ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 10, Issue 10, April 2021

Simulation of IoT Web-based Standard Smart Building Using Packet Tracer

Omar Kanaan Taha AL sultan, Abdulbary R. Suleiman
Department of computer and information Engineering/ College of Electronic Engineering, Ninevah University, Mosul, Iraq

Abstract-Smart building is the building block of a smart city. This work proposes an IoT based smart building for a scientific department providing many services such as lighting, HVAC, security, water management, Fire/ gas alarms and suppression, and smart park which all can be remotely controlled via the Internet by using either theIoT server webpage or the static IP address of the server through smartphones inside and outside the building, PC or laptop. Programming work is achieved for configuring the sensors, gateway, and servers devices with Java. Python, or Blockly. Standardizations are considered in the work by employing IoT standard technologies and protocols for networking. The paper includes choosing the building of computer and Information Department\ College of electronics engineering\ Ninevah University as a prototype for our IoT smartbuilding simulation using Cisco packet tracer v7.3 which provides many components and devices that simulate the real network.

***Index Terms*— Internet of Things (IoT), Building automation, Cisco Packet Tracer 7.3, IoT standards and protocol.**

I. INTRODUCTION

The Internet of Things (IoT) is a new age of computer technology that enables the processing and sharing of data by connecting things with electronics, software and sensors to the internet. Things can be anything and everything. [1]. (IoT) is one of the promising technologies by which intelligent objects which are connected to the Internet through an IP address can be controlled and managed [2]. The Internet of Things is predicted to have a significant effect on life. [3].

Smart building is the building block for the smart city and it means department, hospital, office, school, and any building requires automation and control services. Taxonomy of smart building services is shown in Figure 1.

In Figure 2, the IoT architecture can be separated into three different layers: vision layer, network layer and device layer. The layer of perception includes physical objects, for example, sensors, actuators and RFID tags, that seek to recognize items, capture and transform information of interest into digital data.

The data gathered can be temperature, moisture, location, current, etc. depending on the type of sensors. The digitized signal is then sent to the network secure channels [4]. Move the data from the experience layer to the application layer via a network layer (or called a transmission layer).

Manuscript received: 23 March 2021
Manuscript received in revised form: 21 April 2021
Manuscript accepted: 5 May 2021
Manuscript Available online: 15 May 2021

The following section provides an outline of IoT implementation specifications and guidelines. The platform layer offers various high-quality utilities and software to customers or customers. In this layer are introduced several intelligent technologies including smart construction, smart grid, intelligent transportation, and intelligent health.

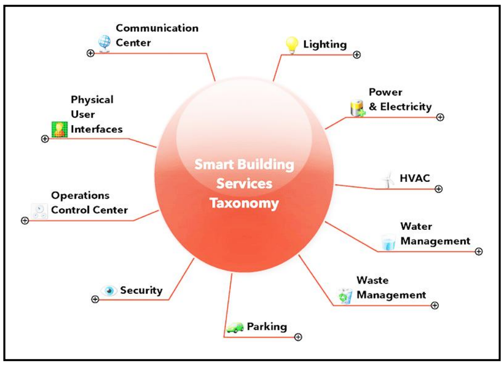

Fig. 1. Smart building services taxonomy [4].

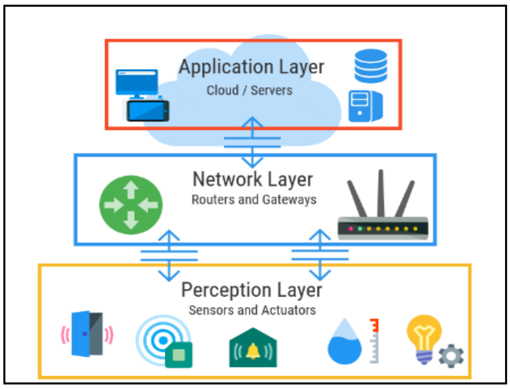

Fig. 2 Three layers IoT architecture

II. PROTOCOLS AND STANDARDS FOR THE INTERNET OF THINGS

The interconnected devices need to communicate using lightweight protocols that don't require extensive use of CPU resources to make full use of the ability of the IT technology. The preferred language options for IoT applications are C-language, Java, MQTT, Python and scripting language. There are many standardization organizations have developed standards to cover all layers, such as IEEE, IETF, and ITU. In general, IEEE works mostly on the data link, IETF works on networks while works on sessions, security and management for several organizations. These protocols and others are mentioned in Figure. 3 with emphasizing more on protocols in boldface. Even though Figure. 3 have been made as up-to-date as possible, new standards are continuously accepted and can therefore appear in the future. We consider these to be the most widely recommended and/or intended for IoT [5].

