AN IOT- BASED SMART CITY MODEL USING PACKET TRACER SIMULATOR

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ABSTRACT

The Internet of Things (IoT) is one of the technology trends nowadays. In addition, the IoT is one means of developing a living life. This paper presents a smart city model based on the IoT using Cisco Packet Tracersimulation software. As a starting point, the paper explains smart city architecture that aims to improve life through three aspects. The first aspect is creating a network that allows users to control their smart devices from anywhere and at any time. The second aspect is bypassing the high budget by improving operational efficiency through the managed interconnection between smart devices within the city. Ultimately, the third aspect is increasing safety and security in all city facilities. The simulation showed that the smart citywould make life in cities more productive and interactive.

KEYWORDS

IoT, Smart City, Cisco, Packet Tracer, Networks

1. INTRODUCTION

The network that links people with their devices via smartphones has become essential due to the increasing dependency on smartphones and computers. People depend on the smartphones at home, work, or even in public areas. Furthermore, a significant amount of technology is necessary for growth, like the Internet of Things (IoT). IoT refers to all the devices connected to the internet and managed via a smartphone, computer, or control devices connected to the World Wide Web (WWW)[1]. The IoT can be used to build a smart homes, offices, or smart cities. The smart city combines IoT-enabled houses, offices, and public buildings. Furthermore, the smart city offers safety and benefits the environment, it satisfies the needs of the community. In this paper, a smart city network model is simulated by the Cisco Packet Tracer tool. The network in this model enables devices to be controlled via a smartphone using predefined configuration conditions from anywhere and at any time. The network model contains different LANs: smart home, smart company, smart garden, and smart parking. It also addresses security concerns by granting access to those who are authorized. In addition, home devices can be monitored from the workplace. Moreover, fire sensors will alert if a fire occurs to provide safety.

The rest of this paper is organized as follows. Section 2 discusses related work. Section 3 discusses the proposed model. The methodology is presented in section 4. Finally, the conclusion and future work are presented in section 5.

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2. Literature Review

Many studies have used IoT to improve infrastructure and make cities safer and more efficient. This section highlights recent studies that used IoT in a variety of environments. The authors in [2] presented a network design for a smart office model. The major objective was to provide a productive and safe working environment. All wired and wireless devices are connected to a single home gateway. The Cisco Packet Tracer tool was used to simulate the model. The proposed design meets the requirements of all workers while also significantly improve safety.

In [3], the authors concentrated on secure smart home automation. The model improves user comfort while simultaneously conserving natural resources and decrease energy use. Cisco Packet Tracer tool was employed to simulate the model. The analysis indicates that smart devices could be successfully connected to a network with the main gateway and monitored, demonstrating that a model of this kind could be utilized in real life for the user's house.

In [4], the authors addressed the importance of providing high-quality infrastructure to city citizens to serve as a model for a smart city. The Cisco Packet Tracer tool was utilized to simulate the model. The basic idea is that IoT devices do not require human involvement, making them suitable for activation in smart cities with a high level of security.

In [5], the authors designed a smart irrigation model that automate the irrigation system and remotely monitor environmental conditions using IoT. The two most essential systems in the model are the sprinkler and humidity control systems. The Cisco Packet Tracer tool was used to simulate the model. The simulation results show that the model may be used in real life to conserve water and increase energy efficiency.

In [6], the authors designed a smart home network model using the Cisco Packet Tracer tool. The design is entirely based on the IoT, allowing all devices to be controlled via smartphones. The smart home model enhances security and is environmentally friendly. The model is effective in extreme conditions.

In previous studies, research has shown that smart models have the potential to improve life flexibility, safety, and security. Smart cities can automate utility systems and help people manage their daily lives efficiently and safely.

