School of Computing

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Title of PROJECT	SMOKE DETECTION WITH FIRE PREVENTION
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Abstract

Environment has been deeply harmed by humans since a great deal of time, but with the technological advancements we can try and heal it. Detection of fire in homes is necessary to avoid destruction of property due to fire accidents both natural and induced. Detection of fire can prove to be very important as it could mean the difference between life and death. Fires can occur from anywhere and at any point of time, hence the presence of Fire Alarm System helps in keeping your family safe. An automatic smoke detecting system will notify the individual as well as take necessary actions in the home in order to prevent the fire from spreading. It will help in detecting fire or smoke at an early stage and can help in saving lives. In our proposed system we are making use of Internet of Things as the technology and though a smoke sensor we will notify various home equipments to take appropriate actions in order to stop the fire from spreading. The system is beneficial as it not just buzzes an alarm but also alerts the home appliances to do as they are needed.

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Chapter 1
Analysis

1. Analysis (Objective)

1.1. Motivation

Fire is very deadly and it leads to loss of human life and property. Fire detection systems are necessary to reduce the destruction of personal belongings and caused by fire both man made and induced. One of the most destructive properties of fire is that it spreads exponentially and with the right medium can spread uncontrollably. This is why timely detection of fire is necessary for avoiding a fire hazard. The Internet of Things is a collection of sensor, actuators, software, electronics embedded with home appliances, physical devices and vehicles which connect with each other to connect and exchange date which helps in increasing the efficiency of everyday appliances using computer-based systems.

1.2. Problem Definition

Fires cause serious damage and disrupts daily life in a devastating manner. Hence preventing them or reducing their effects is a top priority. Though there are many systems that have been created to tackle this problem, false alarms area challenge that is yet to be avoided. Our model, using smoke sensors alerts all the home appliances so that they can take their appropriate actions. The appliances that will be alerted are doors, windows, sprinklers, garage doors etc.

1.3. Scope

Our model, consisting of the smoke sensor has been conditioned to a limit of 0.5; which implies that if the smoke level detected by the sensor reaches more than the level set, appropriate actions will be taken. This can be changes according to the desire of the individual, situation or surroundings. Furthermore, there are a limited set of appliances that are prompted by the smoke sensor; which can be changed. Windows, doors and garage doors open when the smoke level exceeds the given level. The sprinklers too start spraying water inorder to prevent the spread of fire in the household.

CHAPTER TWO
LITERATURE REVIEW

From the beginning of recorded history people have learned that early response to fires had positive results in controlling those fires. When someone discovered a fire the fire brigades and fire departments were alerted by roving watchmen using hand bell-ringers or church sextons ringing church bells or factory steam whistles. Unfortunately, these systems did not provide very much detail and often directed the fire department to the wrong location. But with the advent of the telegraph, invented in the early 1840ís by Samuel F. B. Morse, firefighters were given a faster and more accurate fire reporting system. In 1847, New York became the first American city to begin construction of a municipal fire alarm system required by ordinance to construct a line of telegraph, by setting posts in the ground, for communicating alarms of fire from the City Hall to different fire stations, and to instruct the different bell-ringers in the use of said invention. The Automatic Fire Alarm Telegraph is operated by any dangerous Heat, and detects the presence of fire at its commencement. The apparatus, usually set at 125 Fahrenheit, is placed on the ceiling at regular intervals in every room, office, closet, and elevator in the Building the alarm is given directly to the Insurance patrol and fire department. It tells the exact location of the fire to the companies before they leave their station, giving the particular building and floor. Each instrument performs the service of a constant, vigilant watchman, ready to act in time of danger in every part of the building. Fire and smoke spread within the building can be affected by various factors such as the geometry, dimension, layout and usage of the building. In order to provide fire protection in the building, it is very important to detect fire at its early stage. The most common fire and smoke detection methods include the use of point type detectors (i.e. ionization smoke detectors, photoelectric detectors, heat detectors), line type detectors etc. These detection methods based on the use of fire signatures such smoke and heat. Fire is a chemical reaction known as combustion. It is defined by the rapid oxidation of a combustible material accompanied by release of energy in the form of heat. In order for ignition to occur, the presence of both a fuel and a heat energy source is required. When the two come together, with the appropriate proportions, either by a lack of separation or by some type of active interaction, a fire occurs.

