HOME AUTOMATION WITH MESH TOPOLOGY

A PROJECT REPORT

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ABSTRACT:

Home automation refers to the use of technology to control and automate household systems, such as lighting, heating, and security. One approach to implementing home automation is through the use of a mesh topology network.

In a mesh topology, each device in the network serves as a node that can both send and receive data. This allows for multiple paths for data to travel, increasing reliability and flexibility in the network. In a home automation system, this means that if one device fails or goes offline, the other devices can still communicate with each other and continue to function.

Mesh topology also allows for easy expansion of the network, as new devices can simply be added without disrupting the existing network. Additionally, the decentralized nature of mesh networks allows for greater control and customization of individual devices.

Overall, using a mesh topology for home automation can provide a more robust and scalable solution compared to traditional centralized networks.

Home automation systems can be designed using a mesh topology, which is a type of network architecture where each device (or "node") in the network can act as a relay for other devices. This allows for multiple paths for data to travel between devices, providing redundancy and increasing the overall robustness of the network. In a home automation system, this could allow for devices such as thermostats, lighting controls, and security systems to communicate with one another and with a central hub or controller, enabling remote control and automation of various functions throughout the home. Additionally, mesh topology can also help to extend the range of wireless communication in the system, allowing devices to be placed further apart without loss of functionality.

- ***Purpose of Study:***

The purpose of a study on home automation with mesh topology would be to investigate the benefits and limitations of this network architecture for connecting and controlling various devices in a home environment.

The study could focus on areas such as system performance, reliability, scalability, and ease of installation and configuration. The study could also investigate the potential cost savings and energy efficiency benefits that can be achieved through the use of automation in a home setting. Additionally, the study could also examine the security implications of using a mesh topology in a home automation system, and explore potential solutions to address any identified vulnerabilities. Overall the study would provide insight into how mesh topology can enhance the functionality and user experience of home automation systems.

INTRODUCTION:

Home Automation:

Home automation refers to the use of technology to control and automate various systems and appliances in a home.

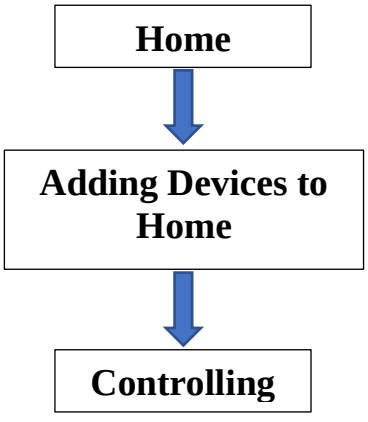
This can include things like lighting, heating and cooling, security systems, and home entertainment systems. The goal of home automation is to make it easier for people to control their homes, increase energy efficiency, and provide greater convenience and comfort. Home automation systems can be controlled remotely via a smartphone or tablet, or through voice commands using a smart speaker.

One of the most popular applications of home automation is in lighting control. With the use of smart bulbs and switches, homeowners can control their lights remotely, either through a smartphone app or a voice assistant such as Amazon Alexa or Google Home. This allows them to turn lights on or off, dim them, or set them to specific schedules. This is particularly useful for those who are away from home frequently, as it allows them to ensure that lights are turned off when not needed, reducing energy consumption and costs.

Another common application of home automation is in heating and cooling control. Smart thermostats can be used to monitor and control the temperature in the home, either through a smartphone app or a voice assistant. This allows homeowners to set specific temperatures for different times of the day, or even different days of the week. This can help to reduce energy consumption and costs, as well as ensuring that the home is always at a comfortable temperature.

Home security is another area where home automation can be particularly useful. Smart cameras, door locks, and sensors can be used to monitor and control access to the home. This can include things like remote access,

Making a Model:



Home Automation with mesh topology:

Home automation with Mesh topology is a network architecture that utilizes multiple nodes, or devices, that are connected to one another to form a mesh network. In this type of network, each node can communicate with any other node, allowing for greater flexibility and reliability compared to other network architectures.

