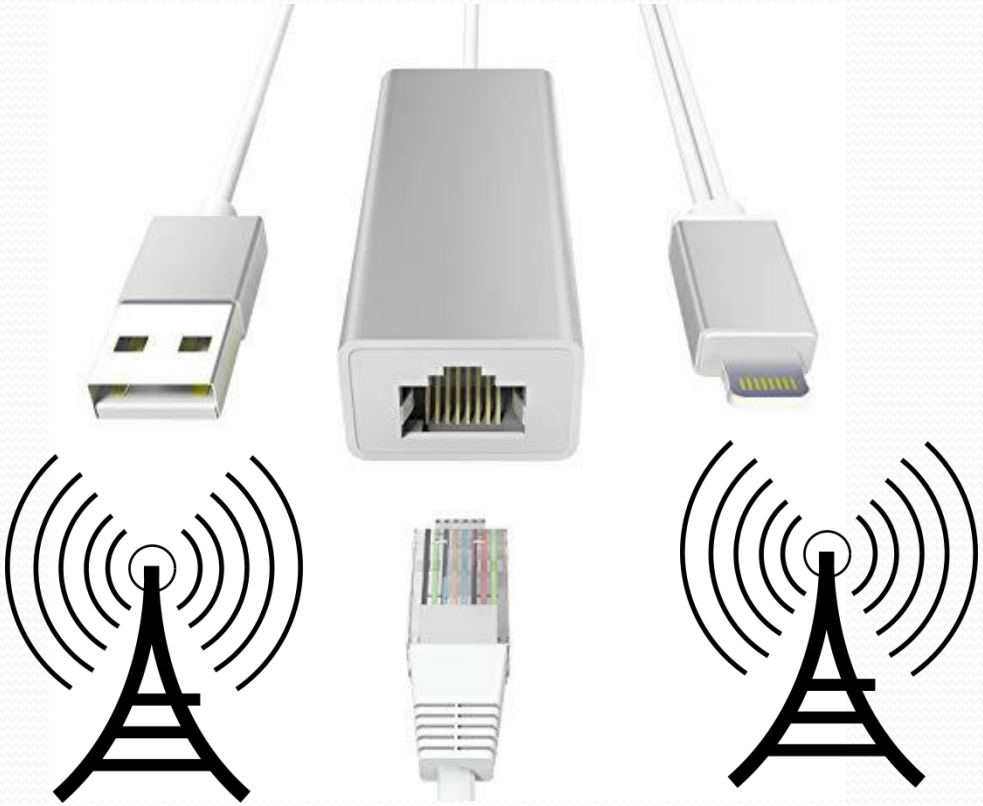
Internet of Things and Applications

Course Code: EE6434D

Module 2



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Wired Networking equipment

Purpose, features, and functions of the following network components

1. Hubs
2. Switches
3. Bridges
4. Routers
5. Gateways, etc

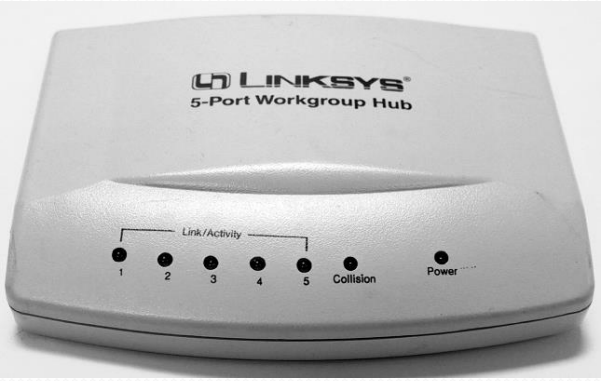

Figure 1 A workgroup hub.

Figure 2 A high-capacity, or high-density, hub.

1. Hubs

Hubs are simple network devices, and their simplicity is reflected in their low cost.

Small hubs with four or five ports (often referred to as *workgroup hubs) cost less than Rs. 2000; with the requisite* cables, they provide everything needed to create a small network.