3. Proposed Model

This study proposes a smart city network model based on IoT. The network connects various devices, enhancing city safety and efficiency and allowing citizens to live flexible lifestyles. Figure 1 illustrates the smart city model, which contains one Wide Area Network (WAN) and five Local Area Networks (LAN). The first network is the company’s network, which is a WAN that contains the first and second LAN networks, which are Branch A and Branch B of the company. The third LAN is the home network that is connected to the company. The fourth LAN is the park and the last is the parking network. After connecting the devices, a dynamic host configuration protocol (DHCP) is used in this model. DHCP is a standardized protocol for dynamic provision of network configuration parameters to Internet hosts that assigns an IP to each network [7]. The smart devices within the city are remotely controlled using a smartphone. The applied security, safety, and management techniques make the city network safer and much more secure. However, the convenience and privacy of the user will be granted.

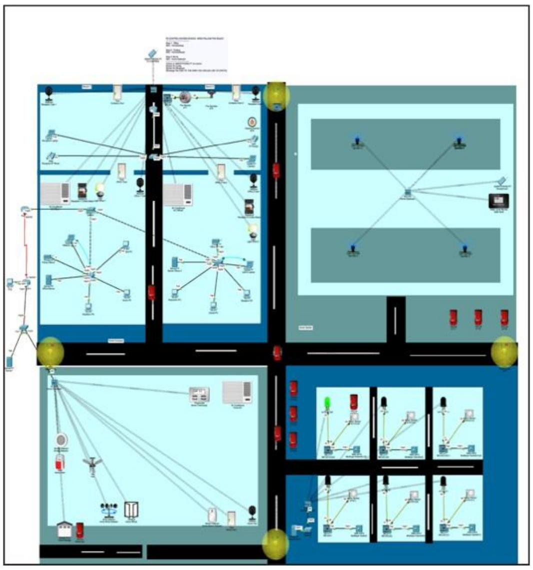

Fig.1 Proposed Smart City Network

3.1. Smart City Network Equipment

A gateway or registry server is required to connect to the network. A gateway is responsible for the entire device control, task allocation and scheduling, and data integration and transmission [8]. After connecting devices to the home gateway, the gateway can be turned on and off using the smartphone [5]. Therefore, each network in the model connects to the gateway. Navigation between networks can be controlled using a smartphone as shown in Fig 2.

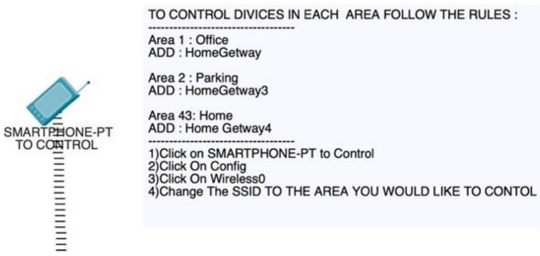

Fig 2. Navigation between Networks

3.2. Connection Setup

In this model, the suggested way to connect devices is to connect them to a getaway that is connected to a smartphone. In the company, the computers, laptops, printers, and servers are connected to a switch using cables. As for the rest of the city, it depends entirely on IoT devices. The devices automatically connect to their getaway. Table 1 shows the devices used in the model network and their function.

No.	Device	Function
1	Router	Used to link WAN by connecting two or more ofpacket switched.
2	Switch	Used to connect systems on local area network.
3	Multilayer Switch	It allows traffic to be sent only where it is needed.
4	Server	Server has several services to provide after being connected to switch or end-user devices.
5	Gateway	Used to register all smart devices after entering IP addresses.
6	Smart Phone	Used to control all smart devices in the regionafter entering the SSID of wireless LAN.
7	IP Phone	Used to communicate between IP Phone devicesby some configuration.
8	Laptop and PC	Used to link the destination access intelligentdevices by switch or server.
9	Air Conditioner	Used to cool the environment.
10	Smart Light	Lights up when motion is detected.
11	Webcam	It starts recording when it senses any motion.
12	Motion Detector	Used to detect any motion.
13	Smoke Detector	Used to sense the smoke level.
14	Siren	Used Siren with Smoke Detector.
15	Wind Detector	Used to close the window when it senses anywind.
16	Ceiling Fan	Used for ventilating the environment.
17	Thermostat	Used to open and close the air conditioner basedon temperature.
18	Water LevelDetector	Used to monitor hold water levels in gardensprinklers.
19	Lawn Sprinkle	Used Lawn Sprinkle with Water Level Detector.
20	Light-emitting diode (LED)	Lights up when it senses any motion.
21	Multipoint control unit (MCU)	Used to connect different intelligent devices.

