

# Design And Implementation Of A Smart Office Network Module Using Visual Simulation Tool

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## *Abstract*

The modern era demands greater speed, efficiency, and quality in every aspect of life. Smart technologies, particularly the Internet of Things (IoT), have revolutionized the way people live and work. In this research paper, we explore the implementation of smart office technology, which includes connectivity and collaboration solutions, to enhance the productivity and safety of employees. For instance, smart parking systems enable employees to plan their commutes ahead of time, while smart meeting room solutions facilitate the selection of the most suitable meeting room for a team based on specific criteria. Furthermore, we discuss the use of IoT devices to limit natural pollution and adopt renewable energy in the office, such as air, sun, and rainwater harvesting. We also consider the implementation of a firewall in our server to ensure the security of our smart office network. By combining these smart concepts and systems, we can create a more efficient, secure, and eco-friendly workplace.

Keywords—Smart Office, Packet Tracer, Detection, Server, IoT.

## **Introduction**

The integration of technology in the workplace has significantly enhanced productivity and employee satisfaction. Smart offices incorporate various technologies that allow employees to control and manage their workspace, including lighting, temperature, and even the ability to book

meeting rooms [5]. This not only boosts employee morale but also increases work efficiency and creates a more dynamic workplace environment [7].

Moreover, smart offices can also benefit businesses by reducing energy consumption and operating costs. For instance, a smart lighting system that automatically turns off when no one is present in the room can save a significant amount of energy. Additionally, smart sensors that monitor temperature and air quality can help regulate HVAC systems, reducing the amount of energy needed to maintain a comfortable environment. Such energy-saving features can also positively impact a company's sustainability efforts, making smart offices a crucial component of green initiatives.

In conclusion, smart offices are rapidly becoming the future of work, offering numerous benefits to both employees and employers. With advancements in technology and increased emphasis on employee wellbeing, smart offices can revolutionize the traditional workplace, creating a dynamic and efficient workspace that is tailored to meet the needs of its users.

### **Problem Statement**

The usage of gas and oil to generate electricity in buildings has a negative impact on the environment, such as: Climate Change, Air Pollution, Water Pollution and Habitat Destruction. Not only that, but it is expected in the next few years that the world's oil reserves will run out in the following few decades [9, 10]. To solve these problems in our country we can switch to renewable energy sources like wind and solar system. Although initially, they are more expensive, renewable energy sources end up being less expensive in the long run and offer a safe and secure energy source in the building.

Security problems are there in each and every building. Imagine an office with no safety devices to warn all employees about a fire or a smoke, this may cause an increase in death due to the delay in warning them. To solve this issue, we can implement an IoT solution to react to any fire and smoke as soon as they occur. In all buildings and offices there are air conditioners and refrigerators, and these devices can leak water. If attention is not paid to the presence of a water leak, it may touch the electric current, which leads to an electrical short circuit. To solve this problem, a water detector must be present to detect the presence of water and alert everyone in the area about it. Moreover, most of the time employees and customers face difficulties finding a parking space or there is not enough parking space in the offices which will cause them to be late. Not only in office buildings, but also on college campuses. A student survey of 2,000 students was done in the US and 84% of students agreed that the car parks are not professionally managed [11]. To prevent this from happening, we will need to implement a smart parking system in the office. The security of all the sensitive data about the company itself,



## B. Home Gateway

The home gateway device in Cisco Packet Tracer is the component that connects most IoT devices. It is also used to connect IoT devices with the servers and routers.

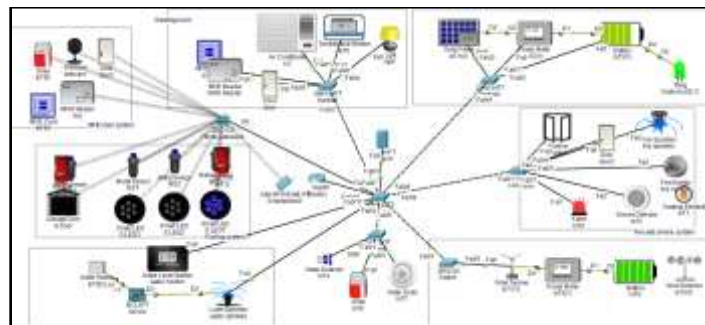
It is crucial that all devices' SSID's and IoT server are under 'Home Gateway' to enable all connections. Following that, the IoT components can be accessed through a smart phone connected to the home gateway itself [13].