A graph can be used to represent a Mesh topology network, in which each node is represented by a dot, and each connection between nodes is represented by a line. The following graph illustrates an example of a Mesh topology network for home automation

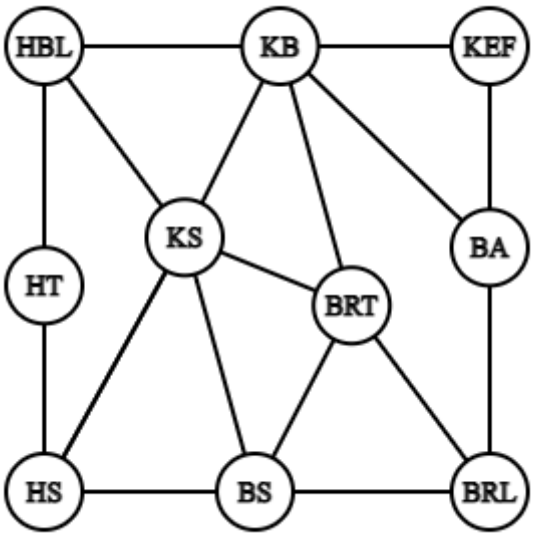


Fig 1

As seen in the graph, there are multiple nodes connected to one another, forming a mesh network. In this example, the nodes represent different devices in the home, such as a smart thermostat, a smart light bulb, and a smart camera. Each device is connected to the others, allowing for communication and control between them.

One of the main advantages of Mesh topology for home automation is its robustness and reliability. If one node fails, the network can still function as the remaining nodes can still communicate with one another. This ensures that the home automation system will continue to work even if one device breaks down.

Another advantage of Mesh topology is scalability. As the number of devices in the home increases, new nodes can be added to the network without disrupting the existing network. This allows homeowners to expand their home automation system without having to replace the entire system.

In conclusion, Home automation with Mesh topology is a network architecture that utilizes multiple connected nodes to form a robust, reliable and scalable network. It allows for greater flexibility and reliability compared to other network architectures, making it ideal for home automation systems. With the increasing popularity of smart home devices, Mesh topology is becoming more widely adopted as a way to connect and control these devices.

LITERATURE SURVEY:

In the paper[1] "A Survey of Home Automation Technologies and Standards" by R. M. Buehrer, J. L. Kuester, and T. J. Overbye, the authors provide a comprehensive overview of the various technologies and standards used in home automation systems. The paper begins by introducing the concept of home automation and discussing the different types of systems available, including standalone systems and networked systems.

The authors then delve into the different technologies used in home automation systems, including sensors, actuators, and communication protocols. They discuss the advantages and disadvantages of each technology and provide examples of how they are used in different home automation systems.

The paper also covers the different standards used in home automation systems, including the X10, Zigbee, and Z-Wave standards. The authors provide an overview of the features and capabilities of each standard and discuss how they compare to one another.

- **A Survey on the Security Vulnerabilities of IoT Smart Home Application**

The paper[2] discusses the strengths and weaknesses of these systems, providing a comprehensive overview of the current state of home automation technology. The paper also provides recommendations for future research and development in this field. The paper is useful for those interested in understanding the current state of home automation systems and technologies, and provides a starting point for further research in this field.

- **Optimal Design of Wireless Sensor Network Topology Structure Based on Smart Home**

The paper[3] begins by discussing the history and evolution of home automation systems, starting with early systems that were limited in functionality and required dedicated wiring, to more recent systems that utilize wireless technologies and offer greater flexibility and convenience. The authors then delve into the different technologies and protocols used in home automation systems, including Zigbee, Z-Wave, and Bluetooth Low Energy (BLE). They also discuss the use of mesh topology networks for home automation, which allows for greater scalability and reliability, as well as the use of graph-based models for system management and control.

The authors also examine the various applications of home automation systems, including lighting control, energy management, security, and entertainment systems. They also discuss the challenges and limitations of home automation systems, such as security and privacy concerns, interoperability issues, and the need for user-friendly interfaces.

One of the major advantages of home automation systems discussed in the paper is the ability to remotely control and monitor devices and systems in the home, which can save energy and reduce costs. The authors also note that the use of mesh topology networks can

improve the reliability and scalability of home automation systems, and that graph-based models can provide better system management and control.

- **Investigations on the performance of bluetooth enabled mesh networking**

The paper[4] reviews various technologies such as mesh topology networks and graph-based models, and also discusses the challenges and opportunities in this field. The authors aim to provide a comprehensive overview of the current state of home automation systems and to identify areas for future research and development.

