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College of Science and Humanities

Computer Science Department

Communication and Network Course Project First semester 2023/2024

Smart Student Residences: An IoT-Based Model Implemented via Cisco Packet Tracer.

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ABSTRACT

Student residences play a crucial role in overall of student success, and with the development of technology and the spread of network concepts. Students now rely on a reliable and secure network connection to collaborate with their classmates and access resources. Our proposed model employs Cisco Packet Tracer to design an IoT-based smart student residence model network that fulfills all student requirements and goals of presenting a dependable network that advances the students both living and educational environments. The final result is that we have designed a network that serves all students, facilitating access control of most needs, and communication, and introducing the Internet of Things to the network has enhanced the services provided.

1. INTRODUCTION

This Smart Student Residences network model topology is designed for students' housing, where various devices are set up to facilitate communication and interaction among the students and the housing managers. Our proposed model was implemented using the Cisco Packet Tracer tool, which is software that allows users to simulate the configuration of Cisco routers and switches using a simulated command-line interface. However, our Smart Student Residences network model aims to provide a reliable network that meets the essential connectivity demands. A reliable network is like the backbone of any organization, especially when the building is student housing, students need a network that facilitates the exchange of information and resources for them and makes communication with their peers and housing managers easier. A residence network is expected to be used by a large number of users and to maintain the integrity of the network, security is essential for preserving a safe and productive learning environment. In our designed network model, we set security measures such as setting passwords for network devices like routers and switches to control access and prevent any external modification on the network. Moreover, to enhance the overall living experience, our designed network utilizes the Internet of Things (IoT). We implemented IoT technologies to allow remote control of devices, where the students can control and manage their devices from their smartphones and the housing managers can control public property technologies such as the smart irrigation system, which optimizes energy and electricity consumption. Furthermore, our network utilizes the IoT by including technologies like web cameras and smart smoke-detecting systems to provide a safe and secure environment for students. The network contains different LANs: smart students' rooms, a studying room, a gym, a security room, smart parking, and a smart garden. To meet the standards of offering a secure and comfortable environment that meets the essential connectivity demands, prioritizing safety, productivity, and comfort.

2. PROPOSED MODEL

By using the Cisco Packet Tracer tool, we have designed an IoT-based Smart Students Residence network. Our network is designed to meet the goals of offering a reliable network that improves the students both living and educational environments. By implementing the basic network concepts such as VLANs, DHCP, VOIP, IoT, and using the appropriate network topologies we implemented a network that enhances the student's lifestyle and provides a safe and secure environment.

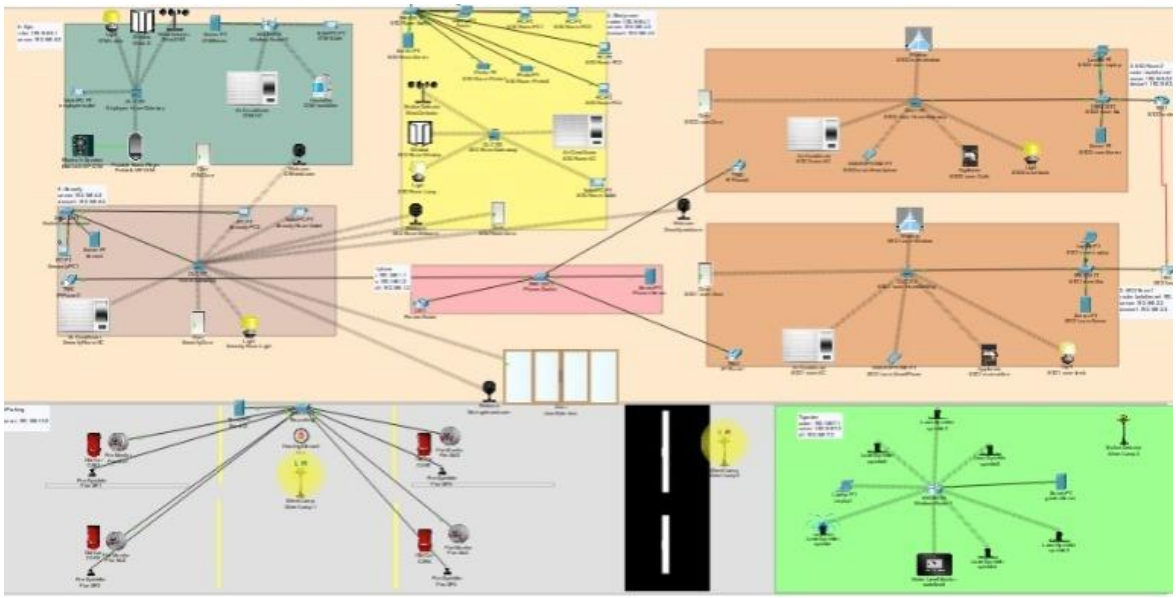

Figure 1 . Student Residence Network

2.1 NETWORK TOPOLOGY

We used star topology in our network since it is less expensive than mesh topology because it uses less cabling, and the star topology is easy to establish. Moreover, the star topology is robust, which means that if one link fails only one link is affected. Lastly, we used star topology since high-speed LANs use a star topology with a central hub.

2.2 CONNECTION SETUP

2.2.1 STUDENT ROOM

We have two students' room models as shown in Figure 2. Firstly, we have the switch of type 2960 connected with the 1841 router, server, laptop, and DLC100 home gateway all by straight cable. The IOT devices are connected to the home gateway wirelessly. We also connected the laptop and the switch with a console capable and protected it with a password to enhance security. The student can control the IOT devices in their room using their smartphone. To elaborate, the student can open the windows curtains, and locks, and open the room door, turning on and off the AC, lamp, coffee maker, and all that control remotely using their smartphone only. Moreover, the student's room routers are connected using serial DCE cables so the two students can exchange information easily using their laptops. Lastly, in each student room, there is an IP phone. The students can use the IP phone to communicate with each other and with the security room to ensure safety and connectivity among all the networks.