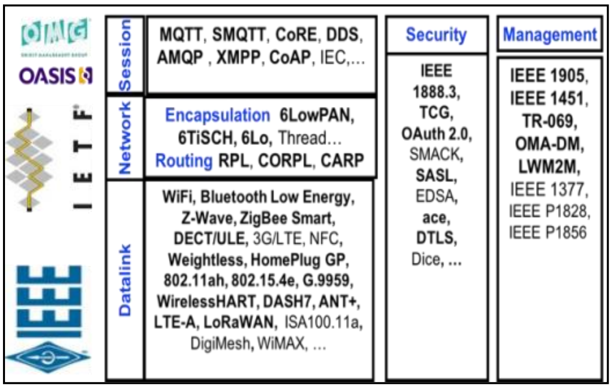

Fig. 3. IoT Technologies, protocols, and Organizations Standards[10].

III. RELATED WORK

This section presents the literature review related to the work.

In 2016, [6] Mrs HK Chaira. "Presented the internet of things for smart college" This concept of Smart College will influence millions of people's thoughts on IoT technologies.

In 2017,[7], the authors verify the proposed architecture for asthma patients based Cloud using Cisco packet tracer. In this proposed architecture, a temperature sensor is used to sense the temperature values from the patient and sent to the Cloud through a wireless router.

In 2019[8]. The project focuses on controlling Home Automation lights and fans and providing Smart security by delivering a captured image to the owner using the internet when an object is detected via an e-mail. For the disabled and the elderly, this was of great benefit.

In 2019, [3]. The Researchers used the Cisco Packet Tracer to simulate Smart Home. The aim of this study is to the simulation of smart devices can be developed. The results of the simulation show that smart objects can be. It is possible to successfully connect to the home portal and objects Monitored, contributing to the concept of real-life implementation.

IV. IOT SMART BUILDING SIMULATION

The proposed architecture on which the simulation is applied represents the department building of the Computer and information department/ College of electronics Engineering/ Ninevah University/ Mosul/Iraq. The rooms in the ground floor are categorized according to their functions as shown in Figure 4. There are 6 smart rooms, Security Room, Office Room, and building – corridor in addition to the outdoor lighting and smart parking.

Simulation programme Packet Tracer version 7.3 is used to simulate the smart construction since it is a revolutionary method for network simulation and viewing. This free tool lets you use your laptop or Android or iOS-based mobile device to configure the network and fix problems. Both the Linux and Windows workspace environments are available for Packet Tracer.

Fig. 4. Smart building diagram.

The Services provided by the current design are Fire – gas Alarms and Suppression Systems, Heating, Ventilation and Air-condition Control (HVAC) Systems, security system, a smart parking system, monitor the temperature and humidity system, outdoor street light control system, the indoor lighting control system, Water level control system and Management of energy consumption system.

V. IOT HARDWARE AND SOFTWARE

In our smart building system, various hardware and software for communication and remote control are used such as sensors, switches, servers, routing, application programming interfaces (APIs) and others. The main purpose of the IoT hardware used is the activation of the system, the specification of actions, security, and detection to support particular goals. The interconnection of these devices, however, is enabled by API which is a computing interface that defines interactions between multiple software intermediaries and gives the devices a platform to operate. It also integrates the devices and gets information through the cloud (WAN) . The APIs used in our work are developed to enhance the functionality of the devices. The Microcontroller Unit (MCU) is a board used to interconnect smart thing like sensors and actuators for controlling and provide programming environment to manage the things connected to it. The building LAN is connected to the Internet through a network gateway. Cloud can provide real-time and realistic services when integrated with IoT. There was no configuration needed for this component Except to easily connect it using different types of cables.[10]. ISP (Internet Service Provider) was artificially connecting different interfaces to simulate internet connectivity. IoT cloud transfers the information gathered by the objects from the smart building environment and sends them to the IoT server. Web-based monitoring and controlling the services for the smart building can be achieved by accessing the IoT server. The Central Office Server after configuring the IoT server, it automatically gets all the IP information from the ISP. It can also be used to connect the cell tower to the router and to transfer information between the router and the cell tower [10].