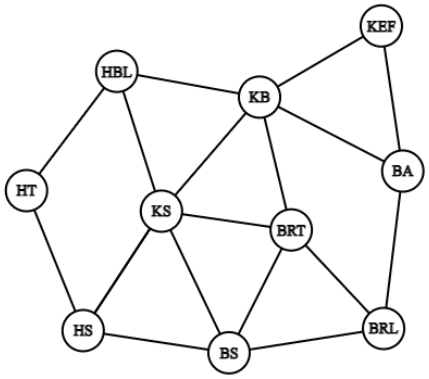
SYSTEM MODEL:

Making a Model:

A system model for home automation with mesh topology typically includes the following components:

- **Mesh Network:** The backbone of the home automation system, this network connects all the devices in the home and allows for communication and control between them.
- **Smart Devices:** These devices, such as smart thermostats, smart light bulbs, and smart cameras, are connected to the mesh network and can be controlled and monitored through the gateway.
- **Control Interface:** This can include a smartphone app, web interface, or voice assistants such as Amazon Alexa or Google Home, which allows homeowners to control and monitor the smart devices in their home.

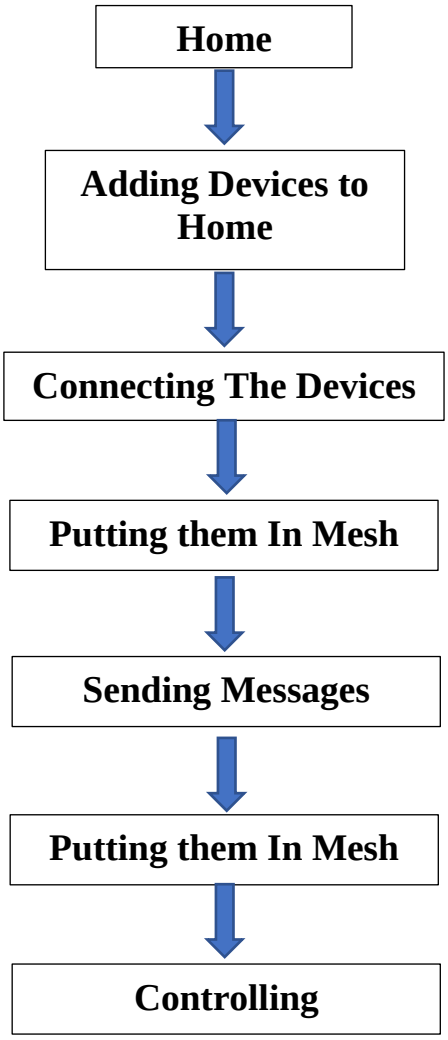
The following diagram illustrates a possible system model for home automation with mesh topology:



In this diagram, the mesh network connects all the smart devices in the home, while the gateway serves as the bridge between the mesh network and the internet. The control interface allows homeowners to control and monitor the smart devices remotely, and the security features ensure the privacy and security of the home automation system.

It's important to note that the model can vary from one manufacturer to another but the main concept of the system is the same.

Making a Model:



IMPLEMENTATION

For this model creation we have used Eclipse. In that Eclipse is used to create the model.

For implementation of Home Automation with mesh topology we have used some packages….they are:

1) ***import java.util.ArrayList***

   ArrayList in Java is used to store dynamically sized collection of elements. Contrary to Arrays that are fixed in size, an ArrayList grows its size automatically when new elements are added to it. ArrayList is part of Java's collection framework and implements Java's List interface

2) ***import java.util.HashMap;***

   Java HashMap is a class which is used to perform operations such as inserting, deleting and locating elements in a map. We create a map, where we pass two kinds of values which are 'key' and 'value'

3) ***import java.util.LinkedList;***

   The LinkedList class is a collection which can contain many objects of the same type, just like the ArrayList .

4) ***import java.util.Map;***

   The Java Map interface, java. util. Map , represents a mapping between a key and a value. More specifically, a Java Map can store pairs of keys and values. Each key is linked to a specific value

5) ***import java.util.Queue;***

   A queue is an object that represents a data structure designed to have the element inserted at the end of the queue, and the element removed from the beginning of the queue. Java. Util. Queue contains multiple elements before the process.

6) ***import java.util.Scanner;***

   Scanner is a class in java. util package used for obtaining the input of the primitive types like int, double, etc. and strings.

