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Home automation based on Z-wave technology

F. I. Sapundzhi

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

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With the rapid expansion of the Internet of Things, more devices and objects are network connected. Many people want to have full control over their home communications and this leads to the growth of the smart home automation industry. Z-wave is one of the most popular technologies used to perform smart home and office automation services. It uses a controller to manage and control all devices. The main purpose of the study is to design and investigate a Z-wave home automation system. The smart home built with Z-wave technology is useful for consumers because it will save energy - no lights or AC will be left on when they are not at home.

Keywords: CAD design, Z-wave, Network, Energy efficiency, Dialux, Smart home

INTRODUCTION

In recent times, the Intelligent Home Automation System trend is to control from a distance using a remote control. With the rapid expansion of the Internet of Things (IoT), the most innovative home systems are controlled by smartphones and microcontrollers. Smartphone applications are used to control and monitor home functions using wireless communication techniques [1, 2].

Many people want to have full control over their home communications and this leads to the growth of the home automation industry. Z-wave is one of the most popular technologies used to perform smart home and office automation services. Z-wave is a wireless protocol that essentially focuses on connectivity within the smart home [3, 4].

As the IoT popularity explodes, more connected devices are being added to people's houses. Many sensors, lightbulbs, heating controls, locks, plugs, and the like-pack in Z-wave talk to each other. This technology uses a controller to manage and control all devices. It operates using low-energy radio waves to communicate from device to device [5-7].

Z-wave protocol is a standard based on the ITU G.9959 specification that operates in the industrial, scientific, and medical radio frequency band. It is developed for low bandwidth data communication applications such as security sensors, home automation, alarms, etc. [7-12].

Z-wave transmits on 868.42 MHz (Europe) and 908.42 MHz (United States) frequencies working with FSK and Gaussian Phase Shift Keying (GPSK) modulations [11-16].

The purpose of this article is to present a Z-wave implementation and design of home automation through Cisco Packet Tracer. Through this technology, we can save money on energy bills when motion detectors are used and the lights are automatically turned off when no motion is detected.

COMPUTER SIMULATIONS AND SYSTEM IMPLEMENTATION

The Z-wave system has three layers - radio, network and an application layer. They work together to create a robust and reliable network that enables numerous nodes and devices to communicate with each other simultaneously. The stack covers Z-wave PHY, MAC, transport, network and application layers (Fig. 1) [11].

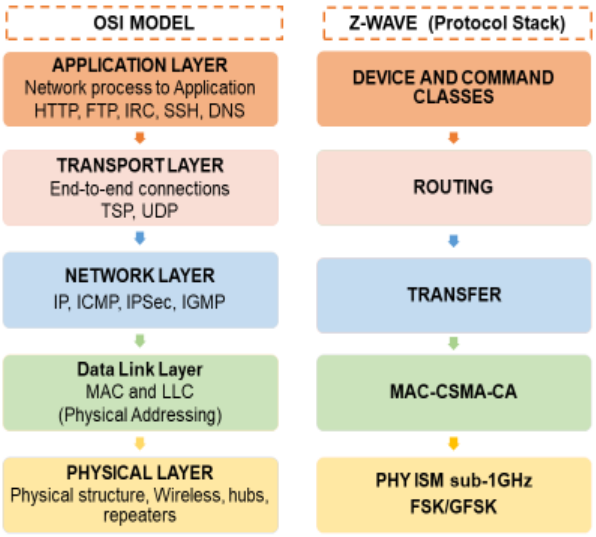

Fig. 1. Diagram of Z-wave protocol stack.

In this technology controlling devices are called controllers (they control other Z-wave devices - remote controls, USB sticks, and IP gateways), and reporting devices are called sensors (they report information by sending a digital or analog signal –

* To whom all correspondence should be sent.
E-mail: sapundzhi@swu.bg

analog and digital sensors) and controlled devices are called actuators (switch digital or analog signals-electrical switches, electrical dimmers, motor control, electrical display, thermostats controls) [13-16].

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

– *AutoCAD* - CAD (computer-aided design) software that architects, engineers, and construction professionals rely on to create precise 2D and 3D drawings. It was used for designing and drawing the electrical installation of the building [18].