3.3. Smart City Network Topology

The physical layout of computers, cables and other network components is known as a network topology [9]. There are many types of topologies such as point-to-point, bus, star, network, ring and wireless. In this model, a wireless topology is used in all networks, except for the company network which uses a star topology.

4. METHODOLOGY

The smart city model is built based on the IoT, where devices can be controlled from anywhere and at any time within the city. In addition, improving operational efficiency through managed connectivity between smart devices within a city. Cisco Packet Tracer tool version 8.2 is used to simulate the model network. Cisco Packet Tracer is a multi-platform simulation application from Cisco that allows network modelling and helps in IoT reformations [10]. One characteristic of the Cisco Packet Tracer tool is the ability to view and analyse the flow of data packets across all IoT devices. This section presents the devices' connection for all networks in this model.

4.1. Implementation and Devices Configuration

Only after connecting the smartphone to the LAN address and signing in using the username and password as displayed in Fig 3. The user can control any device within the city. After that, the user will have control over any devices linked to the same network address. A list of smart devices will appear to the user to control the devices remotely.

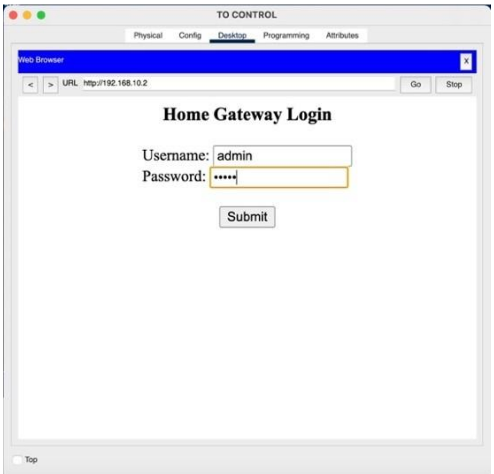

Fig 3. Logging Page

Smart Home is the most important system used in this model. All devices are connected to a single home gateway wirelessly. The home gateway is connected to a switch connected to a DHCP server, which assigns a dynamic IP address to all network components. In Fig 4, all devices are connected wirelessly via the gateway using IoT after logging into the LAN with the address 192.168.10.2 via a smartphone, except for the server and switch device wired to the home gateway.

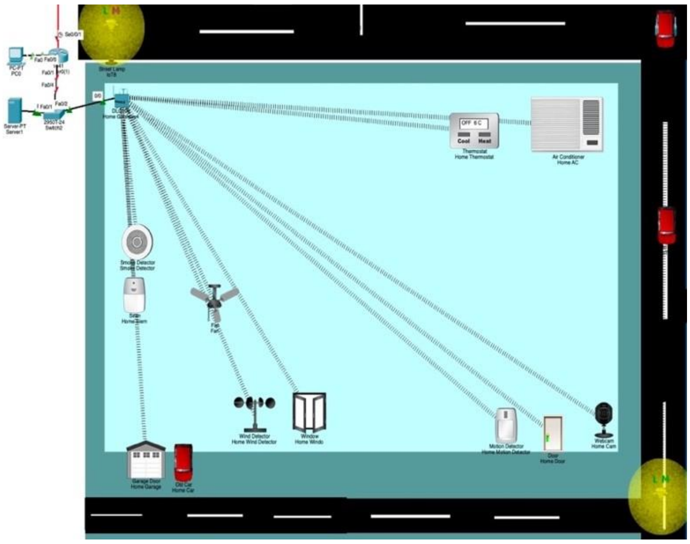

Fig 4. Proposed Smart Home Network

In the smart home network, there is a webcam, a motion detector, and a door. Once a motion around the door is detected, the motion detector will detect it, then the webcam will start recording, as shown in Fig 5 and 6. Furthermore, there is an air conditioner and thermostat; the air conditioner is automatically turned on when the room temperature is less than 25. Moreover, there is a wind detector and window. When there is a motion in the wind, the wind detector will look for a swing and close the window, as shown in Fig 7 and 8.