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 10, Issue 10, April 2021

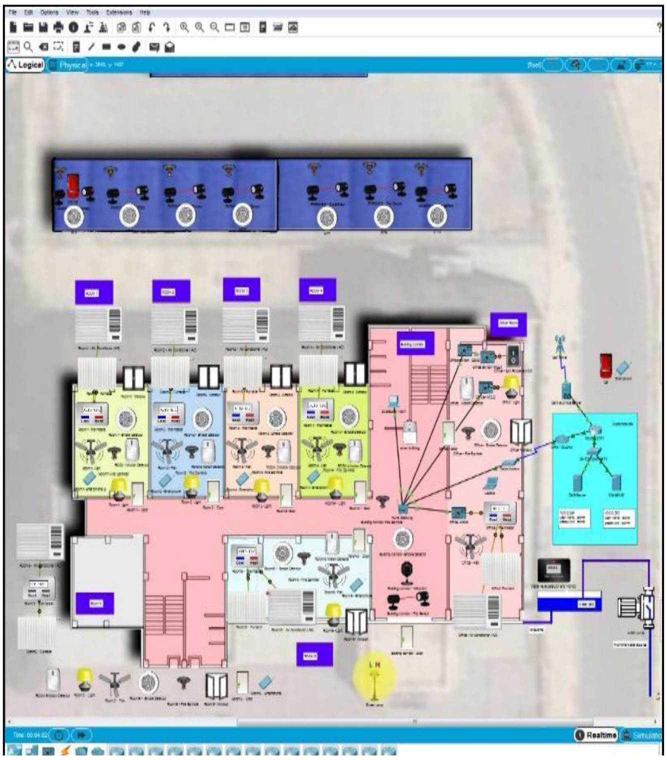

Fig. 5. Cisco Packet Tracer layout of Smart-Building simulation.

The Cellular Tower has used to remotely access and control building services. Both the cell tower and the central office server had only a small range of configurable parameters. The central office server can be connected to a maximum of six cell towers. A smartphone is an advanced technological tool that lets human beings make their lives simpler and more efficient than they were decades ago. In our project, all smart building IoT devices can also be controlled via an internet the connection from a remote location by a smartphone. it is linked to the cell-tower.

VI. SERVICES PROVIDED BY THE PROPOSED SMART BUILDING IMPLEMENTATION

The intended smart building system contains many services that will be offered according to the previously mentioned location classification and will be explained in the following.

A. The Office Room services

The Office Room is an important room for which we will pay more attention because it contains more smart devices.

1. Fire – gas Alarms and Suppression Systems

When a fire or leakage occurs in the gas system, the level of harmful gases in the room will rise and when it passes the unwanted level the fire sprinkler will work and the Siren – Alarm will activate, which in turn will issue sounds and light to alert automatically. The DNS server will send an email message remotely to the smartphone or Security computer to inform the person responsible for this. In additional, the smart window and door lock will open as shown in Figures 5 and 6.

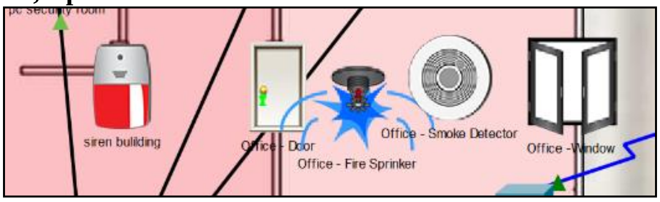

Fig. 6. Fire – gas Alarms after occurringthe problem.

2. ***Heating, Ventilation and Air-condition Control (HVAC) Systems***

The air conditioner and the furnace will be turned on / off automatically as shown in Figure 7. It is also possible to control the fan via the internet. The proposed work is designed to regulate cooling and heating in the building based on the temperature sensed and the availability of the person by the thermostat and motion sensor.

