HARAMAYA UNIVERSITY

HARAMAYA INSTITUTE OF TECHNOLOGY

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

STUDENT DORMITORY SMOKE AND FIRE DETECTING SYSTEM

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INTRODUCTION

- This thesis presents the design and implementation of a comprehensive smoke and fire detection system tailored for student dormitories, utilizing Cisco Packet Tracer IoT technology.

- By leveraging IoT technology, this innovative approach aims to mitigate potential fire risks and ensure the emergency responses thereby fostering a safer and more secure living space for dormitory residents.

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Background

- Traditional fire detection systems often rely on manual monitoring and individual alarms, which may not provide timely or comprehensive alerts.

- IoT with regard to fire safety and suppression systems can aid in a lot of different areas for the protection of property and individuals within the buildings.

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Problem Statement

The need for an integrated system that can offer

- Real-time alerts
- Remote monitoring
- Centralized control
- Fast detection
- Fast response during fire incidents

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Objectives

General objective

- reducing the risk of fire-related accidents
- safeguarding the well-being of dormitory occupants.

Specific objective

- Analyze causes and patterns of fire incidents in student dormitories
- Design a comprehensive smoke and fire detection system specifically for student dormitories.

Scope of the project

- This system enables real-time monitoring and control through smartphones and switches, aiming to enhance safety and responsiveness to fire emergencies.

- It involves the strategic installation of IoT-enabled smoke and fire detectors throughout dormitory buildings, which are connected to a centralized management system via a home gateway.

Significance of the study

- It provide a practical solution that can be easily implemented and maintained
- A cost-effective and efficient smoke and fire detecting system
- enhance safety with providing faster detection and response times.
- reducing potential damages and saving lives

Overview of IOT

- **IoT**, or the Internet of Things, refers to the **network** of **physical objects** or "things" **embedded** with **sensors**, software, and other technologies that enable them to connect and exchange data with other devices andsystems over the internet.

- **IoT** in the student dormitory smoke and fire detecting system refers to the integration of interconnected smart devices and sensors that enable ***real-time monitoring***, ***alerting***, and ***automated response mechanisms*** to enhance safety and security within dormitory premises.

METHOD AND DESIGN

System Requirment

Functional Requirements

- ❑ Detect smoke and fire accurately and promptly.
- ❑ Trigger alarms and notifications to alert residents and
- ❑ Activate fire suppression systems like sprinklers authorities.

Non-Functional Requirements

- ❑ Ensure system reliability and low false alarm rates.
- ❑ Maintain high availability and fault tolerance.
- ❑ Ensure data security and privacy.

System design

Use case diagram

A visual representation of the system's key features and the roles played by the administrator in managing various aspects of dormitory operations is shown by the use case diagram.