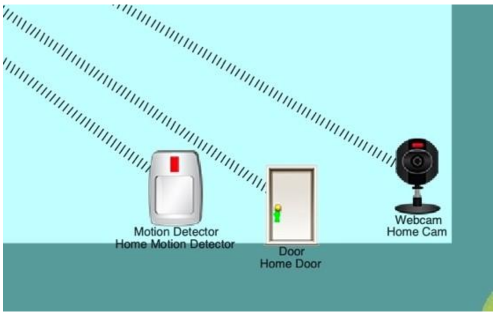

Fig6. There is motion around the door.

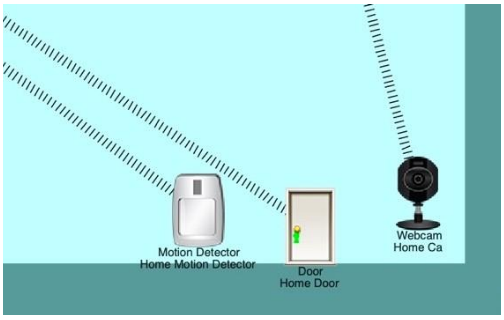

Fig5. There is no motion around the door.

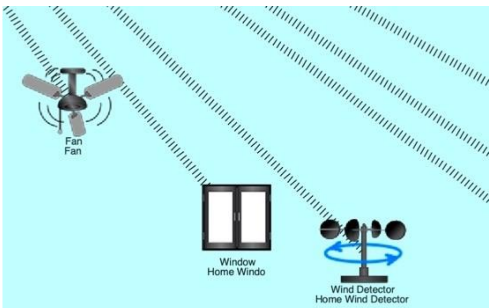

Fig 8. There is wind motion.

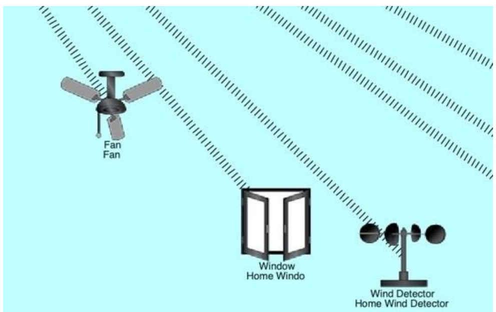

Fig 7. There is no wind motion.

Smart Company network has two branches: A and B as shown in Fig 9. Branch A address starts with 1/24, while branch B address starts with 24/64. In each branch there are two sections, a reception and office sections.

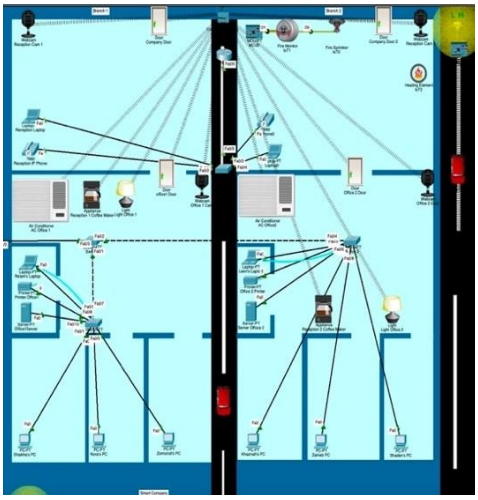

Fig 9. Smart Company Network

Branch A: The reception section contains a laptop and an IP phone connected via a switch. As for the office section, there are PCs, laptops, printers, and computers. A switch connects the devices to a server, which allows them to bee connected to the gateway. In addition, there are two webcams, doors, air conditioners and office lighting connected wirelessly.

Branch B: This branch has the same content and devices as branch A but is equipped with a fire monitoring device and fire sprinklers. The fire monitoring device detects the fire (heating element). When the fire monitoring detects a fire, the fire sprinkler works to extinguish the fire.