– *DIALux evo* - a software for professional lighting design and it was used for computer modeling of the interior, the lighting and 3D visualization of the home [19].

– *Cisco Packet Tracer* was used for network design by connecting different devices to allow for various troubleshooting tests, connectivity and communication testing [20].

The electrical installation interior in the house is designed in AutoCAD which includes electrical wirings details with earthling wire details. Basement, first floor, second floor, attic level, and house plan details are also included in the drawing. It also shows the dimension and circuit flow diagram (Fig. 2) [21]. 2D design of the home automation of the LAN and TV cable in AutoCAD is presented in Fig. 3.

The home automation system consists of three main components: 1) software application through which the user can control the system by computer, smartphone or tablet; 2) transmitter device that connects the software to other devices and 3) peripherals used to execute specified commands. The sensors used in the automation of the building are the most intelligent way to catch all the action happening in the home in real-time. The devices monitor movements, track ambient lighting, keep a tab on indoor temperature and humidity, listen for seismic activity, and protect the home from UV lighting.

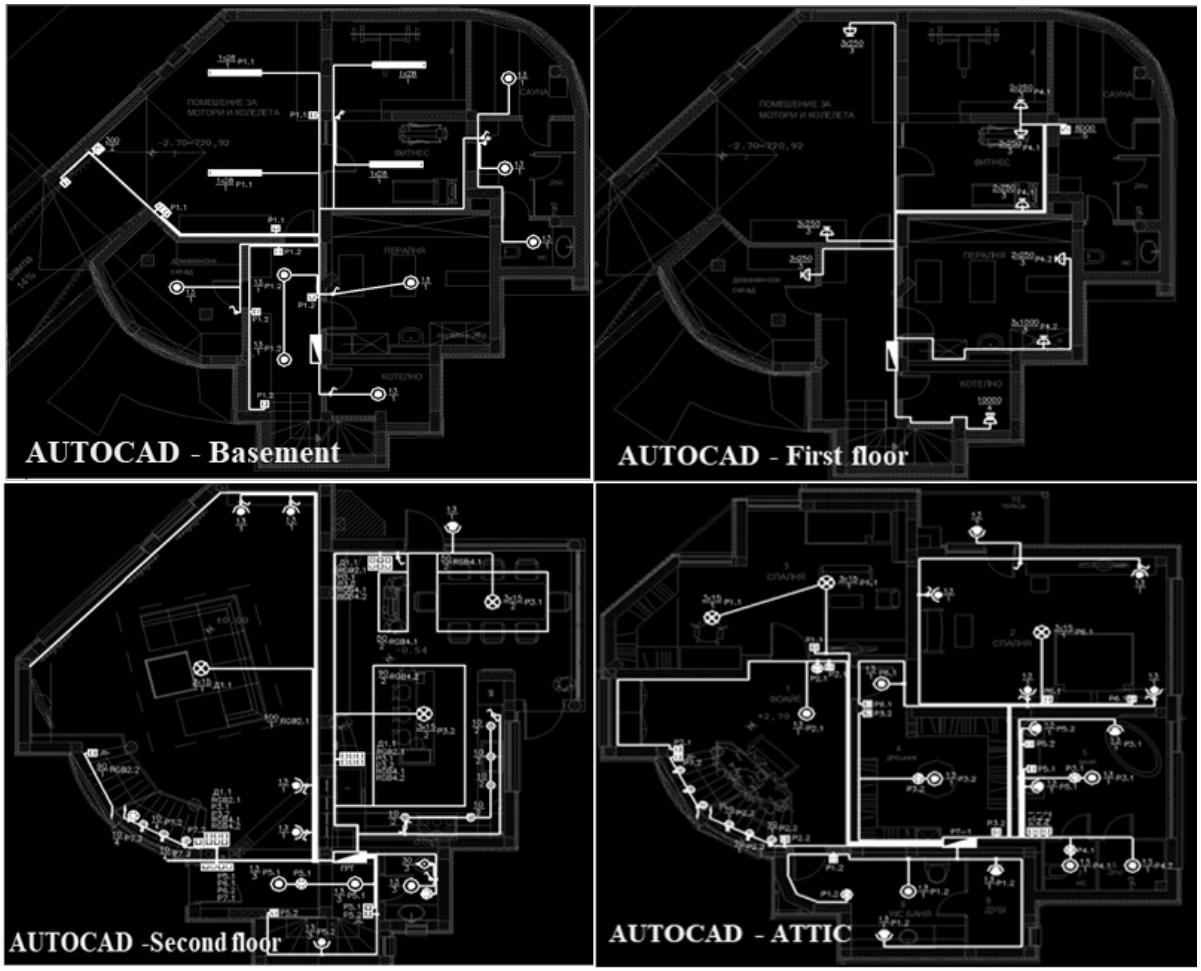

Fig. 2. Design and installation of the current systems of the building realized by AutoCAD.

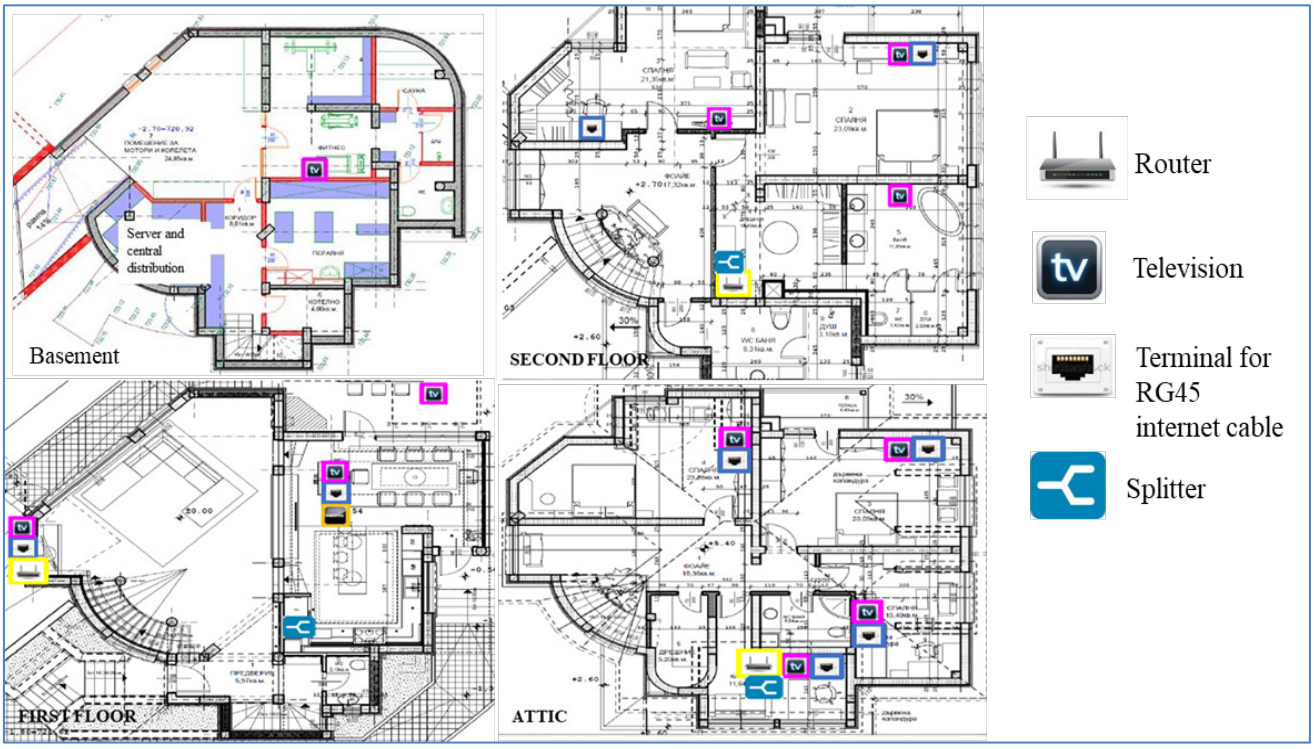

Fig. 3. Design and installation of low-current systems of the building realized by AutoCAD.