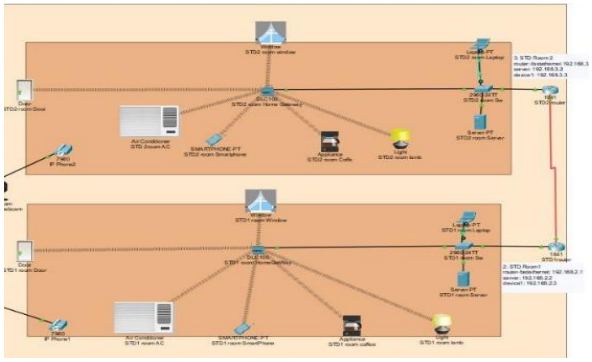

Figure 2. Students Room

2.2.2 STUDYING ROOM

As shown in Figure 3, we used a 1941 router connected with a switch by straight cable and with a laptop by console cable protected with a password. The switch is connected to the server, 2 printers, 2 PCs, and 1 laptop, all by straight cable. We used 3 services in the studying room server, such as HTTP, DHCP, and Email. Also, the study room contains a home gateway to increase the efficiency of controlling the room's IOT devices remotely using the tablet in the room. Moreover, the windows are connected with wind detectors to close the window automatically once the detector detects a wind. The lamp and the AC IOT devices can be remotely controlled by the tablet.

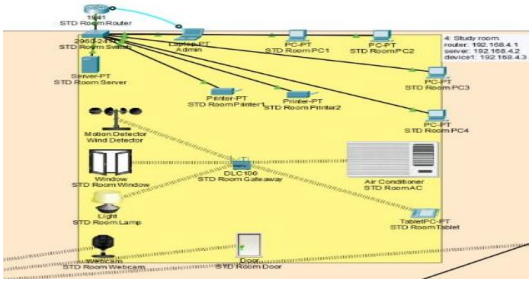

Figure 3. Studying Room

2.2.3 GYM

As shown in Figure 4. We separated the control of devices into two parts. Both Students and employees control the first section through a tablet connected to a server that We use it to employ one of its services which is IoT services. The server is connected to a wireless router via a straight cable. The IoT devices is connected wirelessly to the wireless router, allowing students to remotely control the opening, and closing of the AC and humidifier. The second section is controlled by employees through a home getaway connected tablet device, which allows employees to control the light and Bluetooth speaker. Moreover, the windows are connected with wind detectors to close the window automatically once the detector detects a wind.

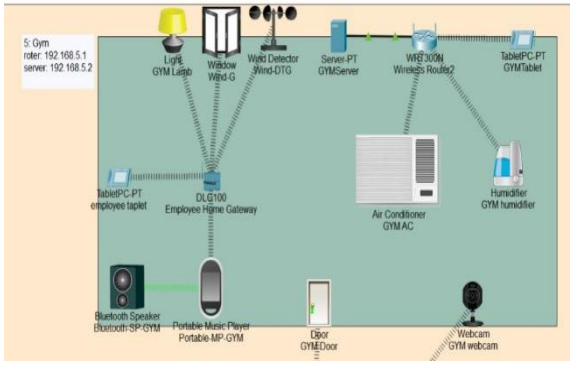

Figure 4. Gym

2.2.4 SECURITY ROOM

As in Figure 5. We have a switch type (2960) connected to 2 PCs, a server, and a home getaway, all via a straight cable. Also, the switch is connected to the PC with a cable console, and it is protected with a password to enhance security. IoT Devices are connected wirelessly to the home getaway. To enhance security, the housing managers can control IoT security devices remotely via the tablet. The security devices we use, like web cameras, we place them in several locations in the building, such as the gym, the study room, and between the student rooms. In addition, when anyone passes through the main door, it will open automatically with the Security Webcam running, all connected to the security room. This is to enhance the concept of security and comfort for students. Lastly, the security room contains an IP phone connected to the phones in the two student rooms, enabling the students to communicate with the housing managers easily from their rooms without the need to visit the housing managers' security room.

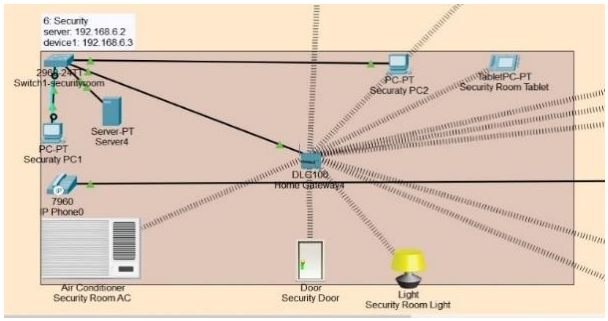

Figure 5. Security Room

2.2.5 SMART PARKING AND FIRE DETECTING SYSTEM

In order to enhance safety in the building, we have established the smart parking fire system as shown in Figure 6. So, we have a 2960 type switch connected to the server that we use it to employ one of its services which is IoT services. IoT devices such as fire motion and fire sprinklers are also connected. All via a straight cable. Therefore, when the fire, which is (the heating element), passes near the fire motion device, the fire sprinklers will open to extinguish the fire, as this process exists in every parking lot.