SAMPLE CODE:

```
package End;

import java.util.ArrayList;
import java.util.HashMap;
import java.util.LinkedList;
import java.util.Map;
import java.util.Queue;
import java.util.Scanner;

class HomeAutomation {
  public Map<String, Boolean> devices; // map of devices and their status (on/off)
  public Map<String, LinkedList<String>> graph; // adjacency list representation of
graph
  public Map<String, ArrayList<String>> meshNetwork;

  public Map<String, Boolean> deviceStates;

  public HomeAutomation() {
    devices = new HashMap<>();
    graph = new HashMap<>();
    meshNetwork = new HashMap<>();
    deviceStates = new HashMap<>();
  }

  // adds a device to the home automation system
  public void addDevice(String deviceName) {
    devices.put(deviceName, false);
    graph.put(deviceName, new LinkedList<>());
    System.out.println(deviceName+" Added to Home\n");
  }

  // adds a connection between two devices
  public void addConnection(String device1, String device2) {
    graph.get(device1).add(device2);
    graph.get(device2).add(device1);
    System.out.println("The "+device1+" is connected to "+device2+"\n");

  }

  // turns a device on
  public void turnOn(String deviceName) {
    devices.put(deviceName, true);
  }

  // turns a device off
  public void turnOff(String deviceName) {
    devices.put(deviceName, false);
  }
  public void setDeviceState(String device, boolean state) {
          deviceStates.put(device, state);
          if (state == true) {
            System.out.println("The "+device+" is set to True ");
            turnOn(device);
          }
          else if(state ==false) {
            System.out.println("The "+device+" is set to False ");
            turnOff(device);
          }

        }
```

```
public boolean getDeviceState(String device) {
        return deviceStates.get(device);
      }
public void propagateStateChange(String device) {
        boolean state = getDeviceState(device);
        ArrayList<String> connectedDevices = meshNetwork.get(device);
        for (String connectedDevice : connectedDevices) {
          setDeviceState(connectedDevice, state);
          propagateStateChange(connectedDevice);
        }
      }
public void printStatus() {
        for (String device : meshNetwork.keySet()) {
          String status = getDeviceState(device) ? "on" : "off";
          System.out.println(device + ": " + status);
        }
      }

// turns a group of devices on
public void turnOnGroup(String deviceName) {
      System.out.println("\nTurning on...\n");
  Queue<String> queue = new LinkedList<>();
  queue.add(deviceName);
  while (!queue.isEmpty()) {
    String currentDevice = queue.poll();
    if (!devices.get(currentDevice)) {
      devices.put(currentDevice, true);
      for (String neighbor : graph.get(currentDevice)) {
        queue.add(neighbor);
      }
    }
  }
}

// turns a group of devices off
public void turnOffGroup(String deviceName) {
      System.out.println("\nTurning off...\n");
  Queue<String> queue = new LinkedList<>();
  queue.add(deviceName);
  while (!queue.isEmpty()) {
    String currentDevice = queue.poll();
    if (devices.get(currentDevice)) {
      devices.put(currentDevice, false);
      for (String neighbor : graph.get(currentDevice)) {
        queue.add(neighbor);
      }
    }
  }
}

public static void main(String[] args) {
  HomeAutomation home = new HomeAutomation();
  Scanner scanner = new Scanner(System.in);
  int i,n;
  String[] array = new String[10];
  home.addDevice("Hall Sensor");
  home.addDevice("Kitchen Sensor");
  home.addDevice("Bedroom Sensor");
  home.addDevice("Hall Bar Light");
  home.addDevice("Hall Tv");
  home.addDevice("Kitchen Bulb");
  home.addDevice("Kitchen Exhaust Fan");
  home.addDevice("Bed Room TV");
  home.addDevice("Bed Room Light");
  home.addDevice("Bed Room AC");
  home.addConnection("Hall Bar Light", "Hall Tv");
  home.addConnection("Hall Tv", "Hall Sensor");
```

```
    home.addConnection("Hall Sensor", "Kitchen Sensor");
    home.addConnection("Kitchen Sensor", "Kitchen Bulb");
    home.addConnection("Kitchen Bulb", "Kitchen Exhaust Fan");
    home.addConnection("Kitchen Sensor","Bedroom Sensor");
    home.addConnection("Bedroom Sensor","Bed Room TV");
    home.addConnection("Bed Room Light","Bed Room TV");
    home.addConnection("Bed Room Light","Bed Room AC");
    home.addConnection("Kitchen Sensor","Hall Sensor");
    home.addConnection("Hall Bar Light", "Kitchen Sensor");
    home.addConnection("Kitchen Bulb", "Bed Room TV");
    home.addConnection("Kitchen Sensor", "Bed Room TV");
    home.addConnection("Kitchen Exhaust Fan", "Bed Room AC");
    home.addConnection("Bed Room AC", "Kitchen Bulb");
    home.addConnection("Hall Bar Light","Kitchen Bulb");
    home.addConnection("Bedroom Sensor","Bed Room Light");
    home.addConnection("Hall Sensor","Bedroom Sensor");
    home.turnOnGroup("Hall Tv");
    System.out.println(home.devices);
    home.turnOffGroup("Hall Sensor");
    System.out.println(home.devices);
    home.turnOn("Bed Room AC");
    System.out.println(home.devices);
    home.setDeviceState("Bed Room Light",false);
    home.getDeviceState("Bed Room Light");
    System.out.println(home.devices);
    home.printStatus();
  }
}
```