This paper discusses the automatic fire detection system, the composition and working principle. The principle of the proposed circuit is derived from the physical principles of ionization. Fire detectors using two-wire method to reduce the wall alignment, improve reliability, and ease of construction and installation. This describes the overall structure of the fire detection system and control software in the design. Low cost fire detection and control system based on smoke and heat detection is proposed. It is comprised of a combination of electrical/electronic devices/equipment’s working together to detect the presence of fire and alert people through audio or visual medium after detection. These alarms may be activated from smoke detectors or heat detectors which, when detects fire. Then, it automatically operates a relay which can be used to send Short Message Service (SMS) to the registered mobile numbers and switch on a water sprayer or a Solenoid Pump to spray water or fire ceasing foam. A Short Message Service (SMS) was used as a method of wireless connection in the designed system. The adopted (T-BoxN12R device) which was programed in Java to Micro Edition language (J2ME) will keep scanning the received gas smoke data signal from the Gas Smoke Sensor output to pre monitor the ability of occurrence of a fire, once it detects that the collected data (Gas Level) exceed a predefined threshold it will enable the communication with GSM network and send the ALARM SMS message to the predefined phone number. Also it will Turn Alarm Buzzer “ON”, and Turn Water Pumping Motor “ON”.

2.1 Review of the components and theories

2.1.1 The Need for a Fire Detection System

Over the years death rates by fire has increased tremendously. Fire consumes homes and commercial premises quickly, indiscriminately taking lives and ruining property. No one should have to be become a victim of fire, but the reality is that people do become victims every day. The problem with having just detection is that although you know you have a fire (the fire alarm sounders) there is no way to safely suppress the fire yourself and that's if you are there. The Fire service will put it out when called but the smoke damage occurring before they arrive and the water damage after can be quite significant. Fire suppression systems are used to reduce the level of damage and down time by automatically suppressing the fire. Smoke alarms and sprinkler systems combined can reduce fire-related deaths by 82 percent and injuries by 46 percent.

2.1.2 Fire Triangle

The fire triangle or combustion triangle is a simple model for understanding the ingredients necessary for most fires. The triangle illustrates a fire requires three elements: heat, fuel, and an oxidizing agent (usually oxygen).
The fire is prevented or extinguished by removing any one of them. A fire naturally occurs when the elements are combined in the right mixture without sufficient heat, a fire cannot begin, and it cannot continue. Heat can be removed by the application of a substance which reduces the amount of heat available to the fire reaction. This is often water, which requires heat for phase change from water to steam. Introducing sufficient quantities and types of powder or gas in the flame reduces the amount of heat available for the fire reaction in the same manner. Turning off the electricity in an electrical fire removes the ignition source without fuel, a fire will stop. Fuel can be removed naturally, as where the fire has consumed all the burnable fuel, or manually, by mechanically or chemically removing the fuel from the fire. The fire stops because a lower concentration of fuel vapor in the flame leads to a decrease in energy release and a lower temperature. Removing the fuel thereby decreases the heat without sufficient oxygen, a fire cannot begin, and it cannot continue. With a decreased oxygen concentration, the combustion process slows. In most cases, there is plenty of air left when the fire goes out so this is commonly not a major factor.

2.1.3 Types of Fire Protection

2.1.3.1 Active Fire Protection

Active fire protection systems need to respond effectively and appropriately to a fire. They require activation through a combination of detectors or mechanical means and may consist of fire alarms and notification systems, sprinklers, standpipes, water supplies, and smoke detectors. ¬ Detection systems such as alarms to enable immediate evacuation and notify fire services. ¬ Suppression systems such as sprinklers and extinguishers reduce damage to buildings and contents. These systems help reduce the growth of a fire, thereby increasing life safety and limiting structural damage.