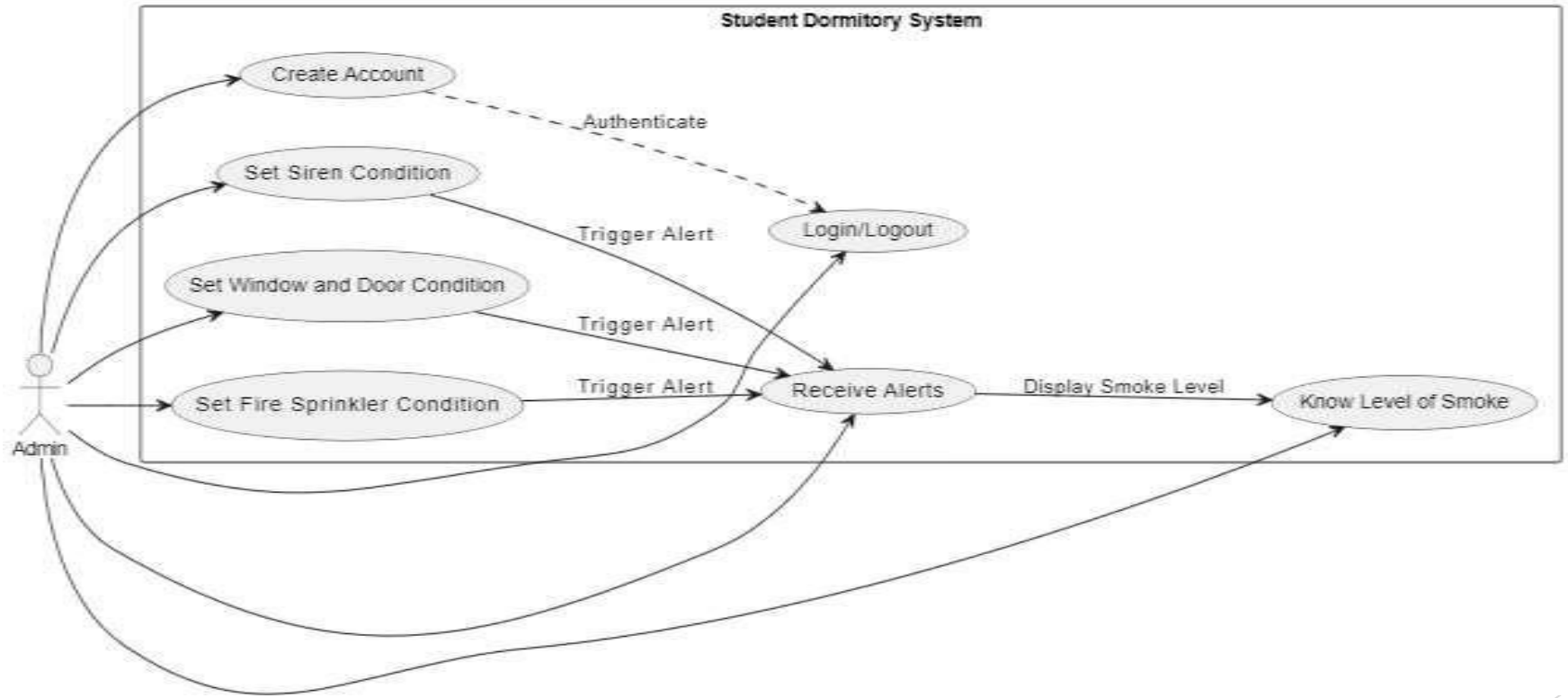

Fig: use case diagram of the system

Sequence diagram

Interactions between the admin(actor and system) various tasks such as account management, system configuration, receiving alerts, and accessing information about the dormitory environment.