**Figure 3. Home Gateway devices accessed from Smart Phone**



## Implementation

**Figure 4. Smart Office Network Module Implementation**



### A. Router and Server Configurations

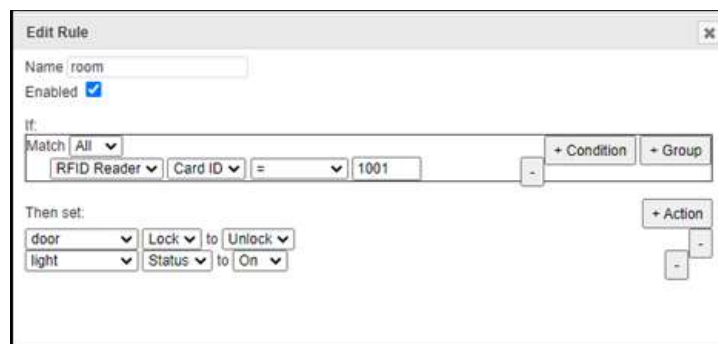
To connect all the IOT devices together we are going to configure some network devices such as router and server. First assigning the IP address and the DHCP pool IoT IP on the router:

```
Router>enable
Router#conf t
Router(config)#hostname OfficeRouter
OfficeRouter(config)#int GigabitEthernet0/0
```

```
OfficeRouter(config-if)#ip add 192.168.10.1 255.255.255.0
OfficeRouter(config-if)#no sh
OfficeRouter(config-if)#
OfficeRouter(config-if)#exit
OfficeRouter(config)#ip dhcp pool iot
OfficeRouter(dhcp-config)#network 192.168.10.1 255.255.255.0
OfficeRouter(dhcp-config)#exit
OfficeRouter(config)#exit
```

The server must be configured too. To connect all the devices to the server, first assign an IP address to the server and link the devices to it. Then we can view all the devices in the server so that we can make conditions for them to make them work automatically. We can add, delete and make as many conditions as we want with the connected devices.

**Figure 5. Editing the Rules**



**Figure 6. The Conditions in a Server**

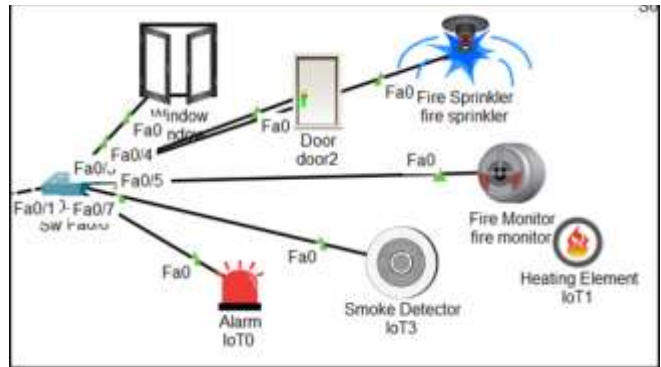
The screenshot shows a web interface titled 'IoT Monitor' for an 'IoT Server - Device Conditions'. It features a table with columns for 'Actions', 'Enabled', 'Name', 'Condition', and 'Actions'. Below the table is an 'Add' button.