2.1.3.2 Passive Fire Detection

¬ Passive Fire Protection attempts to contain fires or slow their spread, to the standard expected by building codes. A PFP system is an integral part of the building layout and construction materials, covering these key areas:

¬ Fire-resistance rated walls.

¬ Firewalls not only have a rating, they are also designed to sub-divide buildings such that if collapse occurs on one side, this will not affect the other side.

¬ Fire-resistant glass using multi-layer intumescing technology or wire mesh embedded within the glass may be used in the fabrication of fire-resistance rated windows in walls or fire doors. ¬ Fire-resistance rated floors.

¬ Occupancy separations. These barriers designated as occupancy separations are intended to segregate parts of buildings.

¬ Closures (fire dampers). Sometimes fire stops are treated in building codes identical to closures.

¬ Grease ducts. (These refer to ducts that lead from commercial cooking equipment such as ranges, deep fryers and double-decker and conveyor-equipped pizza ovens to grease duct fans).

2.2.5 Fire Protection Systems

To detect fires or overheat conditions, detectors are placed in the various zones to be monitored. Fires are detected in reciprocating engine and small turboprop aircraft using one or more of the following: ¬ Overheat detectors: A fire detection system should signal the presence of a fire. Units of the system are installed in locations where there are greater possibilities of a fire. Three detector system types in common use are the thermal switch, thermocouple, and the continuous loop. ¬ Rate-of-temperature-rise detectors ¬ Flame detectors and Observation by crewmembers In addition to these methods, other types of detectors are used in aircraft fire protection systems but are seldom used to detect engine fires. For example, smoke detectors are better suited to monitor areas where materials burn slowly or smolder, such as cargo and baggage compartments. Other types of detectors in this category include carbon monoxide detectors and chemical sampling equipment capable of detecting combustible mixtures that can lead to accumulations of explosive gases. The types of detectors most commonly used for fast detection of fires are the rate-ofrise, optical sensor, pneumatic loop, and electric resistance system.

Chapter 3

Planning

2. Planning

2.1. Computing Environment

Our Smoke detection and fire prevention project was implemented on Cisco-packet tracer for testing. Components used for our project are as follows:

• Home Gateway: A router that forwards the data to the server and the control information to the connected devices for alerting purposes and hence allows it to take necessary actions to extinguish the fire.

• Door: Affects Argon, Carbon Monoxide, Carbon Dioxide, Hydrogen, Helium, Methane, Nitrogen, O2, Ozone, Propane, and Smoke. When the door is opened, those gases will decrease to a maximum of 2% in total change. When the door is opened, the rate of transference for Humidity and Temperature is increased by 25%. The rate of transference for gases is increased by 100%

• Smoke Detector: Detects Smoke. Alarm will go off when it detects the environment variable SMOKE at the level of 40%.

• Fire Sprinkler: Raises the water level. Affects Water Level at a rate of 0.1 cm per second. This is connected to the smoke detector.

• Siren: Makes a loud emergency noise when activated. It is activated when certain conditions are encountered.

• Garage Door: Affects Argon, Carbon Monoxide, Carbon Dioxide, Hydrogen, Helium, Methane, Nitrogen, O2, Ozone, Propane, and Smoke. When the door is opened, those gases will decrease to a maximum of 4% in total change. When the door is opened, the rate of transference for Humidity and Temperature is increased by 50%. The rate of transference for gases is increased by 100%.

• Smartphone: This is the user interface that allows the user to know that a fire occurred at their place with the help of the application running on their smartphone and the amount of smoke generated and hence take necessary steps.

• Window: A window is an opening in a wall, door, roof or vehicle that allows the passage of light, sound, and sometimes air.