Hubs with more ports are available for networks that require greater capacity.

The above figure 1 shows an example of a workgroup hub, and the above figure 2 shows an example of the type of hub you might see on a corporate network.

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Computers connect to a hub via a length of twisted-pair cabling. In addition to ports for connecting computers, even an inexpensive hub generally has a port designated as an uplink port that enables the hub to be connected to another hub to create larger networks.

Most hubs are referred to as either active or passive.

Active regenerate a signal before forwarding it to all the ports on the device and requires a power supply. Small workgroup hubs normally use an external power adapter, but on larger units the power supply is built in.

Passive hubs, which today are seen only on older networks, do not need power and they don't regenerate the data signal. Regeneration of the signal aside, the basic function of a hub is to take data from one of the connected devices and forward it to all the other ports on the hub.

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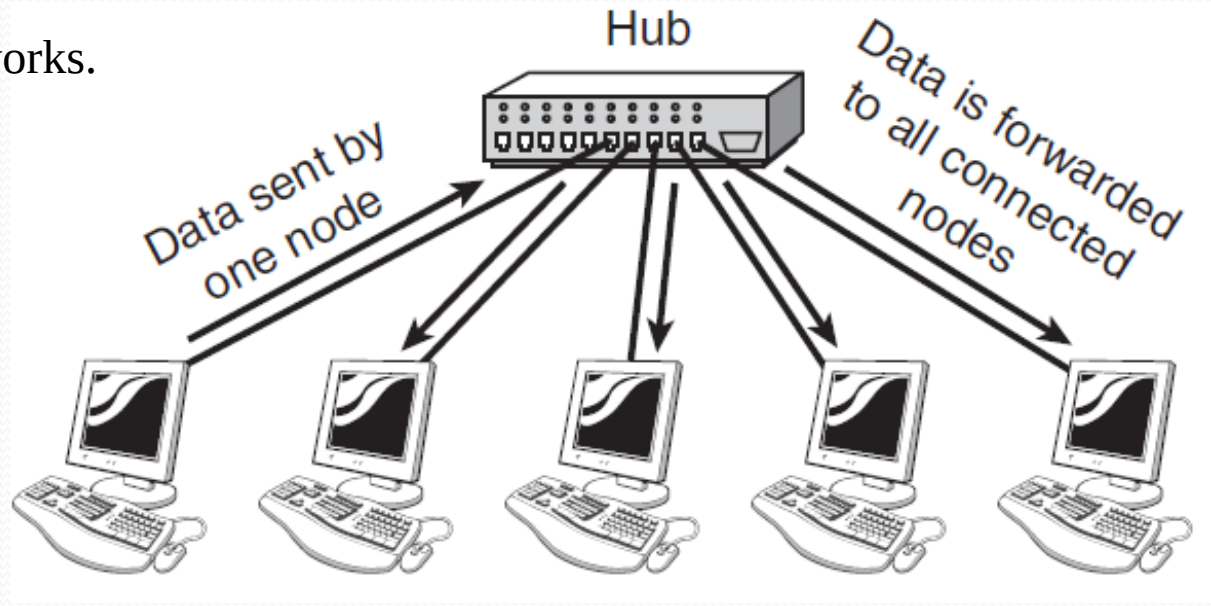
This method of operation is inefficient because, in most cases, the data is intended for only one of the connected devices. You can see a representation of how a hub works in Figure 3.

Due to the inefficiencies of the hub system and the constantly increasing demand for more bandwidth, hubs are slowly but surely being replaced with switches.

As you will see in the next section, switches offer distinct advantages over hubs.

How a hub works.



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2. Switches

On the surface, a *switch looks much like a hub. Despite their similar appearance, switches are* far more efficient than hubs and are far more desirable for today's network environments.

Figure 1 shows an example of a 32-port Ethernet switch. If you refer to Figure 2, you'll notice few differences in the appearance of the high-density hub and this switch.

Figure 1. 32-port Ethernet switch.