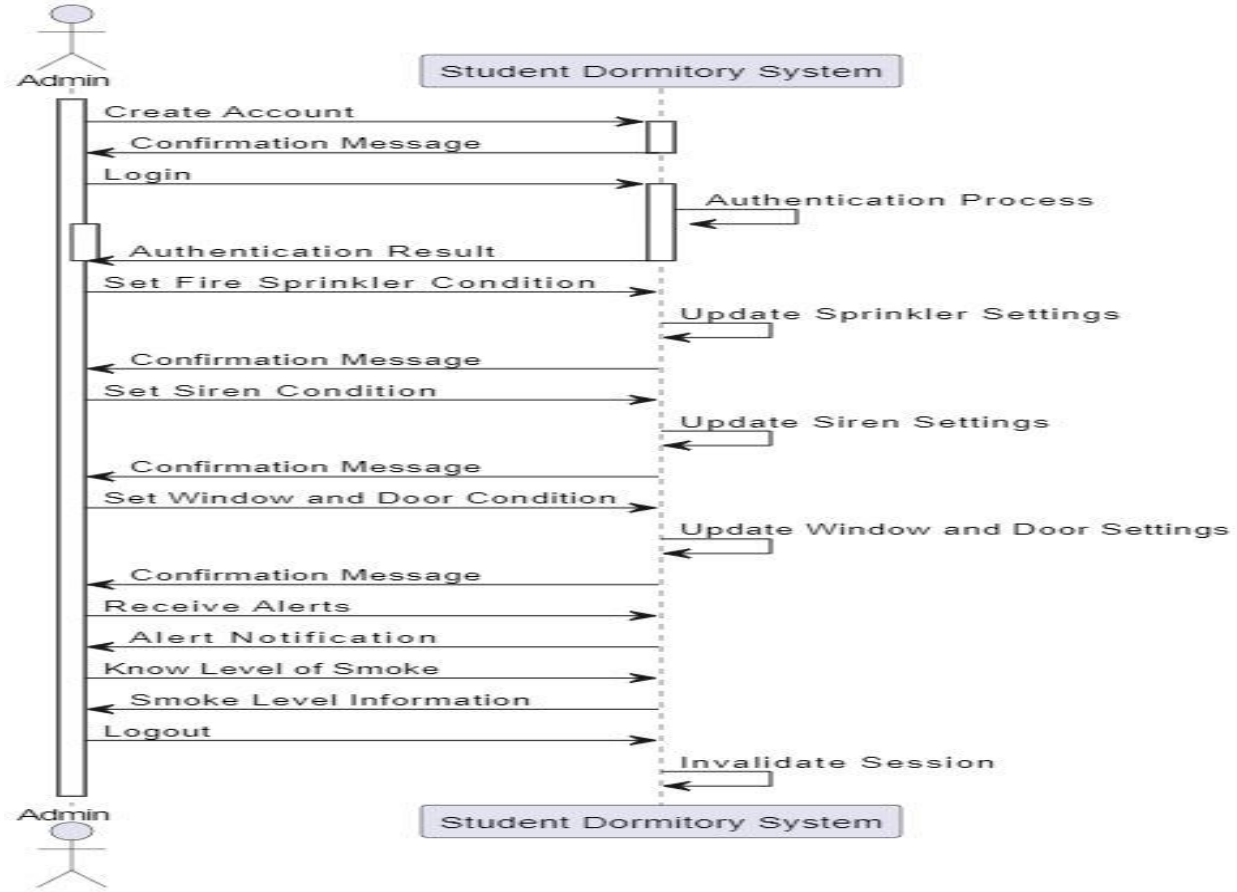

Fig:sequence diagram of the system

Components and Devices

Smoke Detectors: IoT-enabled devices that detect smoke levels.

Fire Detectors: IoT-enabled devices that detect heat and flames.

Home Gateway: Central hub for processing data and managing communication

Smartphones: Connect to the system by going to the web browser and entering the IP of the registration server and logging in using ID and Password

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Switches: Network switches for device connectivity.

Sirens: IoT-enabled audible alarm devices.

Fire Sprinklers: IoT-enabled devices that activate upon fire detection.

Smart Doors and Windows: IoT-enabled devices for evacuation assistance.

Overall System Architecture.

- **Detection Layer:** Comprises smoke and fire detectors placed in each dormitory block.
- **Communication Layer:** Uses wired and wireless communication protocols to transmit data to the home gateway.
- **Control Layer:** The home gateway processes the data and manages the system's overall operation.
- **Response Layer:** Includes devices like sprinklers, sirens, and smart doors/windows that act based on the gateways commands

Data Flow and Processing

Upon detecting smoke or fire, the gateway processes the information and triggers appropriate responses:

- Activating fire sprinklers and sounding sirens.
- Unlocking and opening smart doors and windows for evacuation.

