Cisco Packet Tracer program: Home Gateway, PC, Laptop, IP phone, Printer, Window, Thermostat, Switch, Wireless Router, Server PT, Furnace.

Table 1. The results of home automation.

Name	Activated	Status	Action
Window 1	Yes	Window 1 closed	Open/Closed
Window 2	Yes	Window 2 closed	Temperature rise
Thermostat	Yes	Thermostat temperature below 21 ˚C	Close the window
Thermostat	Yes	Thermostat temperature below 26˚C	Open the window

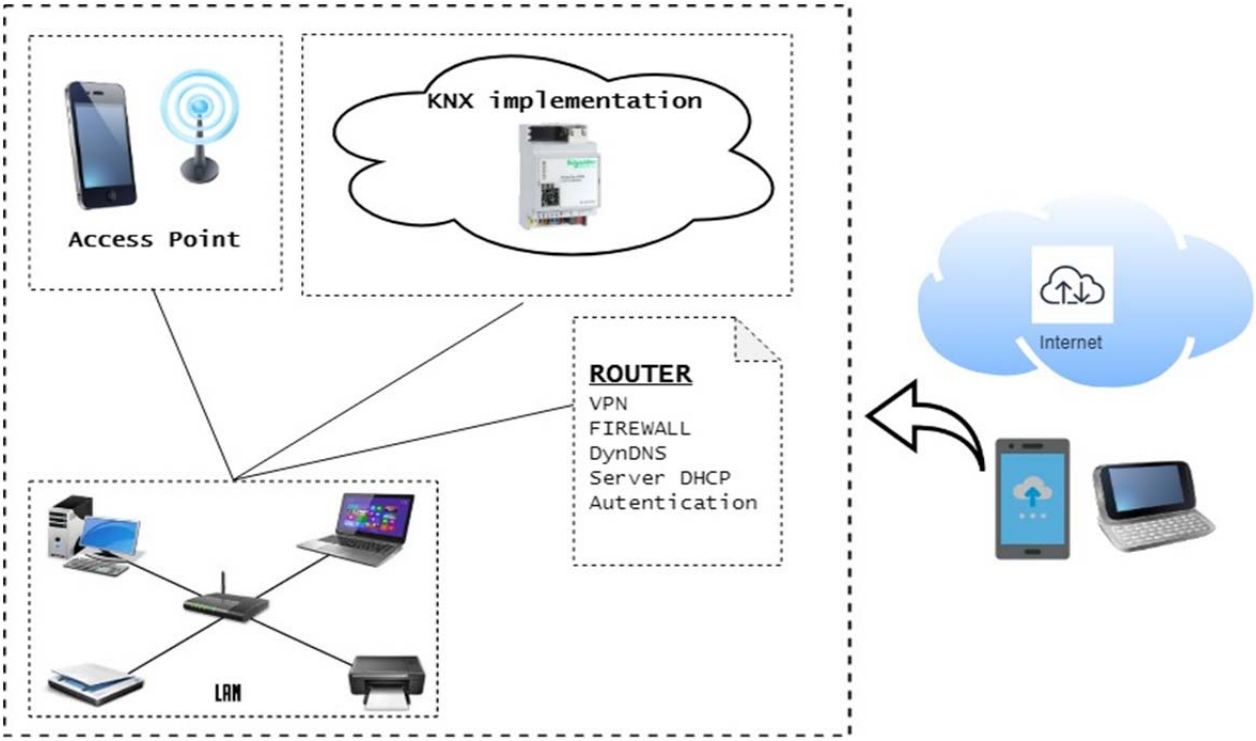

Figure 4. Architecture of the investigated KNX system.

In Figure 4, the architecture of the investigated KNX system is shown. It is equipped with a device - KNX/IP router, which links the KNX environment to the IP network in order to exchange KNX messages with remote devices. The router communicates through the KNXnet/IP protocol. It includes, in addition the tunneling function for the point-to-point connection, the line coupler function. The routing allows the IP router to distribute and receive messages to other lines and areas [11], [12], [13].

The local Wi-Fi router features guarantee an adequate security level for the bounding automation system management. The local access is guaranteed by the Wi-Fi access point; the end-user can remotely control the atelier automation system via phone by using a VPN (Virtual Private Network) tunnel between mobile device and local router.

The test environment used in the KNX system reflects some simple scenarios of building automation: morning scenario - all lights are off and the rolling shutter is pulled up and night - all lights are on and the rolling shutter is lowered.

3. Conclusion

Home automation technologies are for sure an upcoming challenge. In this paper, an efficient ntegration and implementation of KNX. TP in atelier automation is presented. In the next project we will research the interaction between a KNX-based home automation system and an Android mobile device.

Acknowledgements

This paper is partially supported by the National Scientific Program "Information and Communication Technologies for a Single Digital Market in Science, Education and Security (ICTinSES)", financed by the Ministry of Education and Science.

We also gratefully acknowledge the support by the company Chikalov EOOD with manager Aleksandar Georgiev Chikalov.

References

[1]. Younis, M. et al. (2018). Design and Implementation of a contactless smart house network system. *International Journal of Electrical and Computer Engineering, 8*(6), 4663-4672.

[2]. Chhaya L., et al. (2018). IoT-based implementation of field area network using smart grid communication infrastructure, *Smart Cities, 1*(1), 176-189.

[3]. KNX Association. (2019). *KNX Handbook for home and building control*. eBook

[4]. Bakni, M., et al. (2018). An Approach to Evaluate Network Simulators: An Experience with Packet Tracer. *Revista Venezolana de Computación, 5*(1), 29-36.

[5]. Lammle, T. (2003). CCNA: Cisco certified network associate study guide, 5th Edition, SYBEX Press.

[6]. Acosta, I. (2011). Towards an analysis of daylighting simulation software, *Energies. 4*, 1010-1024.

[7]. DIAL GmbH. 2015. DIALux evo – new calculation method. Retrieved from: http://www.dial.de/DIAL/fileadmin/download/dialux/wissen/DIALux_evo-_New_calculation_method.pdf [accessed: 12 June 2019].

[8]. Kollatou, T., Tsiamitros, D., Stimoniaris, D., Kikis, V., Zehir, M. A., Batman, A., ... & Dialynas, E. (2014, October). Advanced Demand-Side Management in Microgrids using KNX Technologies. In *2014 KNX Scientific Conference* (Vol. 1, pp. 30-3).

[9]. Wu, Y. H., Han, N., & Yan, D. (2012). The Research and Implementation of KNX Communication Kernel Based on ATMega32. In *Advanced Materials Research* (Vol. 433, pp. 3269-3275). Trans Tech Publications Ltd.

[10]. Merz, H., Hnasemann, T., Huber, C. (2009). *Building Automation: Communication systems with EIB/KNX, LON, and BACnet*. 1st ed. Berlin, Germany: Springer-Verlag Press.

[11]. Sapundzhi, F. I., & Popstoilov, M. S. (2018). Optimization algorithms for finding the shortest paths. *Bulgarian Chemical Communications*, *50*(Special Issue B), 115-120.

[12]. Sapundzhi, F., & Popstoilov, M. (2019, October). C# implementation of the maximum flow problem. In *2019 27th National Conference with International Participation (TELECOM)* (pp. 62-65). IEEE.

[13]. Judmayer, A., Krammer, L., & Kastner, W. (2014, May). On the security of security extensions for IP-based KNX networks. In *2014 10th IEEE Workshop on Factory Communication Systems (WFCS 2014)* (pp. 1-10). IEEE.