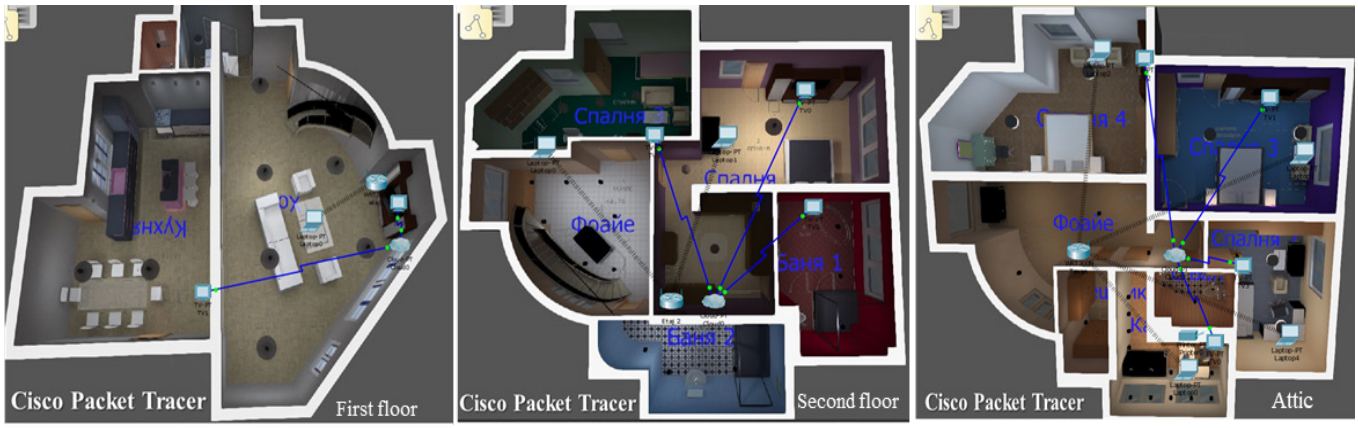

Fig. 4. 3D Design of the building realized on DIAlux Evo and Cisco Packet Tracer.

They can be configured to work with the Z-wave controller to receive real-time updates and notifications of building activity. The installed sensors make it possible to monitor home activities in real-time.

3D visualization and lighting design of the building realized on the DIAlux Evo program are presented in Fig. 4.

Smart sensors are designed to provide an integrated solution for staying connected with the home, even while we are at work or on a vacation.

The new generations of sensor devices used in home automation have some significant improvements, with sensors now transmitting signals faster and farther.

Motion sensors can be successfully applied in building an intelligent security system. The new sensors feature a range of 5 meters and a field of view of 120°. They capture traffic data and intelligently track every activity in the home. These sensors are used to increase security in the home and to monitor movements, even when we are away from home. They make our home automation system more powerful and smarter.

Z-wave is successfully used to maintain the room temperature, including control of motorized curtains and windows, fans and thermostats. The sensors connected to the Z-wave smart gateway can intelligently control the heating in the home.

Z-wave smart home products can communicate with each other, regardless of brand or building platform, using a central smart hub.

Z-wave is the leading wireless technology behind many of the secure, reliable brands that work to make everyone's home smarter and safer. Z-wave smart home products can communicate with each other, regardless of brand or building platform, using a central smart hub.

A smart hub is used in the automation of the building. The central smart hub ensures that devices in the home are connected to each other and to the user by a simple mobile application for smartphones (tablets). It acts as a central command center for each connected Z-wave device and for connection to the user. Z-wave smart home hubs have a variety of features and capabilities, including Wi-Fi technology that allows remote access to the system [21-28].

There is a smart lighting in the house, which allows remote control of light, on or off, dimming, changing the brightness and color of light and more. The user can create a schedule to turn on the lights at certain hours. Smart lights allow the user to control the energy consumption of the smart home.

CONCLUSIONS

Designing and building of smart homes is related to the necessity of wireless connectivity and Z-wave technology is among the most popular ones for home automation. Bluetooth and Zigbee wireless communication protocols often lack coverage, and Wi-Fi places its limitations on a low-power ecosystem. The Z-wave standard meets the requirements for home automation and Z-wave devices are interoperable - can be easily accessed through the internet or a Z-wave gateway.

We introduced a home automation system based on Z-wave. The smart home built with this technology is useful for consumers as it will save energy, because there will be no lights or AC power left on when they are not at home. In the next project, we will explore the interaction between a Z-wave-based home automation system and control with an Android mobile device.

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