As with a hub, computers connect to a switch via a length of twisted-pair cable. Multiple switches are often interconnected to create larger networks.

Despite their similarity in appearance and their identical physical connections to computers, switches offer significant operational advantages over hubs.

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As discussed earlier in the chapter, a hub forwards data to all ports, regardless of whether the data is intended for the system connected to the port. This arrangement is inefficient; however, it requires little intelligence on the part of the hub, which is why hubs are inexpensive.

Rather than forwarding data to all the connected ports, a switch forwards data only to the port on which the destination system is connected. It looks at the Media Access Control (MAC) addresses of the devices connected to it to determine the correct port. A MAC address is a unique number that is stamped into every NIC (Network Interface Card).

By forwarding data only to the system to which the data is addressed, the switch decreases the amount of traffic on each network link dramatically. In effect, the switch literally channels (or switches, if you prefer) data between the ports. Figure 2 illustrates how a switch works.

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The collisions occur on the network when two devices attempt to transmit at the same time. Such collisions cause the performance of the network to degrade. By channelling data only to the connections that should receive it, switches reduce the number of collisions that occur on the network. As a result, switches provide significant performance improvements over hubs.

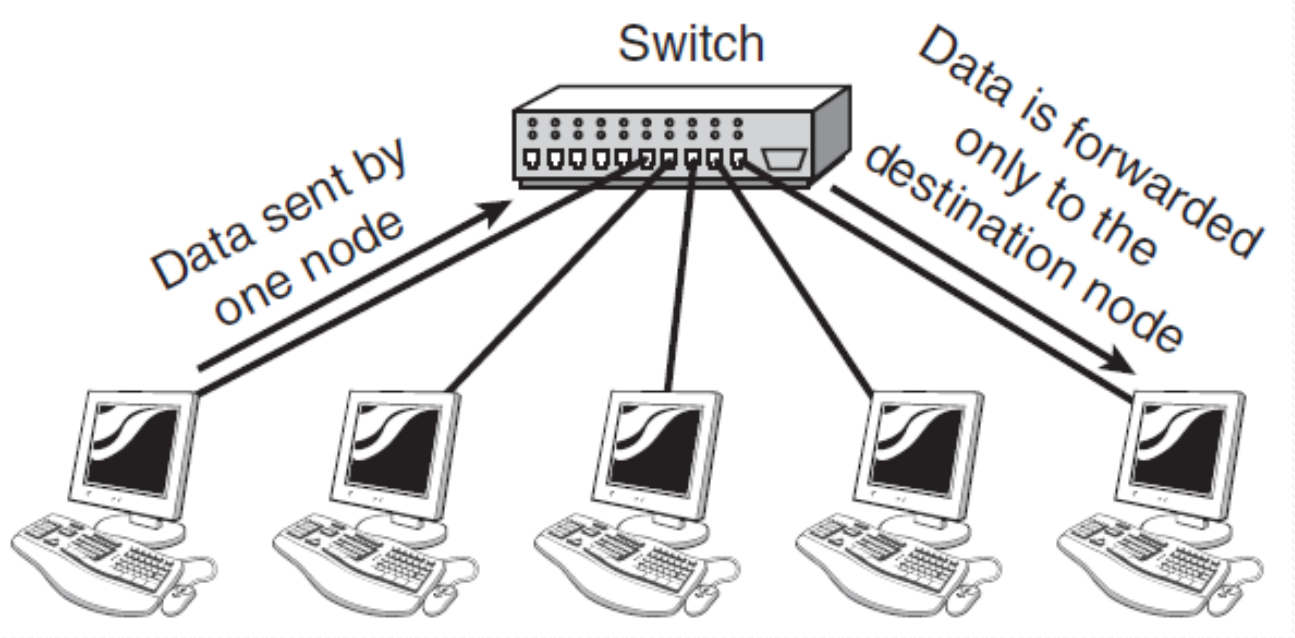

Figure 2 How a switch works.