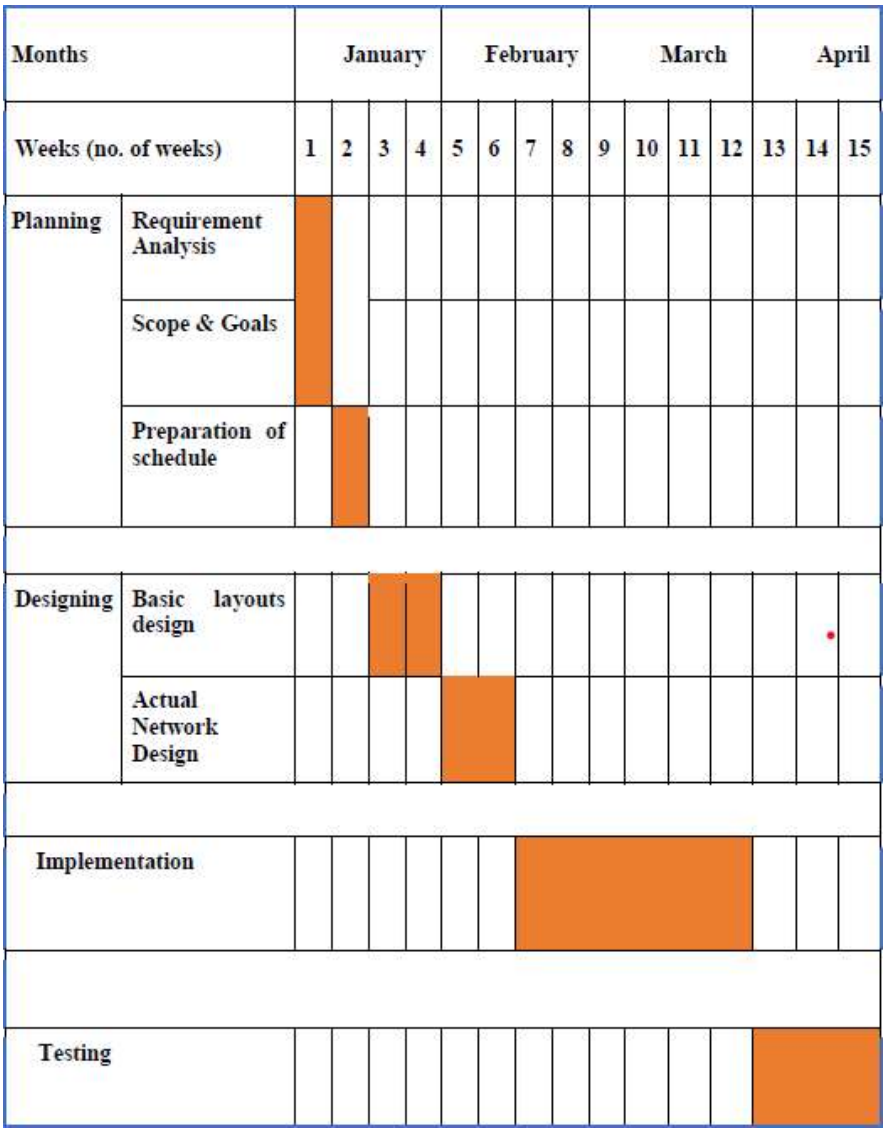
2.2. Project Implementation Schedule

Table 2.1. Project Implementation Schedule

Sr no.	Task Name	Duration	Start Date	End Date
1	Planning	15 days	10-01-2020	25-01-2020
2	Design	15 days	26-01-2020	11-02-2020
3	Implementation	45 days	12-02-2020	27-03-2020
4	Testing	13 days	01-04-2020	14-04-2020

The duration of the project was 15 weeks. So, the first two weeks were allocated for planning of the project. The planning included what topics to be covered and which components will be required for the project to be completed. Also, the flow of the tasks was also decided in the planning phase. Then, four weeks were allocated for the designing phase. In this phase, the architecture of the system was developed. We designed the architecture for our Wireless Network. The connection of the devices was drawn out visually. The next part was the implementation part to which we allocated 6 weeks. In the implementation part, we created our project in the Cisco Packet Tracer. We created a network and made the configurations as required. We had to make changes several times before we finally developed the complete system. The last three weeks were allocated for the testing of the developed system. In this phase, we created many test cases based on our system. These test cases were then checked in the systemto get a result on whether the system is performing as desired or is there any malfunction. The test cases were covered for almost all the modules in the project.