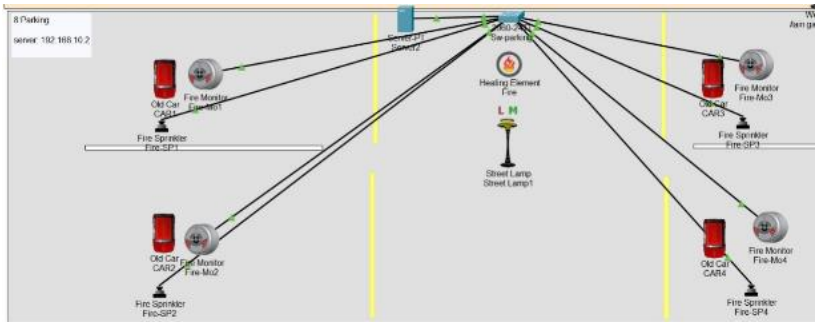

Figure 6. Parking

2.2.6 SMART GARDEN

As shown in Figure 7, the garden contains a wireless router connecting with the server via a straight cable. Also, the wireless router is connected wirelessly to a laptop, water level monitor, and 6 lawn sprinklers. We used the server in the garden to use its IoT service to enable remote control of the water monitoring level and the sprinkler using the laptop. The sprinkler and the water level monitor are connected with a condition, once the water level in the soil reaches 9 cm or less, the sprinkler will turn on until the water level in the soil rises to 10 cm or more. Lastly, the garden contains a lamp that will turn on once it senses a motion in the garden.

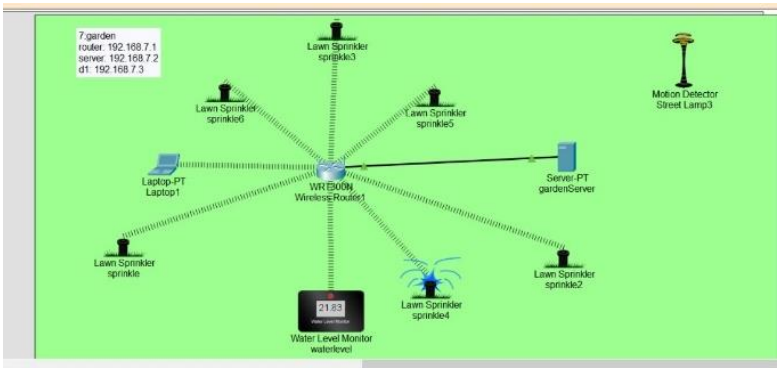

Figure 7. Smart Garden

2.3 EQUIPMENT

Device Name	Quantity
Laptop	4
Server	8
Switch	6
Weird Router	4
Wireless router	2
Serial Wire	1
Straight Wire	More than 30
Console Cable	4
PC	6
Home Gateway	5
Lamb	5
Street Lamb	3
Appliance (coffee maker)	2
Smartphone	2
Tablet	3
Webcam	4
Window	4
Window Detector	2
Bluetooth speaker	1
Portable Music Player	1
Humidifier	1
AC	5
Lawn Sprinkle	6
Fire Motion	4
Fire Sprinkle	4
Old Car	4
Heating element	1
Door	6
IP Phone	3
Printer	2
Water Level Monitor	1
Wireless connection	More than 30

Table 1. Equipment and Devices

3. METHODOLOGY

Implementation and Configuration of Devices:

3.1 ROUTERS

3.1.1 Connecting Two Routers Configuration in Students' Room

We used two routers of type (1841) for the student's room, and we connected the routers STD1 router and STD2 router by adding serial ports to both routers and serial DCE cable in between. Also, we configure the interfaces in the CLI as shown in Figure 8 and Figure 9.

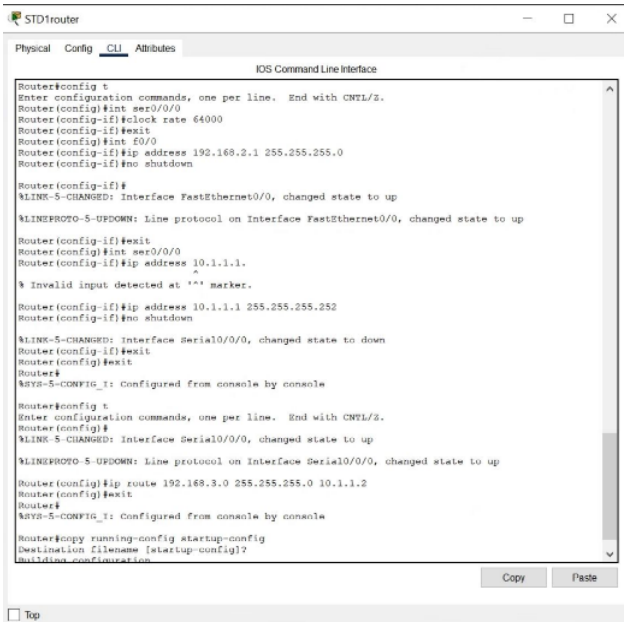

Figure 9. STD1 Router

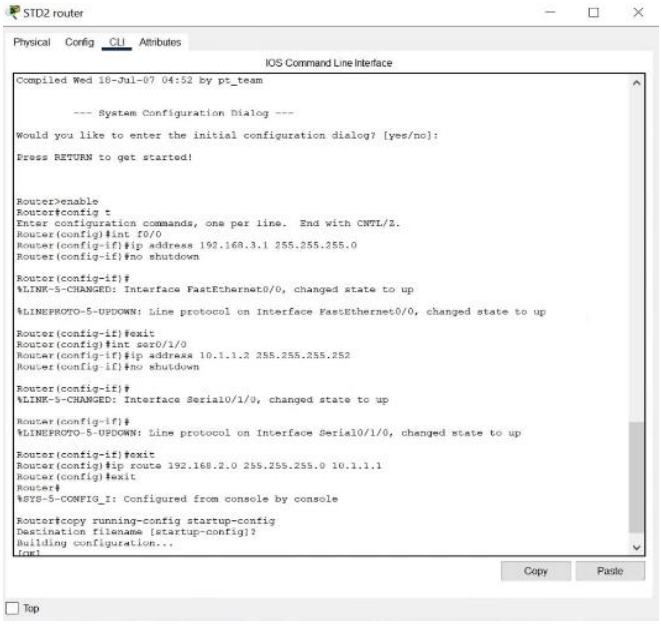

Figure 8. STD2 Router

3.1.2 Router Basic Configuration

In the studying room, we've used a (Cisco 1914 Router) type, the router is connected by a straight cable with the studying room switch, and by a console cable with the admin laptop. The basic router configuration was applied such as changing the hostname and setting passwords as shown in the figure below.