Wired Networking equipment

Switches can also further improve performance over the performance of hubs by using a mechanism called full-duplex. On a standard network connection, the communication between the system and the switch or hub is said to be half-duplex. In a half-duplex connection, data can be either sent or received on the wire but not at the same time.

Because switches manage the data flow on the connection, a switch can operate in full-duplex mode—it can send and receive data on the connection at the same time. In a full-duplex connection, the maximum data throughput is double that for a half-duplex connection—for example, 10Mbps becomes 20Mbps, and 100Mbps becomes 200Mbps. As you can imagine, the difference in performance between a 100Mbps network connection and a 200Mbps connection is considerable.

Wired Networking equipment

Switches use three methods to deal with data as it arrives:

Cut-through: In a cut-through configuration, the switch begins to forward the packet as soon as it is received. No error checking is performed on the packet, so the packet is moved through quickly. The downside of cut-through is that because the integrity of the packet is not checked, the switch can propagate errors.

Store-and-forward: In a store-and-forward configuration, the switch waits to receive the entire packet before beginning to forward it. It also performs basic error checking.

Fragment-free: Building on the speed advantages of cut-through switching, fragment free switching works by reading only the part of the packet that enables it to identify fragments of a transmission.

Wired Networking equipment

Hub and Switch Ports

Hubs and switches have two types of ports: medium dependent interface (MDI) and medium dependent interface crossed (MDI-X). The two types of ports differ in their wiring. As the *X* implies, an MDI-X port's wiring is crossed; this is because the transmit wire from the connected device must be wired to the receive line on the other.

On most modern hubs and switches, a special port called the *uplink port allows you to connect* two hubs and switches to create larger networks. Because the aim of this type of network connection is to make each hub or switch think that it is simply part of a larger network,

the connection for the port is not crossed; a straight-through network cable is used to connect the two hubs or switches together. Figure 2 shows the uplink port on an Ethernet switch.

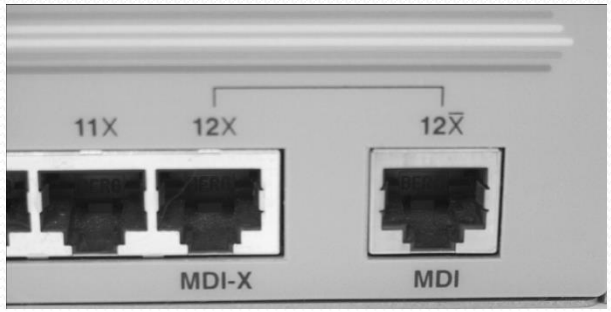

Figure 3 uplink port

Wired Networking equipment

3. Router

Routers are an increasingly common sight in any network environment, from a small home office that uses one to connect to an Internet service provider (ISP) to a corporate IT environment where racks of routers manage data communication with disparate remote sites. Routers make internetworking possible, and in view of this, they warrant detailed attention.

Routers are network devices that literally route data around the network. By examining data as it arrives, the router can determine the destination address for the data; then, by using tables of defined routes, the router determines the best way for the data to continue its journey.