Table 2.2. Timeline Chart



Chapter 4
Design

3. Design

3.1. Construction and Design

3.1.1. Navigation

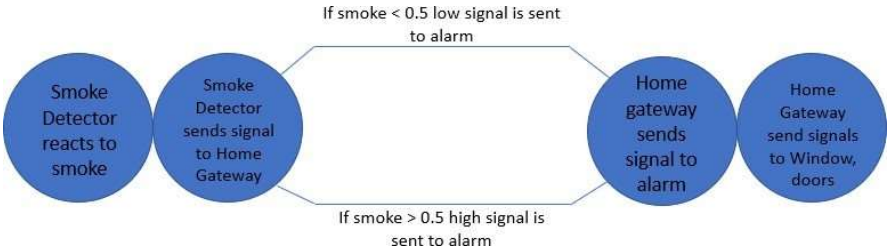


Figure 3.1. Smoke Detector

3.1.2. Page Layout

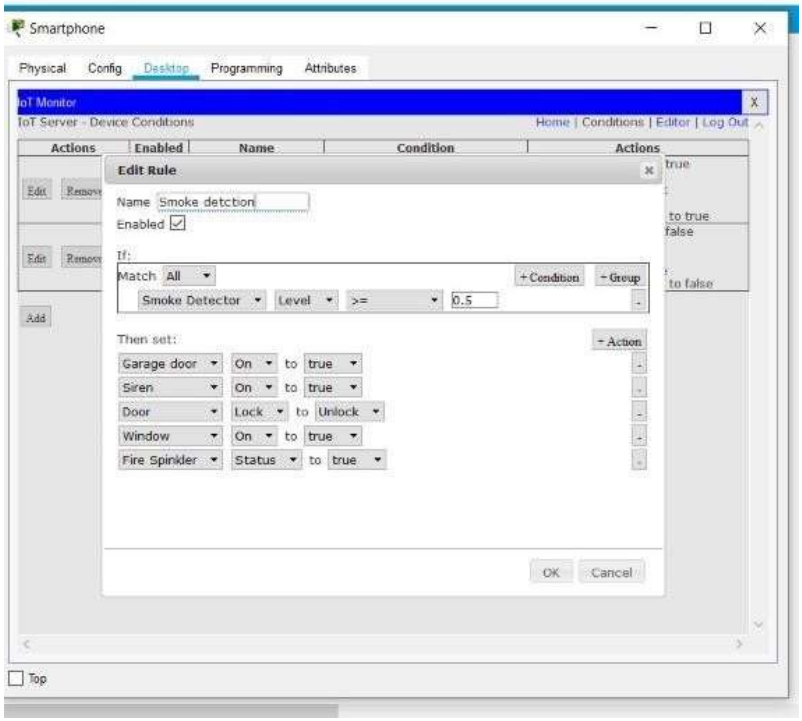


Figure 3.2. Smoke Detector On Rules

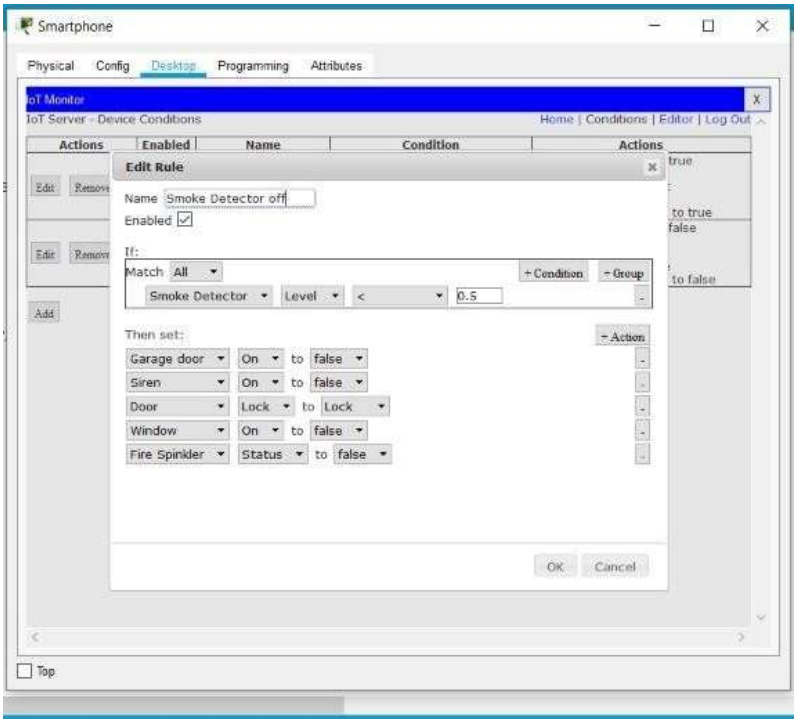


Figure 3.3. Smoke Detector Off rules