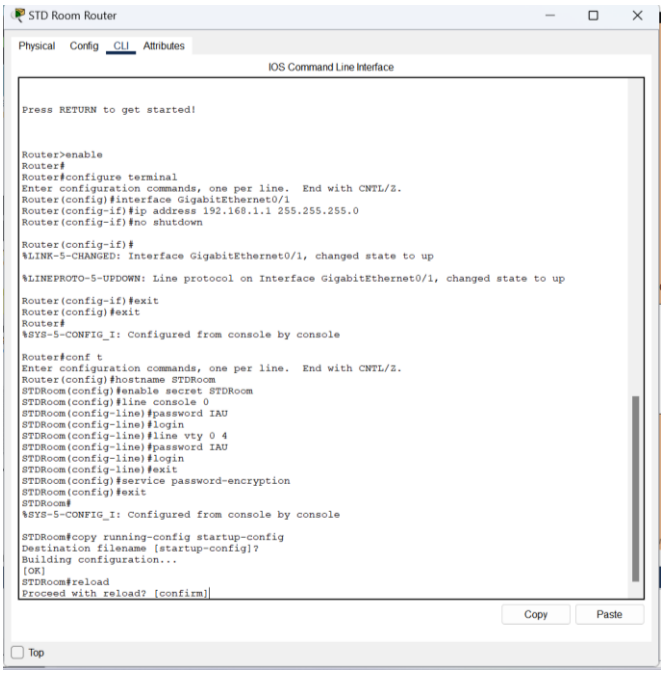

Figure 10. Studying Room Router Configuration

3.1.3 Wireless Router

We used the wireless router in the garden (see Figure 11) and gym (see Figure 12) to enable the students to control the IoT smart devices in the gym.

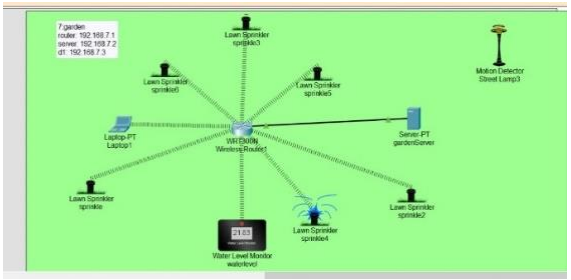

Figure 11. Garden

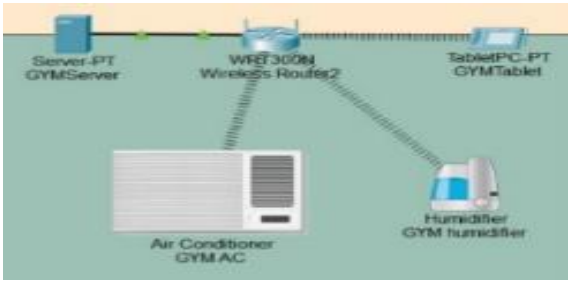

Figure 12. Gym

3.2 SWITCH

Most of the switches in our network have the same basic configuration as the study room switch. In the study room, we used a Switch (Cisco 2960 Switch) to connect the devices in this network, the switch is connected to the STD Room Router using a straight cable. Also, the switch we connected the switch to the server and the rest of the room devices (PCs, Printers, etc..).

3.2.1 Switch Basic Configuration

1- We used the command **hostname** to set system's network as "***STDRoom***".

2- We set " ***STD Room*** ", as a password for the service.

3- We set "***IAU"***, as a password for Virtual terminal interface.

4- We encrypted both passwords.

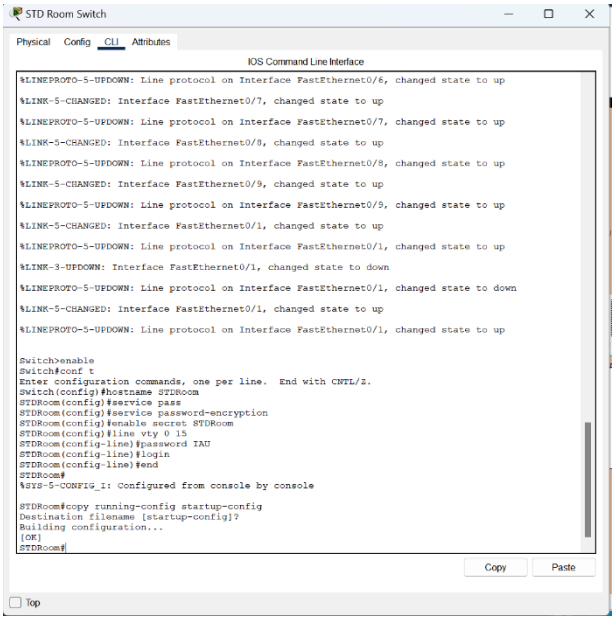

Figure 13. STD Room Switch Configuration

3.3 SERVER

To enhance the efficiency and reliability of the network, we applied server services such as IoT, DHCP, HTTP, and Email.

3.3.1 IoT Service

We connected the server with a wireless router and implemented the IoT services in the server by wirelessly linking the tablet with the wireless router to control the IoT devices located in the Gym and the Garden.