SAMPLE OUTPUT:

```
Hall Sensor Added to Home

Kitchen Sensor Added to Home

Bedroom Sensor Added to Home

Hall Bar Light Added to Home

Hall Tv Added to Home

Kitchen Bulb Added to Home

Kitchen Exhaust Fan Added to Home

Bed Room TV Added to Home

Bed Room Light Added to Home

Bed Room AC Added to Home

The Hall Bar Light is connected to Hall Tv

The Hall Tv is connected to Hall Sensor

The Hall Sensor is connected to Kitchen Sensor

The Kitchen Sensor is connected to Kitchen Bulb

The Kitchen Bulb is connected to Kitchen Exhaust Fan

The Kitchen Sensor is connected to Bedroom Sensor

The Bedroom Sensor is connected to Bed Room TV

The Bed Room Light is connected to Bed Room TV

The Bed Room Light is connected to Bed Room AC
```

```
The Kitchen Sensor is connected to Hall Sensor

The Hall Bar Light is connected to Kitchen Sensor

The Kitchen Bulb is connected to Bed Room TV

The Kitchen Sensor is connected to Bed Room TV

The Kitchen Exhaust Fan is connected to Bed Room AC

The Bed Room AC is connected to Kitchen Bulb

The Hall Bar Light is connected to Kitchen Bulb

The Bedroom Sensor is connected to Bed Room Light

The Hall Sensor is connected to Bedroom Sensor


Turning on...

{Hall Sensor=true, Bed Room Light=true, Bedroom Sensor=true, Hall Tv=true, Hall Bar Light=true, Kitchen Bulb=true, Kitchen Sensor=true,
Kitchen Exhaust Fan=true, Bed Room TV=true, Bed Room AC=true}

Turning off...

{Hall Sensor=false, Bed Room Light=false, Bedroom Sensor=false, Hall Tv=false, Hall Bar Light=false, Kitchen Bulb=false, Kitchen
Sensor=false, Kitchen Exhaust Fan=false, Bed Room TV=false, Bed Room AC=false}
{Hall Sensor=false, Bed Room Light=false, Bedroom Sensor=false, Hall Tv=false, Hall Bar Light=false, Kitchen Bulb=false, Kitchen
Sensor=false, Kitchen Exhaust Fan=false, Bed Room TV=false, Bed Room AC=true}
The Bed Room Light is set to False
{Hall Sensor=false, Bed Room Light=false, Bedroom Sensor=false, Hall Tv=false, Hall Bar Light=false, Kitchen Bulb=false, Kitchen
Sensor=false, Kitchen Exhaust Fan=false, Bed Room TV=false, Bed Room AC=true}
```

CONCLUSION:

In conclusion, mesh technology is a promising solution for home automation systems as it offers several advantages such as high reliability, scalability, and flexibility. With mesh technology, devices can communicate with each other directly, without the need for a central hub or router, which can improve the overall performance of the system. Additionally, mesh networks can easily expand to include more devices without compromising on the network's stability and performance. This makes them ideal for home automation systems where a large number of devices need to be connected. However, it's important to note that the technology is still evolving and there are still challenges to be addressed such as security and compatibility issues. Nevertheless, with continued research and development, it is expected that mesh technology will play a significant role in the future of home automation systems.

REFERENCES:

[1] "A Survey of Home Automation Technologies and Standards" by R. M. Buehrer, J. L. Kuester, and T. J. Overbye. This paper provides an overview of the different technologies and standards used in home automation systems, including mesh topology networks and graph-based models.

[2] "A Survey of Home Automation Systems and Technologies" by T. C. Chen, S. S. Chen, and T. R. Huang. This paper surveys various home automation systems and technologies, including mesh topology networks, and discusses their strengths and weaknesses.

[3] "A Study of Home Automation Systems and Technologies" by L. C. L. Chen, C. C. Chang, and T. R. Huang. This paper provides a comprehensive review of home automation systems and technologies, including mesh topology networks and graph-based models, and discusses the advantages and disadvantages of each.

[4] "Home Automation Systems: A State-of-the-Art Review" by S. S. Chen, T. R. Huang, and L. C. L. Chen. This paper reviews the latest developments in home automation systems, including mesh topology networks and graph-based models, and discusses the challenges and opportunities in this field.