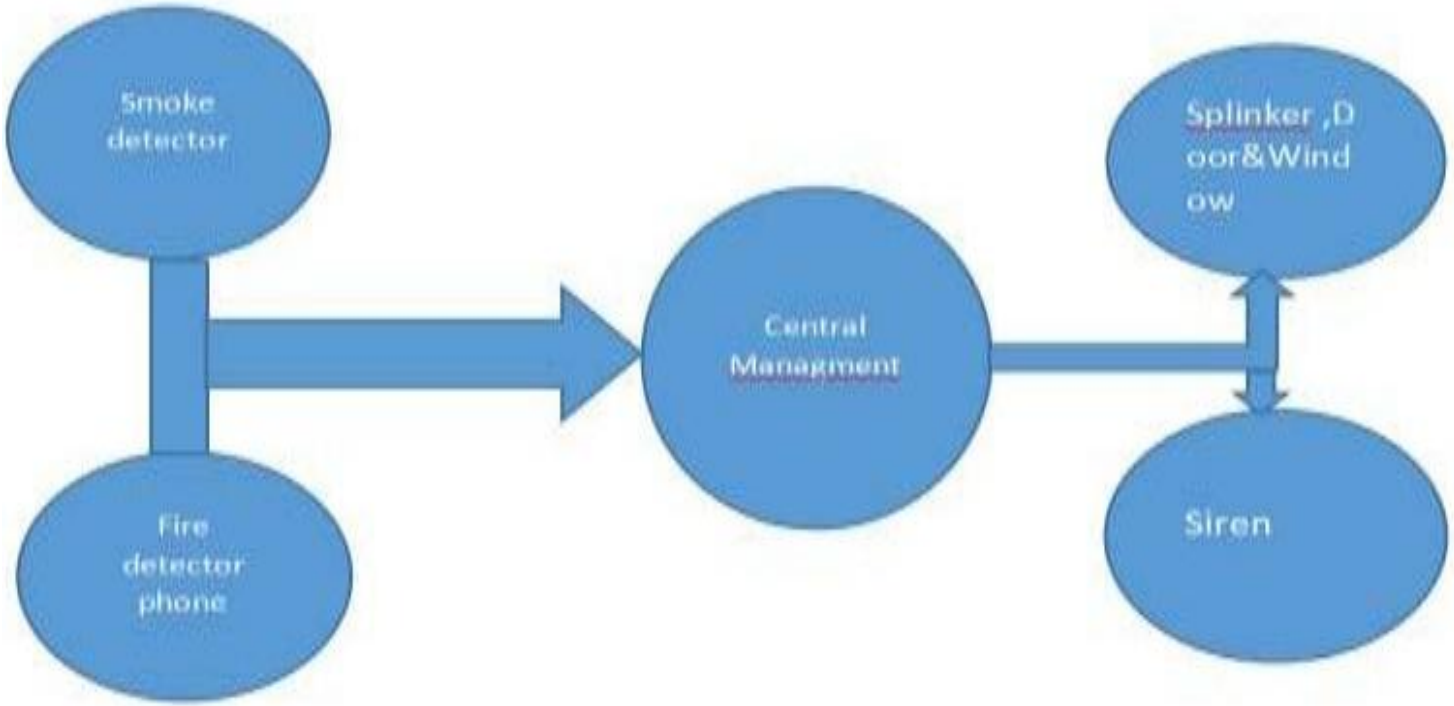

Fig:data flow and processing

IMPLEMENTATION

We used Cisco packet Tracer to implement the system because it is a powerful network simulation tool that allows for the **design**, **visualization**, and **analysis** of network systems, including **IoT devices**.

Connecting and Configuring Smoke and Fire Detectors

1. **Place Detectors**: Position smoke and fire detectors in each dormitory block.
2. **Connect to Gateway via switch**: Connect detectors to the Home Gateway via Wi-Fi.
3. **Configure Detection Parameters**: Set detection thresholds and ensure detectors are calibrated correctly

Cont…

Configuring Smart Devices and Actuators.

1. **Add Sirens and Sprinklers**: Position sirens and sprinklers throughout the dormitory.
2. **Configure Response Actions**: Program the sirens to sound and sprinklers to activate up on receiving fire or smoke alerts from the Home Gateway.
3. **Smart Doors and Windows**: Set up and configure to unlock and open automatically during emergencies.

Programming Notifications.

1. **Add Smartphones/Tablets:** Simulate smartphones using PC/Tablets.
2. **Connect to Gateway:** Ensure these devices are connected to the Home Gateway for receiving notifications.
3. **Notification Settings:** Program the Home Gateway to send alerts to these devices upon detection of fire or smoke.

Network Configuration.

IP Addressing and DHCP.

Assign IP Addresses: configure **Dynamic IP** addresses to critical devices like the Home Gateway, switches, and Smartphone.

DHCP Setup: Configure the Home Gateway to act as a **DHCP server** for dynamic IP addressing of other IoT devices.

Wireless Configuration.

Configure Wi-Fi: Set up **SSID** and security parameters for the wireless network.