Additionally, there are two routers in the company, the first router connects branch A to branch B via Voice over Internet Protocol (VoIP). VoIP is a technology that has been widely used for IP telephony services [11]. Where the branches can communicate with each other via IP Phone as shown in Fig 10. The other router connects the smart company and smart home networks as shown in Fig 11. To verify the connectivity between branch A and branch B, a “PING” command in Command Prompt is used as shown in Fig 12.

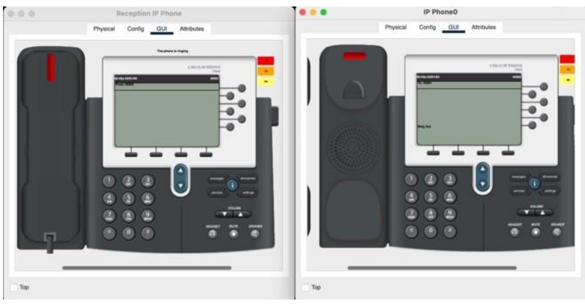

Figure 11. IP Phone A Connection with

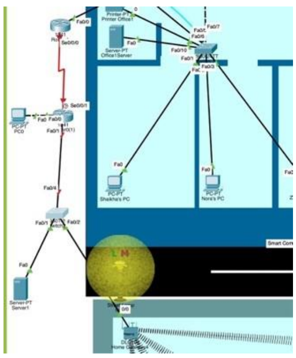

Fig 10. Router-to-Router

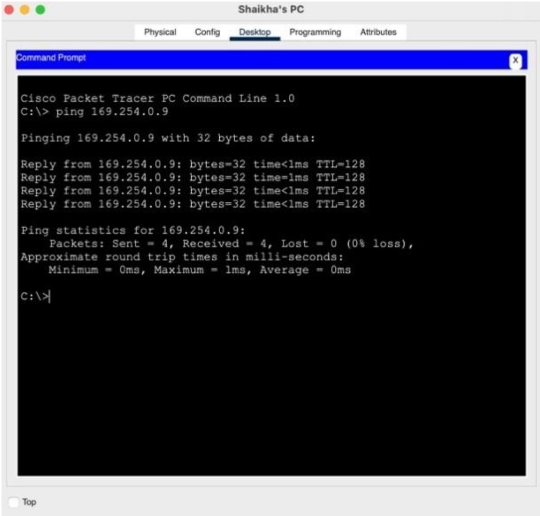

Fig 12. PING Between Branches

Smart Garden is the fourth LAN, shown in Fig 13, contains several lawn sprinklers, a water level sensor and garden smartphone. The mechanism of action in this area depends on the water level monitor. If the water level is less than 5 centimetres, the sprinklers will start sprinkling water. If it is more than 5 centimetres, the sprinklers will not work as shown in Fig 14 and 15. All these devices in the smart garden are connected wirelessly through the gateway device using IoT. As the garden is on public property and cannot be controlled by a personal device in this network, there is no link between the gateway and the controller smartphone.