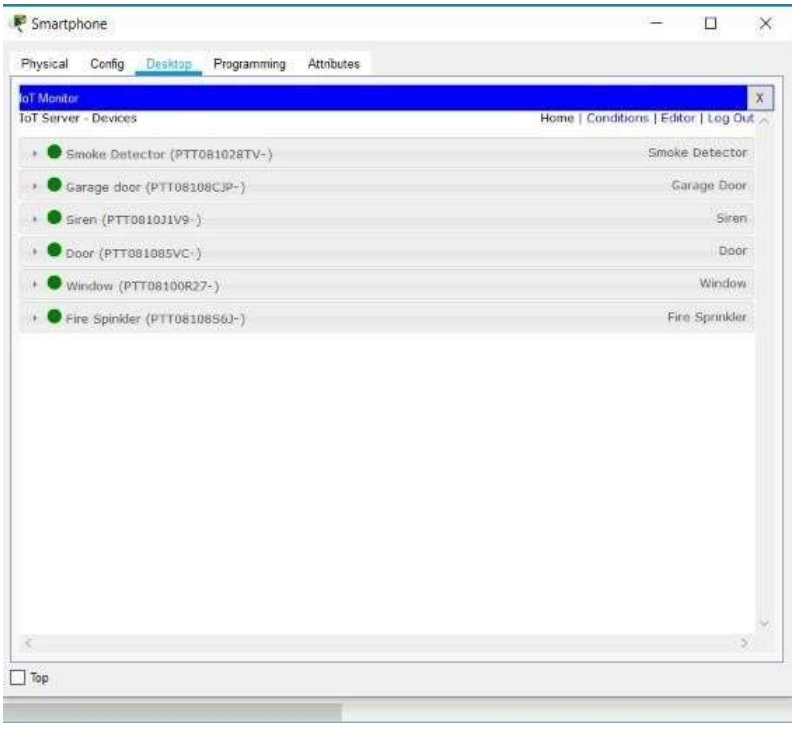


Figure 3.4. Devices in the system

Chapter 5
Implementation

4. Implementation

4.1. Network Design

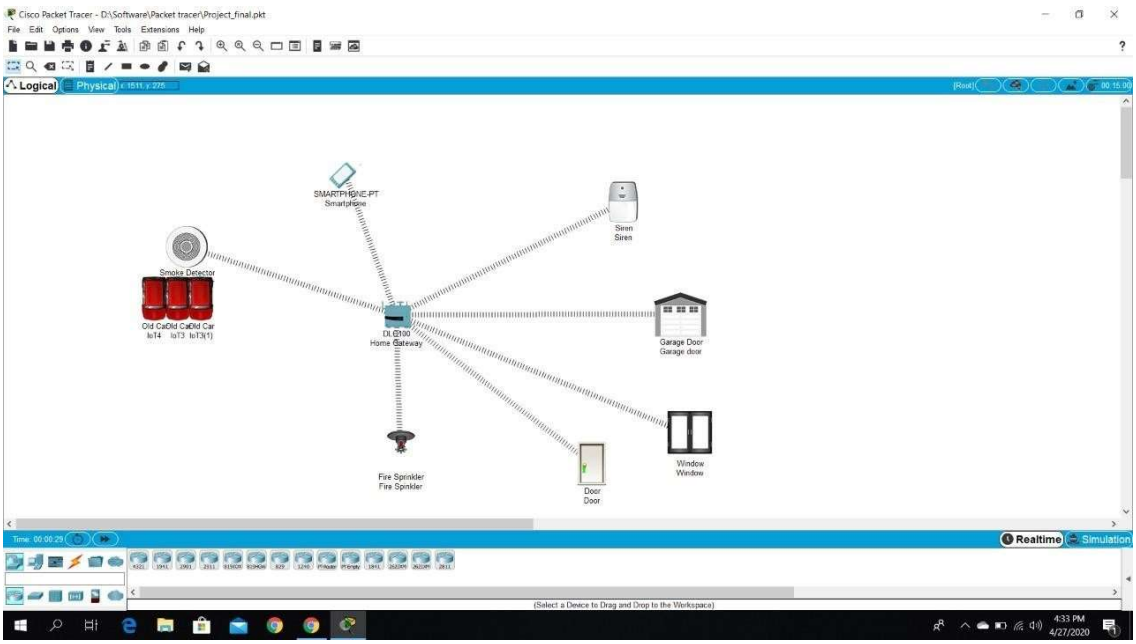


Fig 4.1. Network Design (Before)

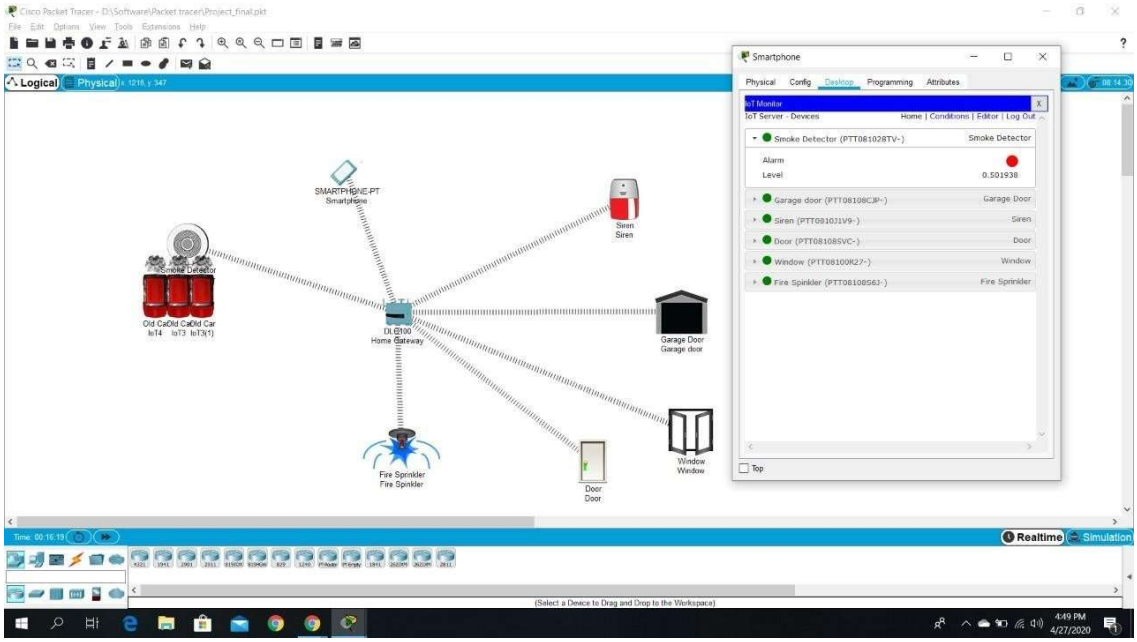


Fig 4.2. Network Design (After)

4.2. Configuration

1. DLC Home Gateway
   • Created a web page with username and password to connect and gain control of the system.
   • Registration can be done on this router.
   • Range of the router is set to maximum (1000 meters or 1km).
   • Ip address is assigned as 192.168.25.1 dynamically.

2. Smartphone
   • 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.
   • Ip address is assigned as 192.168.25.100 dynamically.