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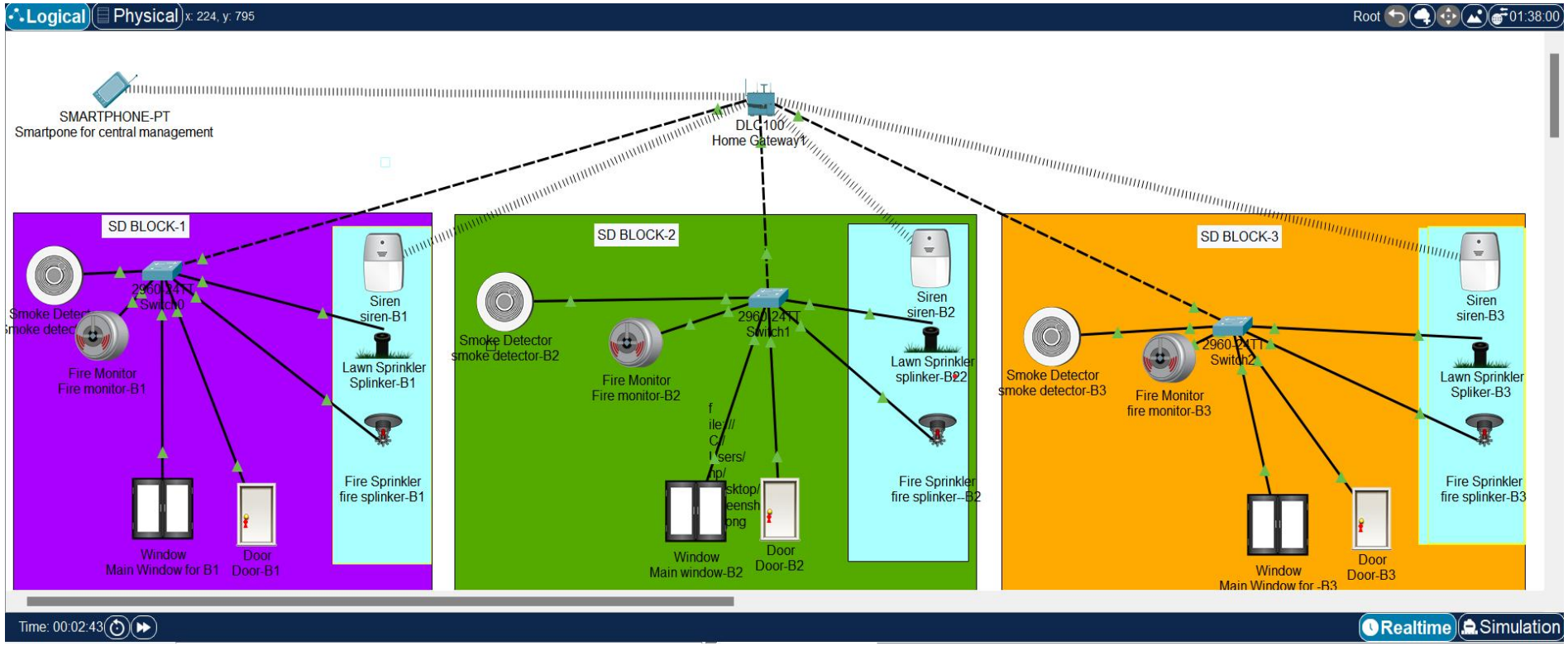
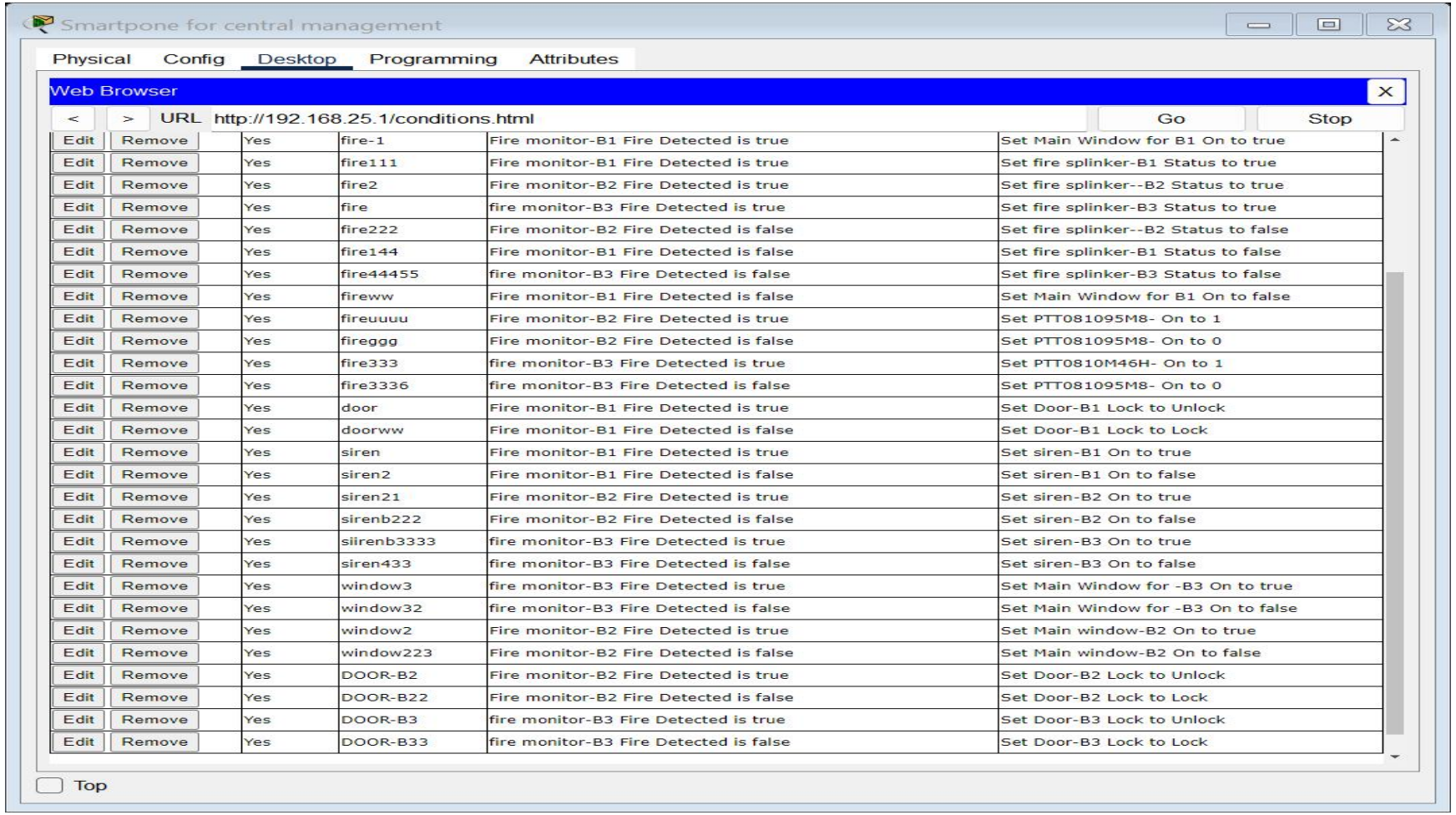