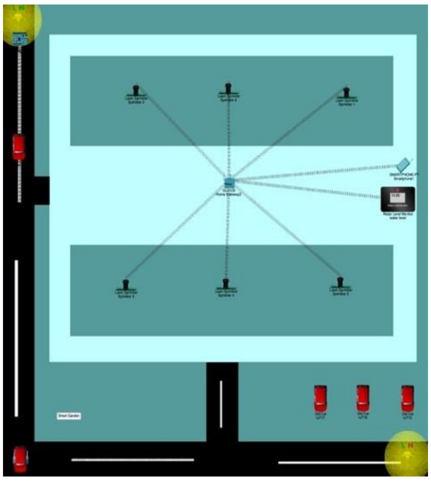

Fig13. Proposed Smart Garden Network

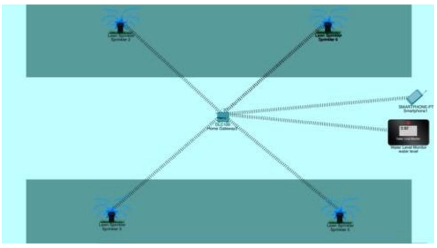

Fig 14. Less than 5 cm

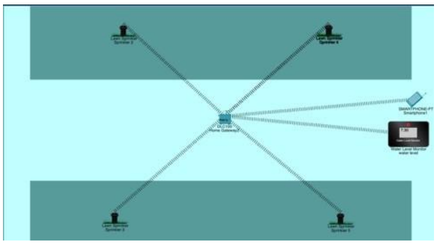

Fig 15. More than 5 cm

Smart Parking is the fifth LAN. As shown in Fig 16, the parking network is a set of simple tools and devices that are connected to each other. In general, this area contains motion sensors, a Light Emitting Diode (LED), a Multi-point Control Unit (MCU), a Multi-Layer Switch(MLS) and cars. Particularly in each parking, there is an LED, MCU, motion sensor and an MLS. LED, motion sensor and MLS are connected to the MCU linked via a wire. Moreover, the LED is connected wirelessly to the home gateway. The home gateway and server are connected to the switch via wire. The smart parking mechanism relies on the LED and motion sensor. When the motion sensor senses the presence of the car, the LED will automatically light up. Conversely, when the motion sensor does not sense the car's presence, the LED will remain off as in Fig 17.

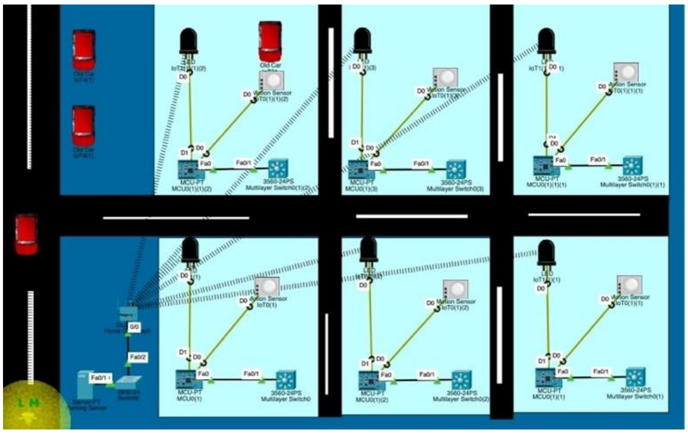

Fig16. Smart Parking Network

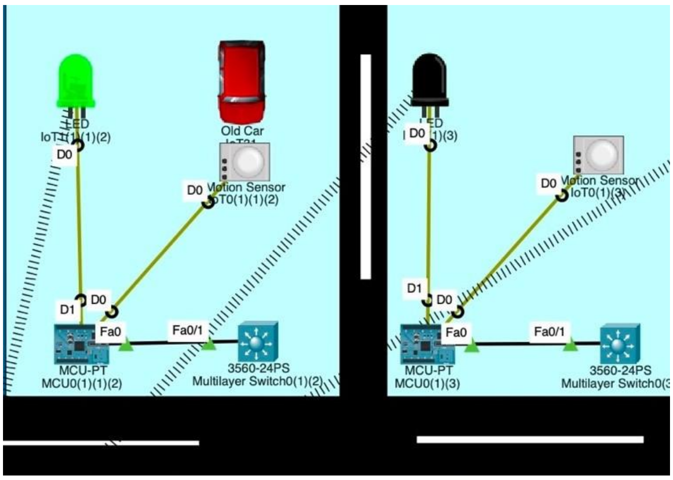

Fig17. Motion sensor and LED

5. Conclusion and Future Work

In this paper, an IoT-based smart city network model is proposed. In this model, the user can control devices remotely from anywhere and at any time within the city using a smartphone. The network model contains different LANs: smart home, smart company, smart garden, and smart parking. It also prevents accessing to public property by users unless they are allowed, and monitors the home and office environment against risks. The Cisco Packet Tracer tool was used to simulate the model. Furthermore, it is advised to improve the facilities in future work to make the model more realistic. For instance, adding hospitals based on IoT. Also, it is recommended to automate the traffic system which makes the cities less crowded.

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