3. Monitor the Temperature and Humidity systems

The level of temperature in the room can be monitored through the thermostat device located in the smart building via the internet server as shown in Figure 8.

4. The indoor lighting control systems for the smart building

The indoor light can be controlled and monitored using IoT server services. The corresponding lamp for the office room is connected to a microcontroller. As previously mentioned, the building was divided into many locations. the office room light has additional features to be closer to real life. the MCU2 microcontroller was added and linked to a gateway device to control the lighting device, which does work as a component. The MCU1 and SBC0 microcontrollers have also been added to control Rocker switch. The light inside the office room will be turned off automatically if no movement detected or the Office **-** light Rocker switch is OFF, as shown in Figure 5. If a person is available and the Office **-** light Rocker switch is on the lights will ON as shown in Figure 9.

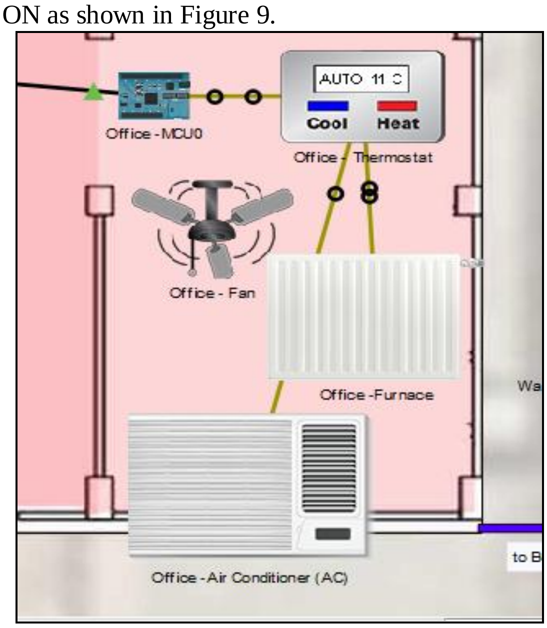

Fig. 7.Heating, Ventilation and Air-condition Control (HVAC) Systems

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 10, Issue 10, April 2021

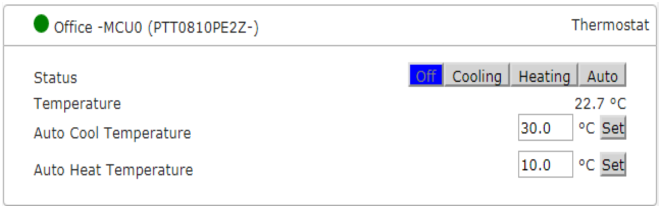

Fig. 8.Temperature Office Room Monitoring

5. Water level control system

The amount of water is measured periodically by the water level detector. If the level in the tank is low, the water pump will be turned ON, if the level is high, the pump will switch off. Figures 5 and 10 below shows the Water pump status.