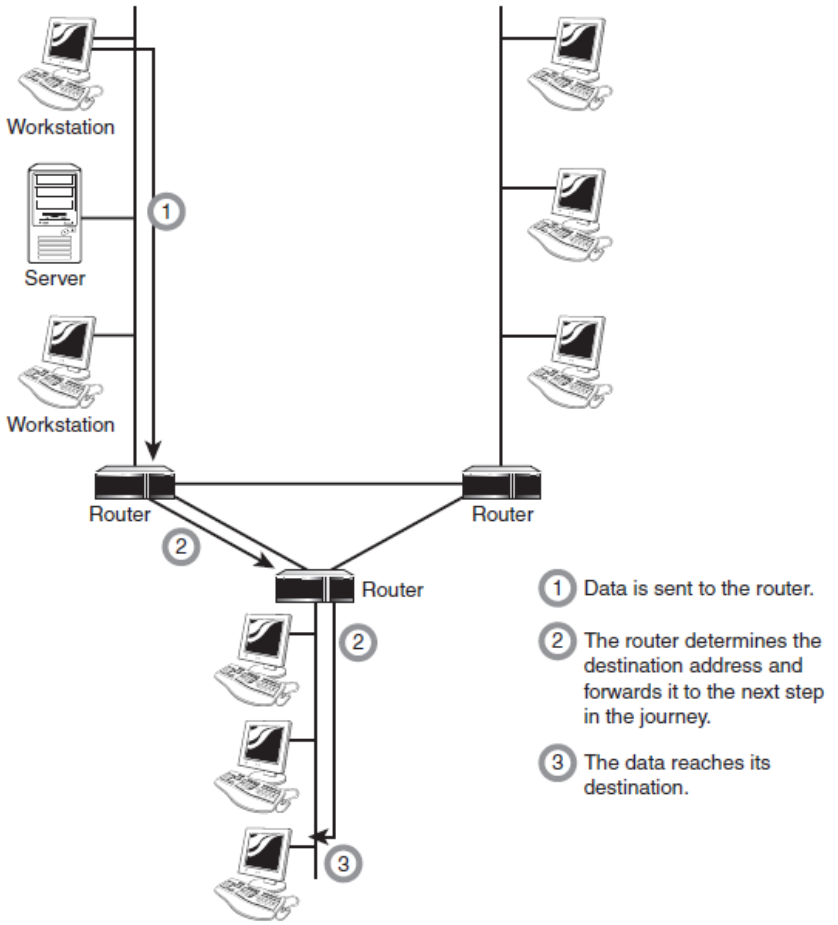

Figure 1 The basic function of a router.

Wired Networking equipment

Unlike bridges and switches, which use the hardware-configured MAC address to determine the destination of the data, routers use the software-configured network address to make decisions. This approach makes routers more functional than bridges or switches, and it also makes them more complex because they have to work harder to determine the information. Figure 1 shows basically how a router functions.

The basic requirement for a router is that it must have at least two network interfaces. If they are LAN interfaces, the router can manage and route the information between two LAN segments. More commonly, a router is used to provide connectivity across wide area network (WAN) links.

Figure 2 shows a router with two LAN ports (marked AUI 0 and AUI 1) and two WAN ports (marked Serial 0 and Serial 1). This router is capable of routing data between two LAN segments and two WAN segments.

Figure 2 A router with two LAN ports and two WAN ports.

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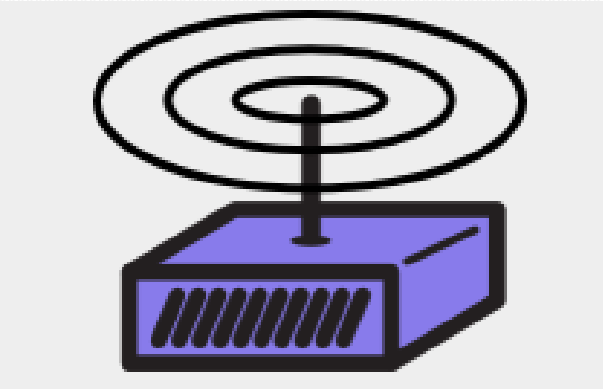
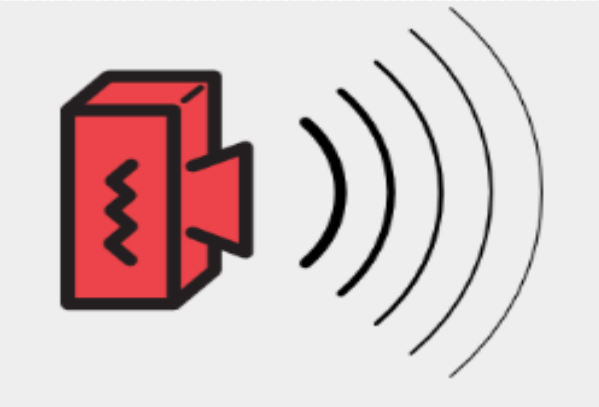
There are three types of routers you will use:

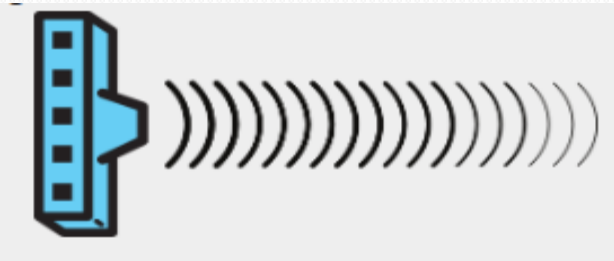
1. Omni directional:. These can send and receive wireless signals in every direction.



2. Sector. These send and receive wireless signals in a limited arc. Limit the connections these routers make to a wedge-shaped area.



3. Focused. These send and receive wireless signals in a narrow beam. Limit the connections to a single thin line.

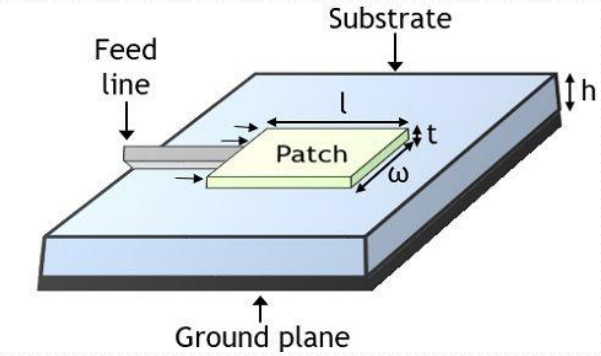


Microstrip Patch Antenna

An antenna that is formed by etching out a patch of conductive material on a dielectric surface is known as a **patch antenna.** The dielectric material is mounted on a ground plane, where the ground plane supports the whole structure. Also, the excitation to the antenna is provided using feed lines connected through the patch.

As it is formed using a microstrip technique by fabricating on a printed circuit board thus is also known as **Microstrip antenna** or **printed antenna**.

Generally, patch antennas are considered as low profile antennas and are used for microwave frequency applications having frequency greater than **100 MHz**.



The substrate which is nothing but the dielectric material is used to separate the strip from the ground plane.

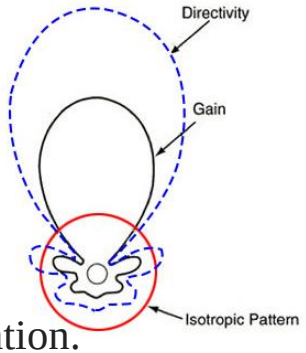
Basically the patch or strip and the feed lines are photo-etched on the surface of the substrate. The patches can be formed in multiple shapes, however, due to easy fabrication *rectangular, circular or square-shaped patches* are generally used.

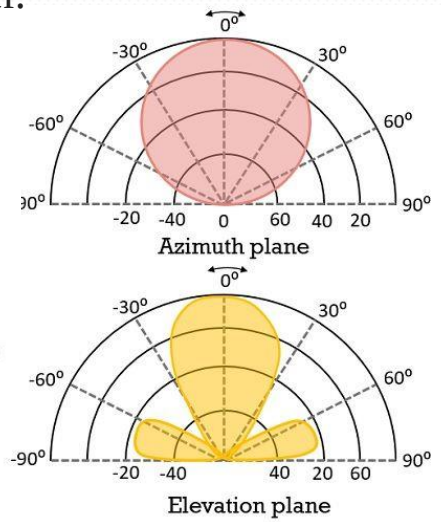
Microstrip Patch Antenna

Performance Characteristics

1. The patch of the antenna must be a very thin conductive region, $\mathbf{t<<\lambda_0}$ (: λ_0 free space wavelength).
2. The ground plane must have comparatively **very large dimensions** than the patch.
3. Photo-etching is done to fabricate the radiating element and feed lines on the substrate.
4. A thick dielectric substrate with dielectric constant within the range of **2.2 to 12** provides good antenna performance.
5. Arrays of microstrip elements in the antenna configuration provide greater directivity.
6. Microstrip antennas provide **high beamwidth**.
7. A very **high-quality factor** is offered by a patch antenna. A large Q results in a narrow bandwidth and low efficiency. However, this can be compensated by increasing the thickness of the substrate. However, the increase in thickness beyond a certain limit will cause an unwanted loss of power.