Actions	Enabled	Name	Condition	Actions
<input type="button" value="Edit"/> <input type="button" value="Remove"/>	Yes	room	PTT0810DNMO- Card ID = 1001	Set PTT0810E9AT- Lock to 0 Set PTT08104HX3- Status to 2
<input type="button" value="Edit"/> <input type="button" value="Remove"/>	Yes	o room	PTT0810DNMO- Card ID != 1001	Set PTT0810E9AT- Lock to 1 Set PTT08104HX3- Status to 0
<input type="button" value="Edit"/> <input type="button" value="Remove"/>	Yes	fair	PTT0810IM41- Fire Detected is true	Set PTT08103267- Status to 1 Set PTT08101351- Lock to 0 Set PTT0810638L- On to 1
<input type="button" value="Edit"/> <input type="button" value="Remove"/>	Yes	ac	Match all: • PTT0810DNMO- Card ID = 1001 • PTT0810A3JR- Temperature >= 20	Set PTT081003VG- On to 1
<input type="button" value="Edit"/> <input type="button" value="Remove"/>	Yes	ac2	Match all: • PTT0810DNMO- Card ID = 1001 • PTT0810A3JR- Temperature <= 19	Set PTT081003VG- On to 0

**B. Safety Systems**

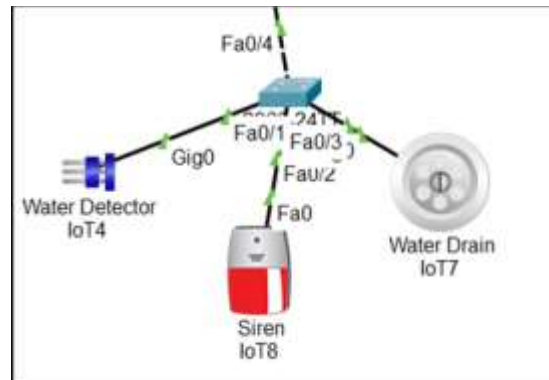
In every plan and building, every official must be concerned about safety and consider it among the strongest plans. If a fire occurs, the alarm, doors and windows will open, and the fire sprinkler will reduce the fire. If any smoke occurs in the office or in the company's parking lot, the smoke detector will work by sending a notification via the server, which will make the alarm system work to alert people to exit the building, then all windows and doors will open in that area.

**Figure 7. Emergency System**



Imagine having a water leakage in the workplace, if you do not have this system the water might touch the wires and cause an electric shock which may lead to a fire. This system will work as follows: First the water explorer will explore water and then send a notification to the turbine, which will work to dry the water. At the same time, the siren will work to warn the employees of water leakage in that area.

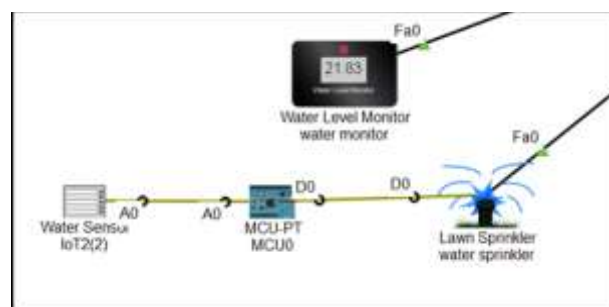
**Figure 8. Water Leakage System**



### C. Renewable Energy Sources Systems

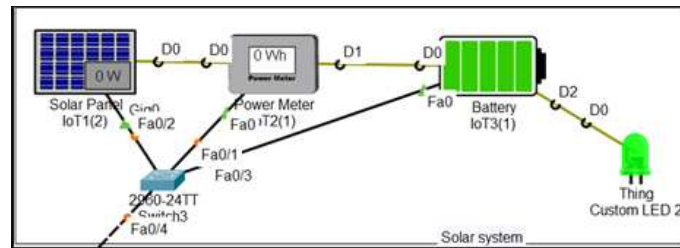
Rainwater harvesting system will benefit from the rainwater for human use. When it rains, water will be collected in tanks. As the water reaches a certain level, the water sensor is strategically placed to sense it. The MCU is programmed to turn on the lawn sprinkler when the amount of water detected is greater than or equal to 5cm. When the lawn sprinkler is turned on, the water level monitor will measure the amount of water that has been released and send a report to the registration server and control the lawn sprinkler remotely.