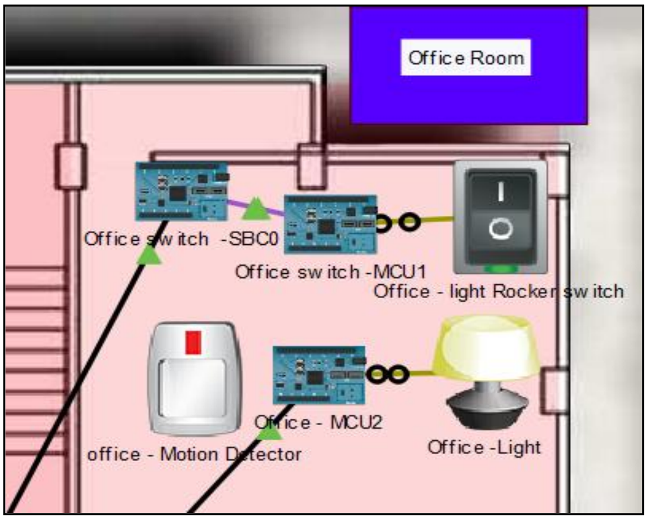

Fig. 9. Office Room Light ON

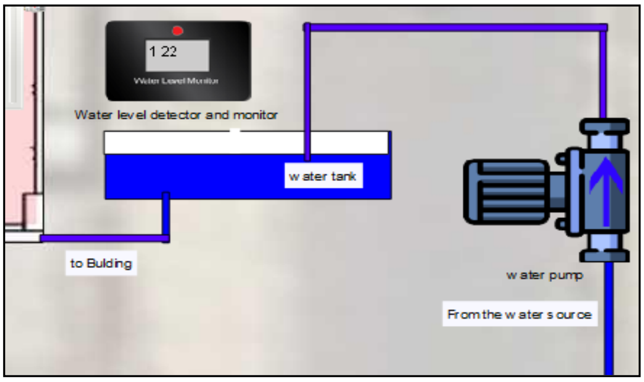

Fig. 10 The Water Pump "ON

6. Door and Window control

The opening and closing of the window lock or door lock can be controlled via the Internet.

7. Management of energy consumption systems

All of the smart building systems mentioned above are essential parts to reduce electrical energy consumption. Moreover, they enhance the overall service capacity of the power grid, realize the intelligent and interactive use of Electricity to improve energy efficiency.

B. Security Room and a building – corridor services

To activate the security system for the building, the trip sensor has to be activated. This system turns on the camera and triggers the siren device when unauthorized persons enter the building. The security can be controlled and monitored by the staff using smartphones or pcs. Figure. 5 displays the scenario when no motion of objects has been detected and the webcam is OFF. In Figure11 the trip sensor is triggered and the webcam is ON. In addition to the services provided by the DNS server, it will send an email to the security computer located in thesecurity room to inform the person in charge that there isa breach in the building. There are additional services in the building – corridor such as fire – gas alarms and suppression systems, management of energy consumption systems and internet provider (home gateway) which was previously explained.

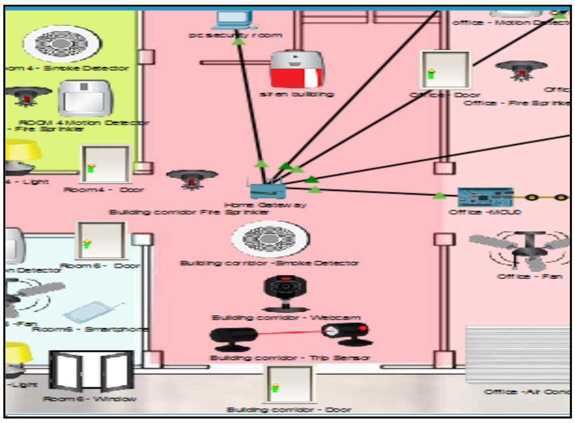

Fig. 11. Siren and Webcam is ONwhen no movements are detected by the Trip sensor

C. *The 6 smart rooms services*

The six smart rooms have somewhat similar services of the office room and have been previously explained such as Fire – gas Alarms and Suppression Systems, (HVAC), monitor the temperature and humidity, Door / Window control, Management of energy consumption and the indoor lighting control systems

D. Smart parking services

A smart parking system uses fire – gas alarms and suppression systems and seven trip sensors that enable users to remotely detect free parking spaces via a smartphone as shown in Figure 12. The trip sensors connected to the IoT server via the home gateway.

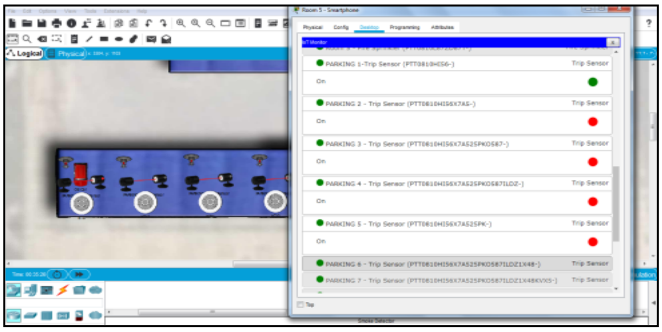

Fig. 12. The smart parking system.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 10, Issue 10, April 2021

E. The outdoor lighting services

An embedded motion sensor and light sensor are provided to control the outdoor street lights. The outdoor lighting services allowing the outdoor lamp to turn "ON" if it has detected a nearby object or a low level of light.