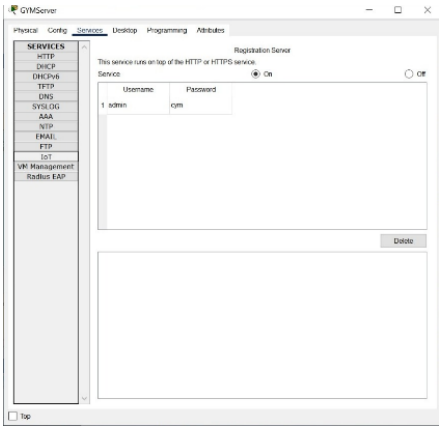

Figure14. IoT Service Server

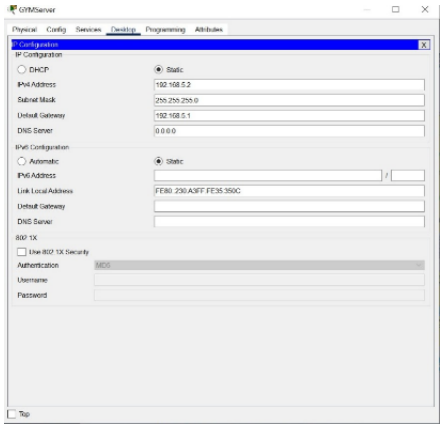

Figure 15. IoT Services Server Config

3.3.2 DHCP Service

In order to simplify the configuration process for the several devices in the study room, we used the Dynamic Host Configuration Protocol (DHCP). This protocol automatically provides the configuration information such as IP address, subnet mask, and default gateway.

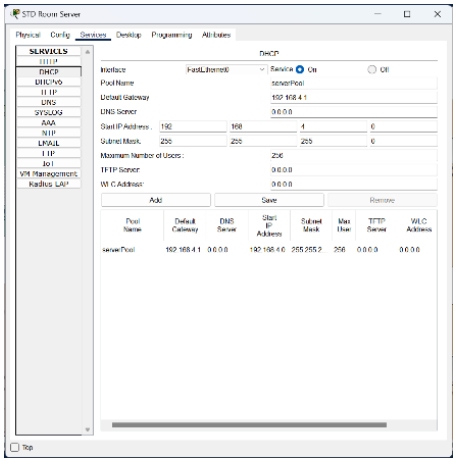

Figure 14 Server DHCP Configuration

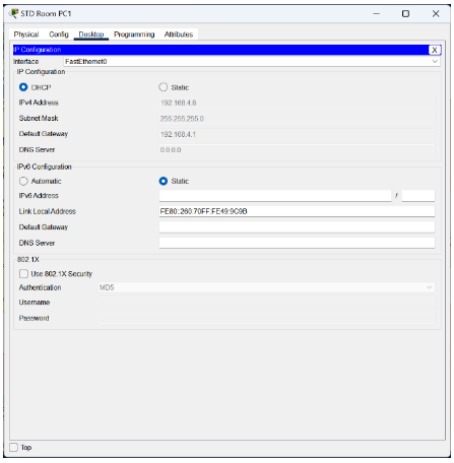

Figure 15 . PC DHCP Configuration

3.3.3 HTTP Service

By applying the Hypertext Transfer Protocol (HTTP), we included the Imam Abdulrahman Bin Faisal University website to enhance the accessibility to the students. This website as shown in Figure 18 can be accessed by entering the server IP address 192.168.4.2 .

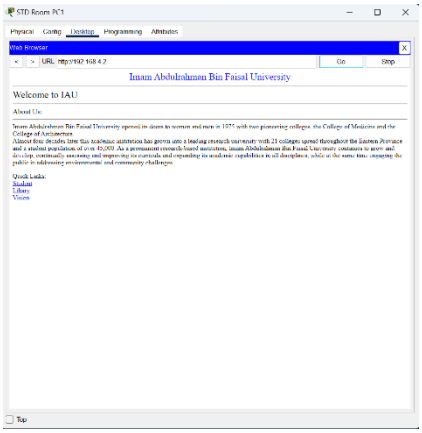

Figure 18. IAU Website Homepage

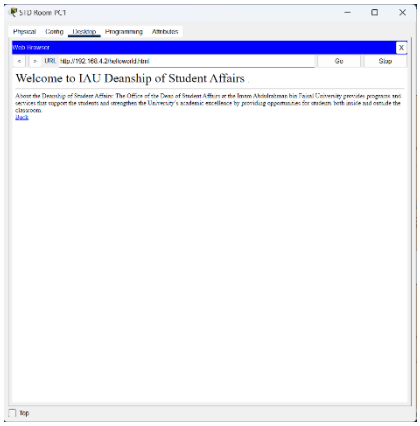

Figure 19. IAU Website Students Page

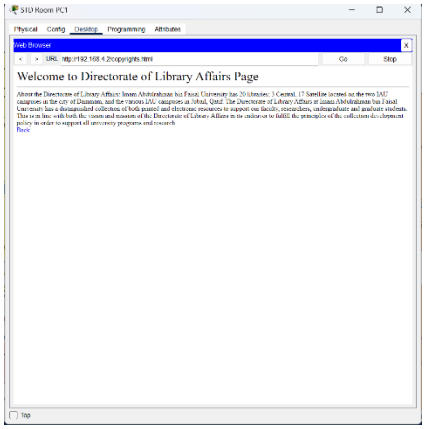

Figure 20. IAU Website Library

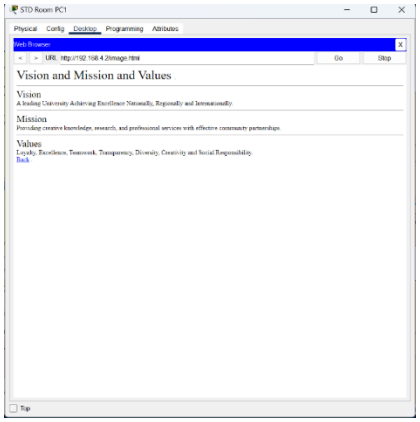

Figure 21. IAU Website Homepage

3.3.4 Email Service

To facilitate communication between students and improve collaboration on projects. We implemented an Email service that allows electronic communication at a distance. We set the domain name as "iau.edu.sa" referring to the Imam Abdulrahman bin Faisal University established domain. In Figure 22 we created a group of users and passwords for both admins and students, enabling them to easily exchange emails.