**Figure 9. Rainwater Harvesting System**

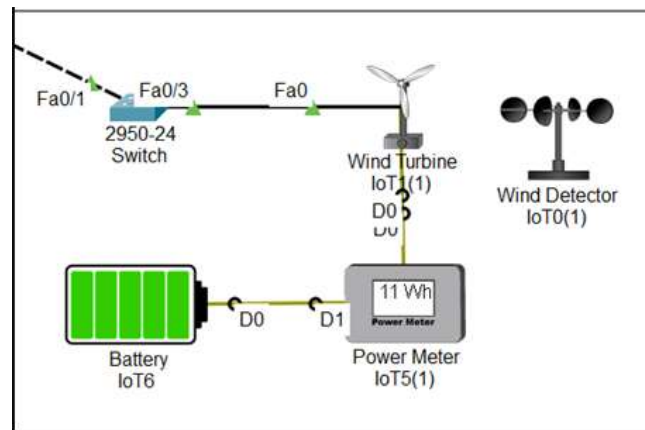


Using solar panels and wind turbines, electricity can be generated for the lights, microwave, AC, and all other devices. The sun charges the solar panel, then sends electricity to the battery. This electricity is read by the power meter connected between them. At the end, the battery distributes power to each connected device. On the other hand, Wind Turbine generates power as long as there is wind in the environment. The battery is charged by the turbine when it produces power.

**Figure 10. Solar System**



**Figure 11. Wind System**



#### D. Security Implementation

Surely, turning an office into a smart office may seem efficient and beneficial for the long run but it is important to implement some security systems to ensure that the smart office module is only accessed by authorized employees and admins. Furthermore, it protects the company's and employees' data from exploitation.

The implementation of a security system in a smart office network is crucial for enhancing security and protecting against potential cyber threats. A firewall is a network security system that monitors and controls incoming and outgoing traffic based on predefined security rules [1],[14]. By analyzing network traffic and blocking unauthorized access, a firewall can prevent malicious attacks, unauthorized access to sensitive data, and other security breaches.

The first step is to enable the firewall service in the server (Server0). After that, is adding the allow action using the IP protocol to allow all IP addresses to access the server. Next was adding the deny action using the ICMP protocol to deny all unauthorized IP addresses to access the smart office components [12].

**Figure 12. Firewall Configuration in Server0**

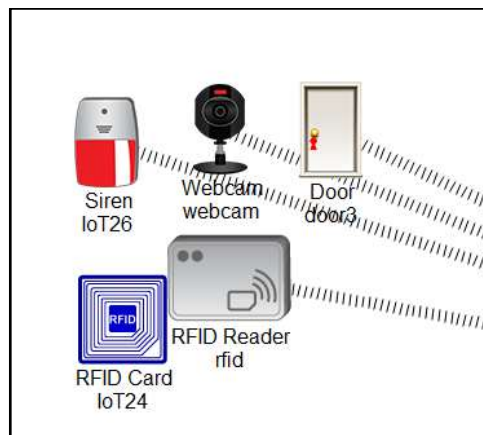




Another important aspect of implementing a firewall in the smart office network module is to regularly update and patch the firewall software to ensure that it is capable of detecting and blocking new threats. It is also to monitor the firewall logs to identify any potential security incidents and take appropriate action.

The next system implemented is the Identity system. The card and the camera will verify the identity of the employee. If the card does not work, then the door will stay locked, and the siren will be triggered. This process helps in improving the environment of the place in terms of confidentiality. We implemented these systems in rooms that hold confidential customer and employee information, work files, services, future plans for the office and business strategies. Adding that, these functions are part from implements the information security triad which are confidentiality, availability and integrity.