3. Smoke Detector
   • Smoke Detector is used to detect any smoke. E.g. When a fire breaks out the smoke detector will detect it. And in our project when the smoke level goes beyond 0.5, certain conditions are triggered such as door, windows are opened and fire sprinkler and siren are turned on.
   • It is connected to Home Gateway using advanced setting in I/O config i.e. (PT-IOT-NM-1W) network adapter setting.
   • Dynamic IP address is assigned using DHCP.

4. Window
   • A window is an opening in a wall that allows the passage of light, sound, and sometimes air.
   • It is connected to Home Gateway using advanced setting in I/O config i.e (PT-IOT-NM-1W) network adapter setting
   • Dynamic IP address is assigned using DHCP

5. Door
   • A door is an opening from where people can enter or leave in a normal routine life as well as in emergency.
   • It is connected to Home Gateway using advanced setting in I/O config i.e (PT-IOT-NM-1W) network adapter setting
   • Dynamic IP address is assigned using DHCP

6. Garage door
   • A Garage door is an opening from where vehicles can enter or leave. In our case this is very crucial as garage doors are huge and can help the air escape when there is a fire outbreak, releasing carbon dioxide and other

gases into the air and helping any people to take clean air if they are stuck in the house.
• It is connected to Home Gateway using advanced setting in I/O config i.e. (PT-IOT-NM-1W) network adapter setting
• Dynamic IP address is assigned using DHCP

7. Fire sprinkler
   • The fire sprinkler sprays streams of water to suppress or extinguish the fire when ordered by the home gateway. This happens when smoke detector detects smoke level more than 0.5.
   • It is connected to Home Gateway using advanced setting in I/O config i.e (PT-IOT-NM-1W) network adapter setting
   • Dynamic IP address is assigned using DHCP

8. Siren
   • A siren is device which makes a loud emergency sound when the smoke detector detects smoke level greater than 0.5.
   • It is connected to Home Gateway using advanced setting in I/O config i.e (PT-IOT-NM-1W) network adapter setting
   • Dynamic IP address is assigned using DHCP

9. Car
   • In Cisco-packet tracer there is no object or entity which can simulate the generation of smoke other than a car.
   • So, we have used 3 cars to represent smoke generation which is similar to smoke generated during fire.

Conditions:

To implement the project, we need to specify certain conditions on which all the devices can be activated and deactivated. Based on how and when these conditions change, there will be changes in the state of the devices. To simulate smoke, we have used 3 cars. The conditions which are mentioned above and are crucial for this simulation are as follows:

IoT Monitor

IoT Server - Device Conditions

Home | Conditions | Editor | Log Out

Actions	Enabled	Name	Condition	Actions
Edit Remove	Yes	Smoke detction	Smoke Detector Level >= 0.5	Set Garage door On to true Set Siren On to true Set Door Lock to Unlock Set Window On to true Set Fire Spinkler Status to true
Edit Remove	Yes	Smoke Detector off	Smoke Detector Level < 0.5	Set Garage door On to false Set Siren On to false Set Door Lock to Lock Set Window On to false Set Fire Spinkler Status to false

Fig 4.3. System Conditions based on Situation

Chapter 6

Testing and Deployment

5. Testing and Deployment

Testing

Table 5.1. Test Cases

Test Case no.	Test Case	Expected Output	Actual Output	Result
1	When smoke detector detects smoke level > 0.5	Door open, window open, garage door open, sprinkler on, siren on.	Door open, window open, garage door open, sprinkler on, siren on.	Pass
2	When smoke detector detects smoke level < 0.5	Door close, window close, garage door close, sprinkler off, siren off.	Door close, window close, garage door close, sprinkler off, siren off.	Pass

Deployment

This system can be of great in domestic as well as industrial settings to detect smoke and alert people on an impending fire since smoke is a precursor for fire, instead of relying on heat/temperature sensors which sounds alarm when the fire has already started. This can go a long way in helping to save human life.

Chapter 7

Maintenance

6. Maintenance

User manual

1. All the components must be regularly checked for proper working.
2. Based on the condition set, check whether all devices are working.
3. The Home gateway is up all the time.
4. Smoke Detector should be able to detect presence of smoke all the time.

Chapter 8

References

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