VII. CONFIGURING THE SIMULATION IN CISCO PACKET TRACER

There are two methods available for configuring or investigating the devices such as routers, home gateway via a Config tab (a GUI interface) or a command-line interface (CLI). The home getaway and the IoT server are configured for authentication service. Figure 13 shows the GUI controlling and monitoring the IoT devices being linked to IoT server via the internet.

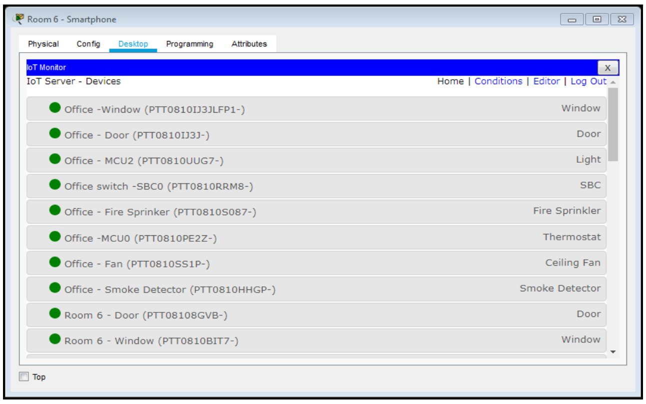

Fig. 13. IoT things that are connected.

List of rules and conditions that are developed forsmart objects such as door, fan, motion detector, and a webcam to give notifications or alarm.as shown in Figure 15.

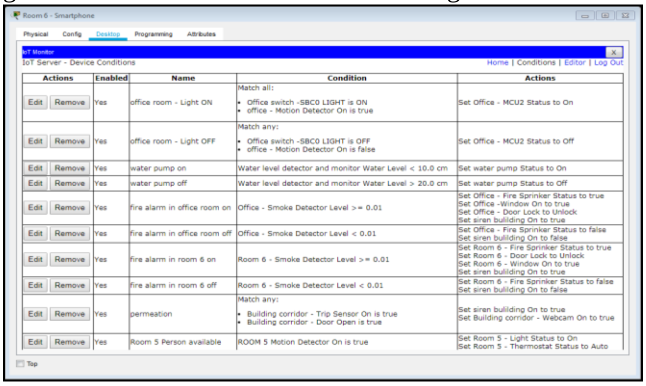

Fig. 14. IoT server device - Pre-set conditions Smartphone interface

VIII. SIMULATION MODE AND ANALYSIS

The ability to switch from real-time to a simulation mode was another very significant Cisco Packet Tracer feature worth noting. Dynamic environment management (temperature, gas, pressure, light, ...) was presented by Packet Tracer 7.3 to make the simulation of IoT devices more realistic. In Physical Workspace, there are containers such as the intercity, city, buildings, and wiring closets, all have their settings of environmental values. There are 24 default environmental elements, such as temperature, rain, water level, wind speed, and gases. In PT, most devices or items affect or respond to the environment such as a fire sprinkler which raises the amount of water and humidity, an old car increases different gases and air temperature when turned on, a smoke detector may be used to activate an alarm when smoke rises to a certain point in the environment. The Thermostats have been added to control the Furnace and the air conditioner (AC) to regulate the temperature between 10 ° C and 30 ° C by operating the air conditioner when the temperature rises above 30 ° C or operating the Furnace when the temperature falls below 10 ° C as shown Figure 16.

A fire of three old cars has been simulated sequentially at the location of the smart parking. The fire- gases alarm systems sensed and send gases level data to the IoT server, the servers will trigger the fire sprinkler, the siren device and send an email to a PC, carbon dioxide level had also returned to normal. Figure 16 clarify the event of CO2 emission variation as a result of burning and distinguishing of three cars.