**Figure 13. Identity Security System**

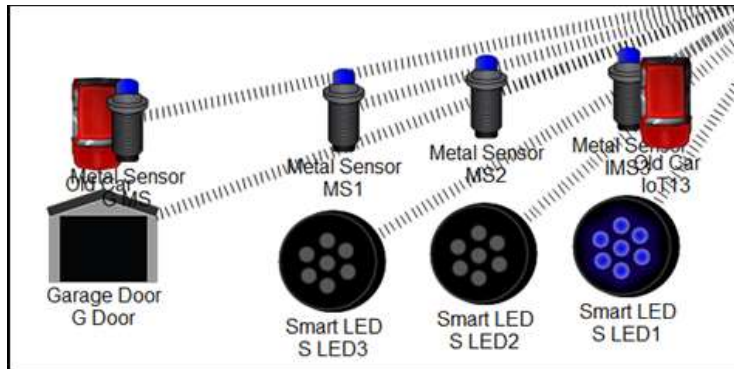


#### E. Parking System and Meeting Rooms

Implementing a smart car park for the office to overcome the parking problems. When the car arrives the metal sensor is going to detect the metal from the car and the garage will open immediately. Then the car is going to choose a parking the metal detector will detect the car and the LED light will open, so whenever the next car enters the parking's will

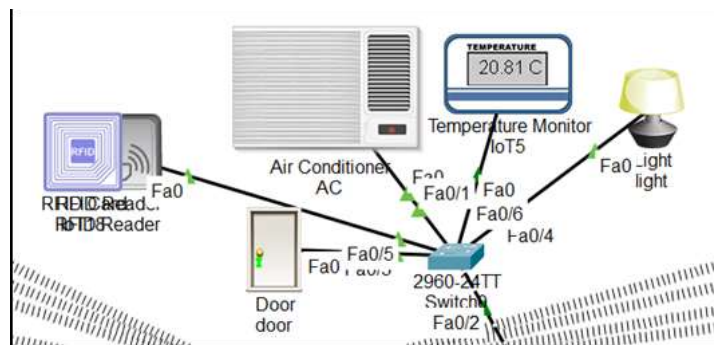
check for the lights to see if it is on that mean there is a car there if off then no car is there.

**Figure 14. Parking System**



Each and every office is going to have a meeting room, we can use IOT to make this room smart and make the employees' life easier. Whenever the person who is going to prepare the meeting room is going to swipe his card if he is a valid person or his card is valid then the door and light are going to open. For the AC first, it is going to check the temperature if it is  $\geq 20$  then the AC is going to open, if  $\leq 19$  then the Ac will not open.

**Figure 15. Meeting Room System**



**Project Outcomes and Recommendations**

Cisco Packet Tracer is a multi-platform visual simulation tool created by Cisco Systems. It enables users to build network topologies and replicate contemporary computer networks. This simulation program undoubtedly guides students in developing competencies such as critical thinking, decision making, and problem solving. By using natural resources to generate electricity, it can reduce future electricity bills by 40% and helps in implementing a smart yet green office. Going forward, we can expand the usage of renewable energy to smart schools, malls, as well as streetlights, speed radars. With the use of rainwater harvesting techniques, we will overcome the problem of water scarcity, which may occur after a few years. In the long run, rainwater harvesting can also be

for daily use after filtering the rainwater. Implementing a smart parking system will help in reducing the parking problems existing in almost every office. This smart parking system can be later implemented in each building, traditional markets and more crowded areas in Oman. Also, the existence of Fire and smoke system will help in It gives workers a sense of security at work. Moreover, adding all those smart concepts and systems in our smart office network module will trigger the need for security. Implementing a security system in our server came in handy as it filters out any unwanted network traffic and allows only authorized users within our network.

### **Conclusion**

In conclusion, the design and implementation of a smart office network module using a visual simulation tool is an innovative approach to optimizing office operations. The visual simulation tool provides a platform for testing and analyzing the efficiency of different network configurations, allowing for the identification and resolution of potential issues before actual deployment. Through the incorporation of various smart technologies, such as IoT devices and automation systems, the module can enhance workplace productivity, safety, and energy efficiency. This research paper has highlighted the key components of the smart office network module, including its architecture, hardware and software requirements, and testing methodology. Overall, this study presents a promising solution for creating a more intelligent and interconnected office environment.

Looking forward to the future, implementation of a smart office network module can serve as a starting point for the development of smart campus. By leveraging the same techniques and principles comma universities and other educational institutions can enhance campus safety comma improve energy efficiency comma and create a more connecting and collaborative learning environment.

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