Fig : System Architectural Design

Simulation and test



Edit	Remove		Yes	fire-1	Fire monitor-B1 Fire Detected is true	Set Main Window for B1 On to true
Edit	Remove		Yes	fire111	Fire monitor-B1 Fire Detected is true	Set fire splinker-B1 Status to true
Edit	Remove		Yes	fire2	Fire monitor-B2 Fire Detected is true	Set fire splinker--B2 Status to true
Edit	Remove		Yes	fire	fire monitor-B3 Fire Detected is true	Set fire splinker-B3 Status to true
Edit	Remove		Yes	fire222	Fire monitor-B2 Fire Detected is false	Set fire splinker--B2 Status to false
Edit	Remove		Yes	fire144	Fire monitor-B1 Fire Detected is false	Set fire splinker-B1 Status to false
Edit	Remove		Yes	fire44455	fire monitor-B3 Fire Detected is false	Set fire splinker-B3 Status to false
Edit	Remove		Yes	fireww	Fire monitor-B1 Fire Detected is false	Set Main Window for B1 On to false
Edit	Remove		Yes	fireuuuu	Fire monitor-B2 Fire Detected is true	Set PTT081095M8- On to 1
Edit	Remove		Yes	fireggg	Fire monitor-B2 Fire Detected is false	Set PTT081095M8- On to 0
Edit	Remove		Yes	fire333	fire monitor-B3 Fire Detected is true	Set PTT0810M46H- On to 1
Edit	Remove		Yes	fire3336	fire monitor-B3 Fire Detected is false	Set PTT081095M8- On to 0
Edit	Remove		Yes	door	Fire monitor-B1 Fire Detected is true	Set Door-B1 Lock to Unlock
Edit	Remove		Yes	doorww	Fire monitor-B1 Fire Detected is false	Set Door-B1 Lock to Lock
Edit	Remove		Yes	siren	Fire monitor-B1 Fire Detected is true	Set siren-B1 On to true
Edit	Remove		Yes	siren2	Fire monitor-B1 Fire Detected is false	Set siren-B1 On to false
Edit	Remove		Yes	siren21	Fire monitor-B2 Fire Detected is true	Set siren-B2 On to true
Edit	Remove		Yes	sirenb222	Fire monitor-B2 Fire Detected is false	Set siren-B2 On to false
Edit	Remove		Yes	siirenb3333	fire monitor-B3 Fire Detected is true	Set siren-B3 On to true
Edit	Remove		Yes	siren433	fire monitor-B3 Fire Detected is false	Set siren-B3 On to false
Edit	Remove		Yes	window3	fire monitor-B3 Fire Detected is true	Set Main Window for -B3 On to true
Edit	Remove		Yes	window32	fire monitor-B3 Fire Detected is false	Set Main Window for -B3 On to false
Edit	Remove		Yes	window2	Fire monitor-B2 Fire Detected is true	Set Main window-B2 On to true
Edit	Remove		Yes	window223	Fire monitor-B2 Fire Detected is false	Set Main window-B2 On to false
Edit	Remove		Yes	DOOR-B2	Fire monitor-B2 Fire Detected is true	Set Door-B2 Lock to Unlock
Edit	Remove		Yes	DOOR-B22	Fire monitor-B2 Fire Detected is false	Set Door-B2 Lock to Lock
Edit	Remove		Yes	DOOR-B3	fire monitor-B3 Fire Detected is true	Set Door-B3 Lock to Unlock
Edit	Remove		Yes	DOOR-B33	fire monitor-B3 Fire Detected is false	Set Door-B3 Lock to Lock