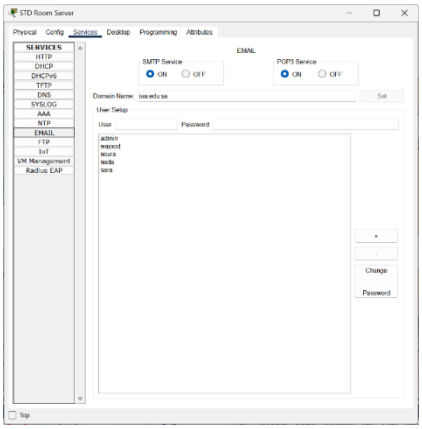

Figure 22. Creating Users and Passwords in the Server

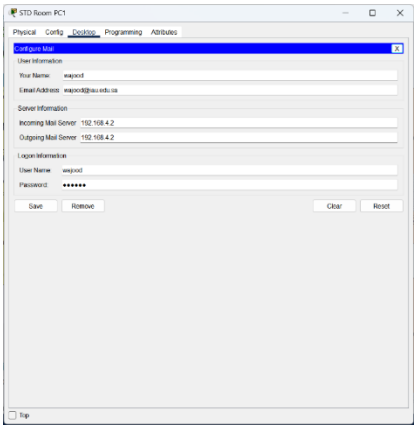

Figure 23. Configuring Email in a PC

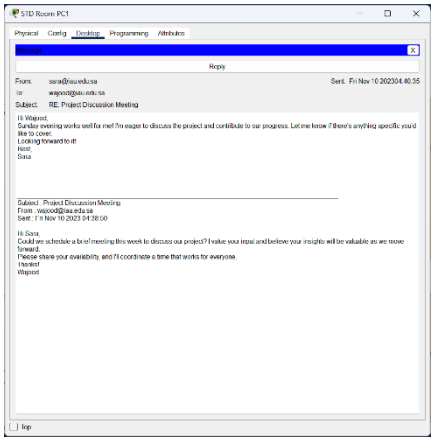

Figure 24. Exchanging Emails Between PC1 and PC4

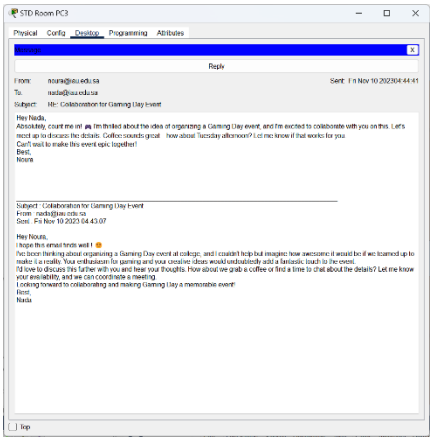

Figure 25. Exchanging Emails Between PC2 and PC3

3.4 HOME GATEWAY

We used the Home Getaway in most rooms by connecting it to the switch using a straight cable. The main reason for using Home Getaway is to enable the students to control the IoT smart devices in their rooms using (Tablet, Smartphone), and help employees and students handle different IoT smart devices in shared spaces using tablets.

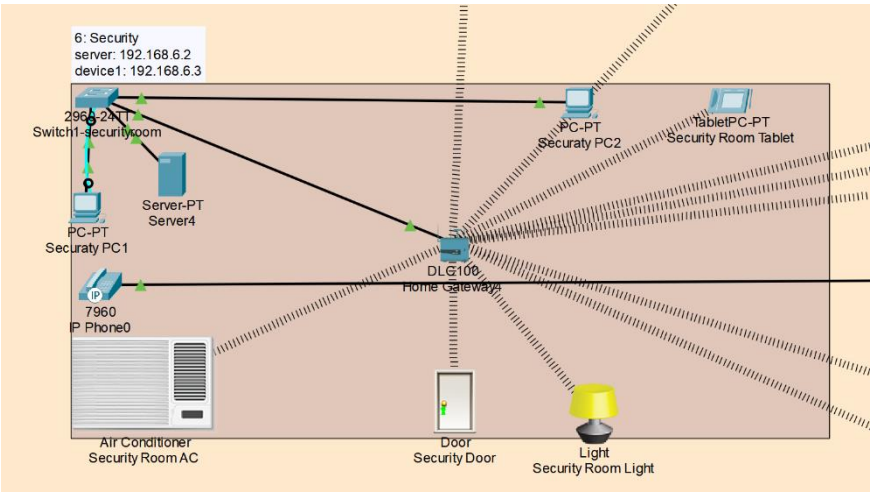

Figure 26. Security Room Home Gateway

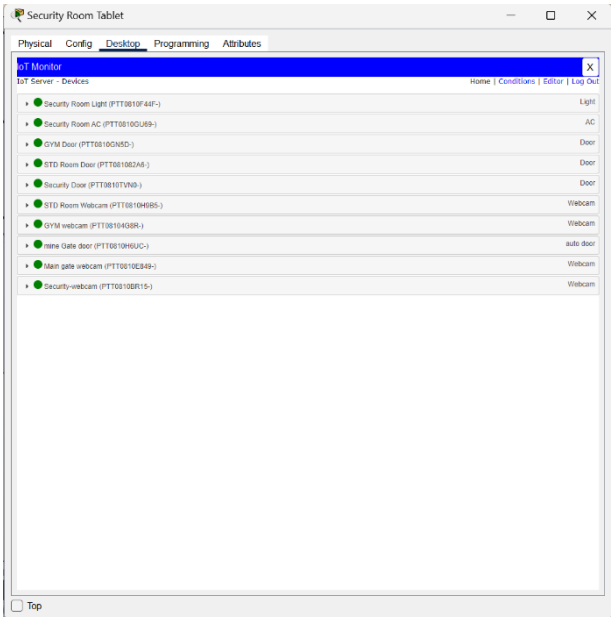

Figure 27. Security Room Tablet IoT Monitor

3.5 IP PHONES

Enhancing communication between students and staff is important for encouraging a positive and productive life environment. We included IP Phones in the students' rooms and in the security room. The main reason is to encourage communication and collaboration among students. Moreover, students can easily contact the security room in case of an emergency.