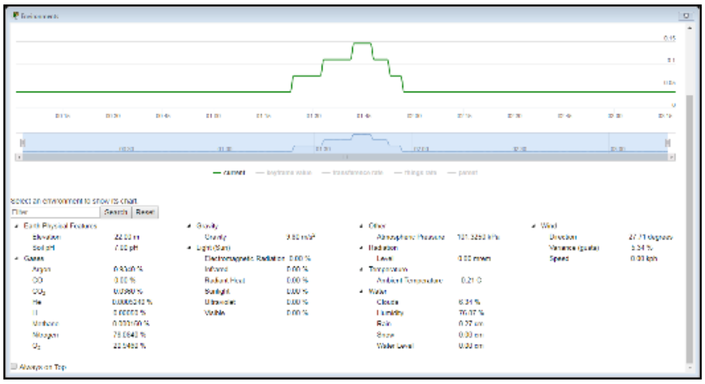

Fig. 15. Simulation results of ambient temperature when the heaters are turned on in the smart building.

Fig. 16. Simulation results of CO2 emission values in a smart building.

IX. CONCLUSION

In our article, the latest cisco packet tracer version (7.3) is used to present smart building as this version includes numerous IoT devices and by which a real network can be simulated including components, devices, and protocols. The Physical Workspace in packet tracer allows to build topology and to arrange devices physically in cities, buildings, and wiring closets.

Smart building is the main building block for a smart city

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 10, Issue 10, April 2021

and must be set up according to standard specifications developed or to be developed. Different services are provided for the different rooms, halls, and spaces of the building according to their functions. A prototype of IoT Web-Based smart building simulation is implemented in which different services are monitored and controlled via webpage GUI on smart phones, Laptop and PC.

Concerning our software work, it can be deduced that different programming languages may be used such as python, JavaScript, and Blockly. Flexibility and scalability are two main features for our smart building prototype since devices and services can be changed added, or removed. Scalability is verified throw addition of new systems.

REFERENCES

[1] Devika E S, Malavika C, "Internet of Things (IoT)-Applications On Various Fields", International Journal of Engineering Research & Technology, Volume 8, Issue 04, PP: 1–5, 2020.

[2] R. Josphineleela, S. S. Sivanya, S. Varshitha, and S. V. Arasi, "A Combined Approach for Home Automation using Raspberry Pi", Indian Journal of Science and Technology, , Volume: 11, Issue: 23, PP: 1-6,2018.

[3] Ghaliya Alfarsi,Jasiya Jabbar, Ragad M Tawafak, Sohail Iqbal Malik, Abir Alsidiri, Maryam Alsinani, "Using Cisco Packet Tracer to simulate Smart Home", International Journal of Engineering Research & Technology, Vol. 8 Issue 12, December, PP:670-674,2019.

[4] Xuyang Liu, K. H. Lam, Ke Zhu,Chao Zheng, Xu Li, Yimeng Du, Chunhua Liu, Philip W. T. Pong, "Overview of Spintronic Sensors with Internet of Things for Smart Living", IEEE Transactions on Magnetics, Volume: 55 Issue: 11,PP:1-22,November 2019.

[5] T. Salman and R. Jain, "A Survey of Protocols and Standards for Internet of Things", Advanced Computing and Communications, Vol. 1, No. 1, PP: 1-20, March 2017.

[6] Swaroopa P T , Mrs. Chaitra H K, "Internet of Things: Smart College", International Journal of Computer Sciences and Engineering, Volume-4, Special Issue-3, PP:105-109, May 2016.

[7] T. G. AL-Jaf, E. H. Al-Hemiary, "Internet of Things Based Cloud Smart Monitoring for Asthma Patient", International Conference on Information Technology, PP: 380–385, 2017.

[8] S. S. Chowdhury, S. Sarkar, S. Syamal, S. Sengupta, and P. Nag, "IoT Based Smart Security and Home Automation System," 2019 IEEE 10th Annu. Ubiquitous Comput. Electron. Mob. Commun. Conf. UEMCON 2019, vol. 7, no. 04, pp. 1158–1161, 2019.

[9] I. Shemsi, "Boosting Campus Network Design Using Cisco Packet Tracer," International Journal of Innovative Science and Research Technology, Volume 2, Issue 11, PP: 43-54, November– 2017.

[10] T. Salman and R. Jain, "Networking protocols and standards for internet of things," Internet Things Data Anal. Handb., PP: 215–238, 2017.