Figure The setted Conditions

Cont…

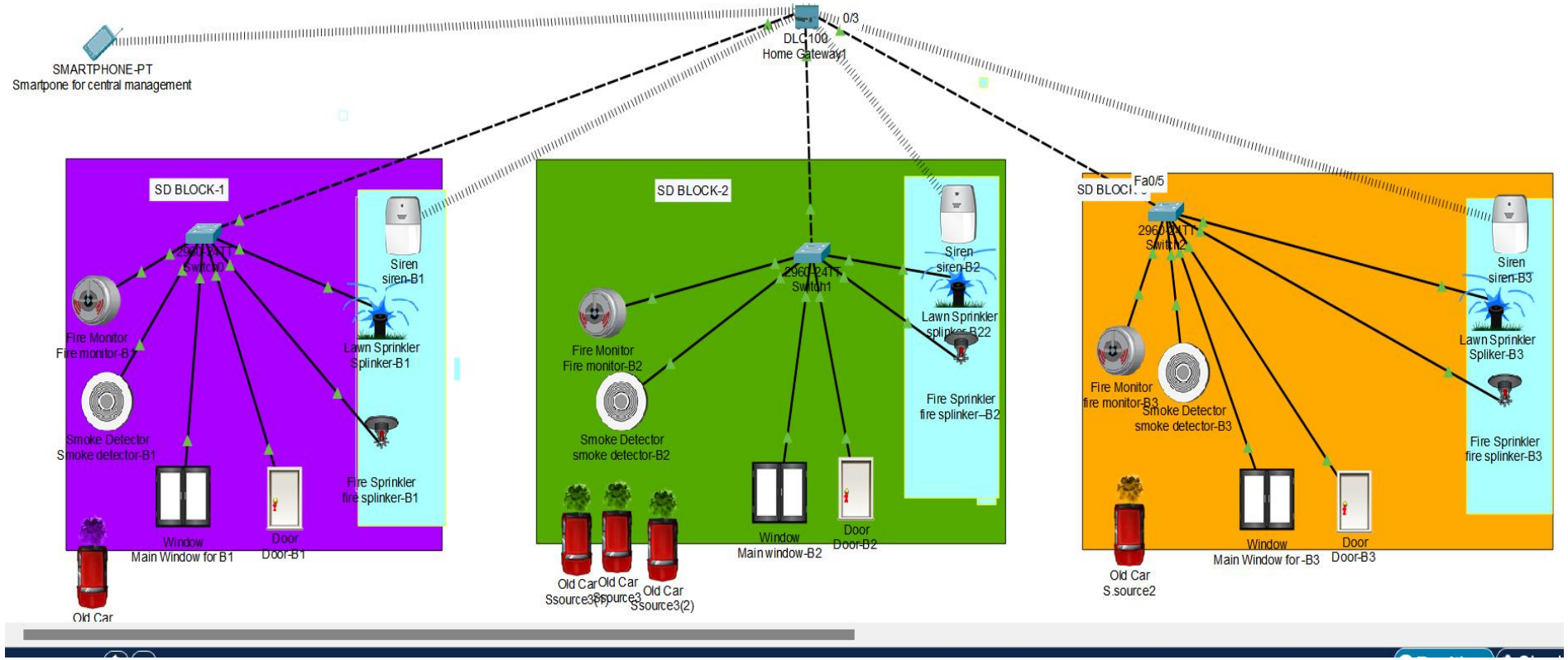


Figure : Smoke Detecting Test

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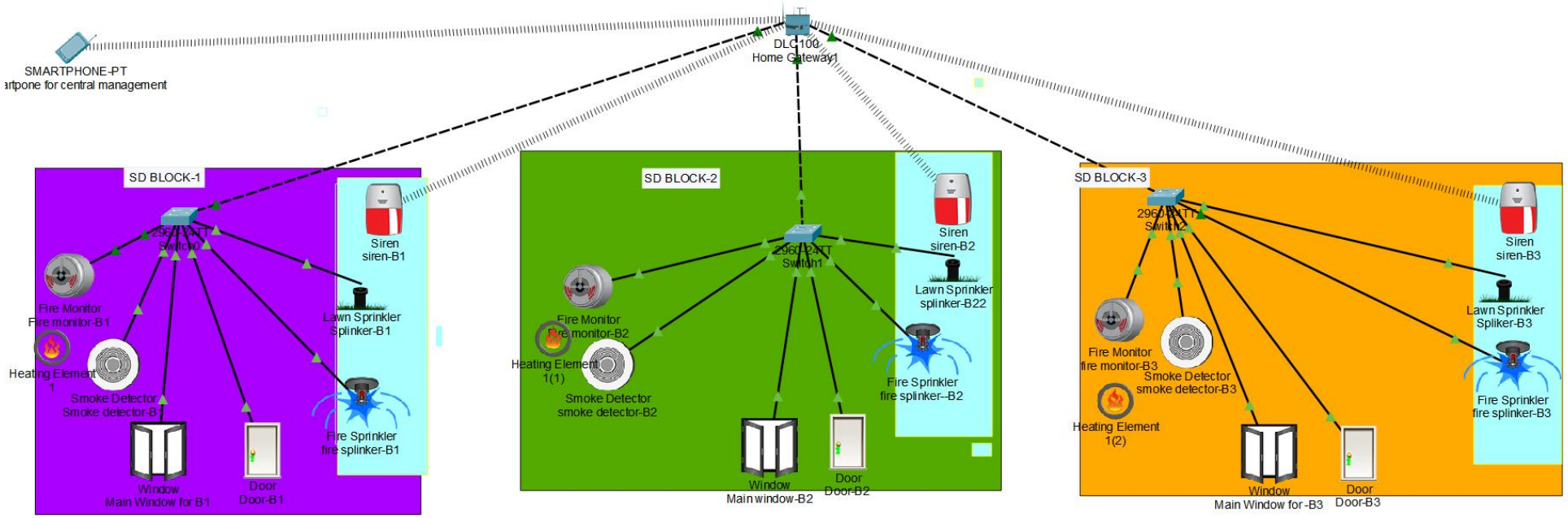

Figure : Fire Detecting Test

Performance Metrics

To evaluate the system's performance, we have used several key metrics:

1. **Detection Time:** The time taken for the system to detect smoke or fire from the moment it appears.
2. **Alert Time:** The time taken to send alerts to residents and emergency services once a threat is detected.
3. **Response Time:** The time taken for the system to activate safety measures such as sprinklers, unlocking smart doors, and opening smart windows.
4. **Accuracy:** The system's ability to correctly identify actual fire/smoke incidents versus false alarms.
5. **Reliability:** The consistency of the system's performance over time, measured by the frequency of system failures or malfunctions.

TESTING AND RESULT

Test Case no.	Test Case	Expected Output	Actual Output	Result
1	When Fire detector/monitor detects high signal heat/flame	Door open, window open ,fire sprinkler on, siren on.	Door open, window open, door open, sprinkler on, sirenon.	Pass
2	When fire detector/monitor detects low signal of heat/flame	Door close, window close, fire sprinkler off, siren off.	Door closed, window close,fire sprinkler off, siren off.	Pass

Limitations and Challenges.

- ❑ Initial Cost
- ❑ Maintenance Requirements
- ❑ False Alarms
- ❑ Integration Challenges

Conclusion

- This system represents a significant advancement in ensuring the safety and security of student dormitories.
- By integrating state-of-the-art technologies such as smart phones, home gateways, switches, fire sprinklers, smoke detectors, fire detectors, smart doors, smart windows, and sirens, this system offers comprehensive fire detection and alert capabilities.
- By empowering occupants with real-time alerts and facilitating timely evacuation, this system mitigates the risk of fire-related incidents and ensures the well-being of dormitory residents.

Recommendations

- Further mitigate false alarms
- Enhancing system efficiency and minimizing disruptions
- Exploring advanced integration techniques

Future Research

To accommodate the needs of larger or more complex dormitory environments.

To facilitate seamless integration with other smart building technologies

It needs continuous research and development of educational materials and training programs

THANK YOU