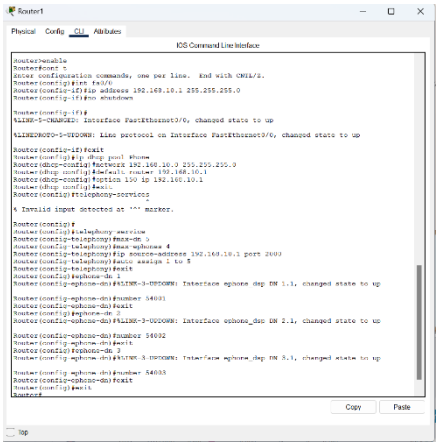

Figure 28. IP Phone Router Configuration

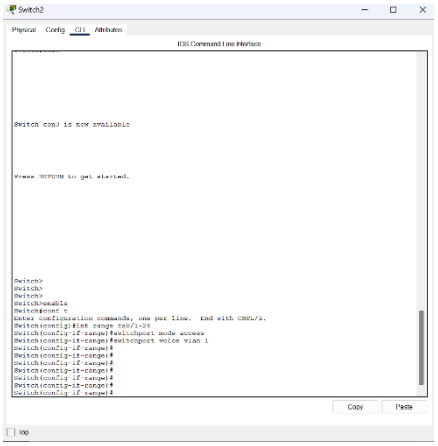

Figure 29. IP Phone Switch Configuration

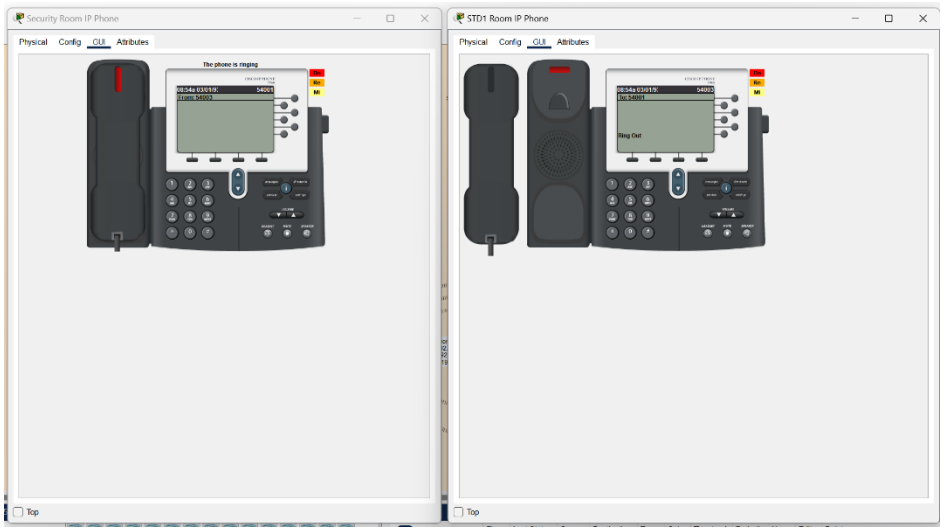

Figure 30. Configured IP Phones

3.6 IoT DEVICES

3.6.1 “Thing” IoT Devices

We used the thing to create a new IoT device in the Cisco Packet Tracer. The first one is a curtain in Figure 31. We place it in students' rooms so they can control it remotely using their smartphones. The second one is an automatic sliding door in Figure 32. We set it as the main gate to the department; once a motion is detected, the door will open, and the camera will start filming those entering. Thirdly, streetlamps in the parking in Figure 33, turn on when motion is detected nearby. The last one is the floor sprinkler in Figure 34. Its functionality is similar to the ceiling fire sprinkler, but it’s on the floor rather than a ceiling; once the fire is detected in the parking lot, the floor fire sprinkler will turn on.

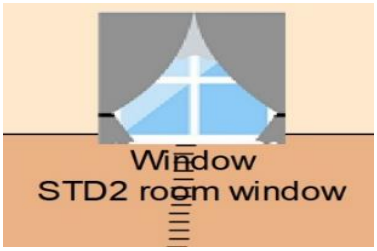

Figure 31. Smart Curtains

Figure 32. Automatic Sliding Door

Figure 33. Smart Street Lamp

Figure 34. Smart Floor Sprinkler

3.6.2 Other IoT Devices

We have implemented many IoT devices in our network, such as Coffee maker, AC, lamp, webcam, door, Humidifier, portable music player with Bluetooth speaker, windows with wind Detector, Fire monitor, cars, and lastly, lawn sprinklers with water level monitor in the parking. All the IoT devices are established to serve our goal, which is to provide an effective, safe, and flexible environment for the students.

Protection Measures in The Network:

- **Student Room 1:**

We used 3 password protection on the **Switch**:

1- privilege mode password: “room1”

2- Virtual terminal interface password: “student1”

3- Console interface password: “student1”

- **Student Room 2:**

We used 3 password protection on the **Switch**:

1- privilege mode password: “room2”

2- Virtual terminal interface password: “student2”

3- Console interface password: “student2”

- **Studying Room:**

We used 3 password protection on the **Router**:

1- privilege mode password: "STDRoom"

2- Virtual terminal interface password: " IAU"

3- Console interface password: "IAU "

We used 2 password protection on the **Switch**:

1- privilege mode password: "STD Room".

2- Virtual terminal interface password: "IAU".

- **Security Room:**

We used 3 password protection on the **Switch**:

1- privilege mode password: "SEC1243"

2- Virtual terminal interface password: "SEC4 "

3- Console interface password: "SEC3"

- **Parking:**

We used 2 password protection on the **Switch**:

1-privilege mode password: “cars”

2- Virtual terminal interface password: “fire”

4. RESULTS AND DISCUSSION

We have created a network that serves all students, facilitating access control of most needs, and communication, and introducing the Internet of Things to the network has enhanced the services provided.

4.1 VERIFY THE CONNECTION

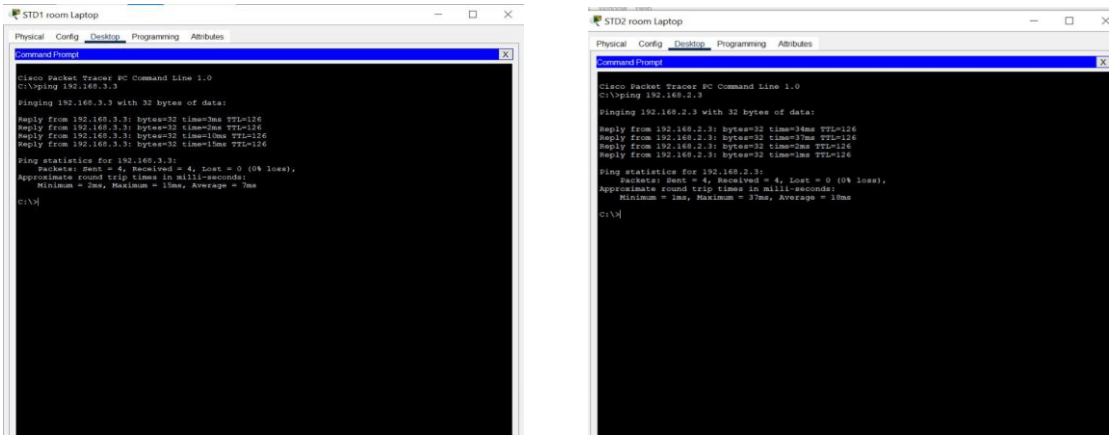

Figure 35 Ping Between STD1 Room Laptop and STD2 Room Laptop

Figure 35. Ping Between Study Room Devices

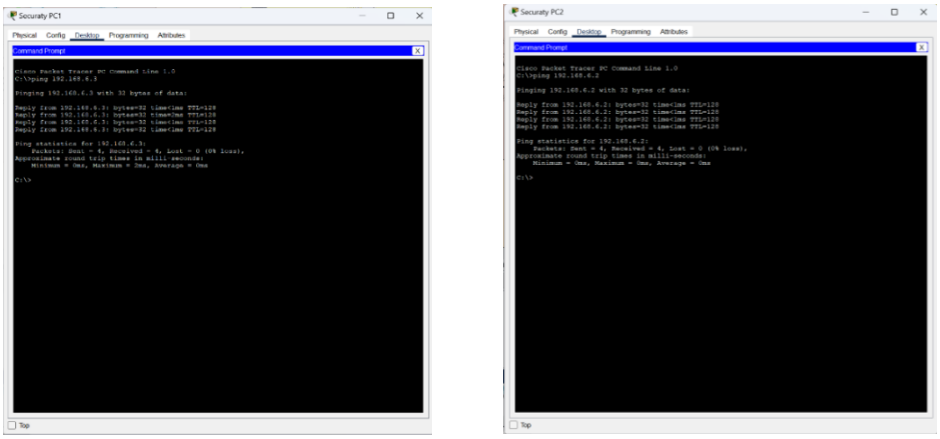

Figure 37. Ping Between Security PC1 and Security PC2

5. FUTURE WORK

Our project aspires to develop in many aspects in the future ،and one of the most important developments we seek to achieve is improving the efficiency of connectivity between the devices in our network, in addition to facilitating connections between the devices in our student housing network by adding more distinctive technologies. To elaborate, we aspire to improve our network by adding an extra security network system and smart fire system inside the building in addition to a smart clinic room network and small smart supermarket network.

6. CONCLUSION

In this report, a student housing network design was implemented using a Cisco Packet Tracer to enhance students' lives and serve their needs. Moreover, the network design used wired and wireless topology and contained the most critical concepts, such as DHCP, Email, VLANs, and VoIP. Lastly, the network model has different LANs: smart student room, smart studying room, smart gym, smart security room, smart parking, and smart garden.

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8. APPENDIX

Device	Interface	IP address	Subnet Mask	Default Gateway
STD1 router	**F0/0**	**192.168.2.1**	**255.255.255.0**	**N/A**
	Ser0/0/0	**10.1.1.1**	**255.255.255.252**	**N/A**
STD1 room Server	**F0/0**	**192.168.2.2**	**255.255.255.0**	**192.168.2.1**
STD1 room Laptop	**NIC**	**192.168.2.3**	**255.255.255.0**	**192.168.2.1**
STD2 router	**F0/0**	**192.168.3.1**	**255.255.255.0**	**N/A**
	Ser0/1/0	**10.1.1.2**	**255.255.255.252**	**N/A**
STD2 room Server	**F0/0**	**192.168.3.2**	**255.255.255.0**	**192.168.3.1**
STD2 room Laptop	**NIC**	**192.168.3.3**	**255.255.255.0**	**192.168.3.1**
STD Room Router	**G0/0**	**192.168.4.1**	**255.255.255.0**	**N/A**
STD Room Server	**NIC**	**192.168.4.2**	**255.255.255.0**	**192.168.4.1**
Laptop Admin	**NIC**	**192.168.4.3**	**255.255.255.0**	**192.168.4.1**
STD Room PC1	**NIC**	**192.168.4.4**	**255.255.255.0**	**192.168.4.1**
STD Room PC2	**NIC**	**192.168.4.5**	**255.255.255.0**	**192.168.4.1**
STD Room PC3	**NIC**	**192.168.4.6**	**255.255.255.0**	**192.168.4.1**
STD Room PC4	**NIC**	**192.168.4.7**	**255.255.255.0**	**192.168.4.1**
STD Room Printer1	**NIC**	**192.168.4.8**	**255.255.255.0**	**192.168.4.1**
STD Room Printer2	**NIC**	**192.168.4.9**	**255.255.255.0**	**192.168.4.1**
Garden Server	**NIC**	**192.168.7.2**	**255.255.255.0**	**192.168.7.1**
Garden laptop	**NIC**	**192.168.7.3**	**255.255.255.0**	**192.168.7.1**

Table 2. Addressing Table