Gain is the product of directivity and efficiency. Where efficiency accounts for the losses on the antenna such as manufacturing faults, surface coating losses, dielectric, resistance, VSWR, or any other factor.





Radiation Patterns of Patch or Microstrip Antenna

Advantages

- ✓ The antenna is of small size and less bulky.
- ✓ It offers an easy fabrication process.
- ✓ Due to less volume and small size, there is an easy installation.
- ✓ It provides easy integration with other devices.
- ✓ It can perform dual and triple frequency operations.
- ✓ The arrays of the antenna can be easily constructed.
- ✓ It offers a high degree of robustness over rigid surfaces.

Wireless Networking equipment

Wireless Access Point (WAP):

Wireless access points, referred to as either WAPs or wireless APs, are a transmitter and receiver(transceiver) device used for wireless LAN (WLAN) radio signals. *A WAP is typically a separate* network device with a built-in antenna, transmitter, and adapter.

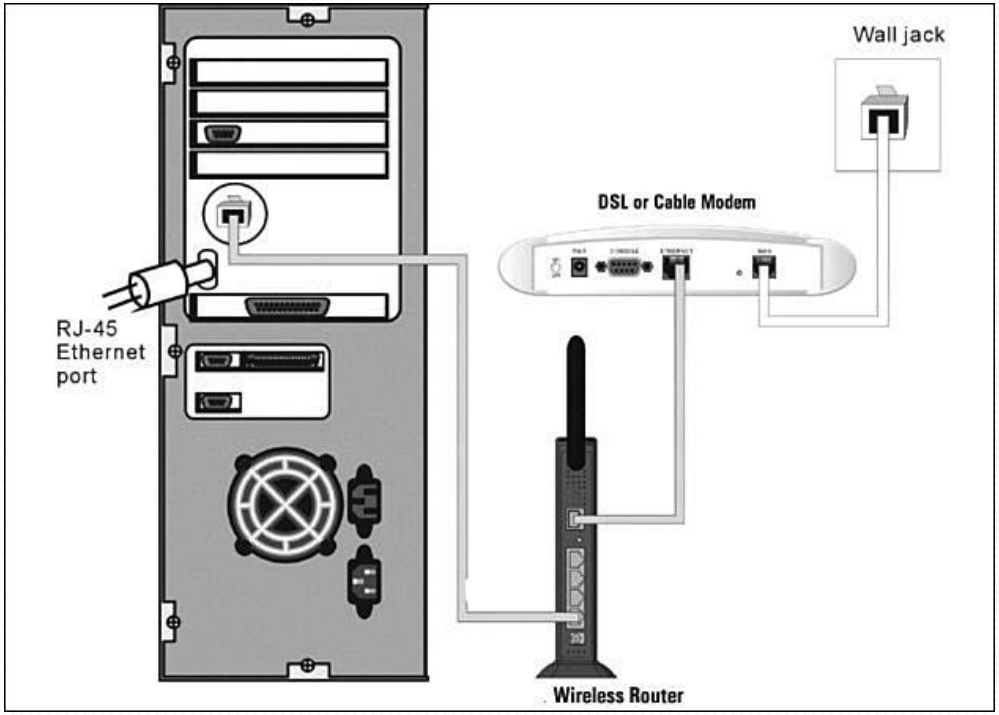


Figure 1 WAPs connect WLANs and a wired Ethernet LAN.

Wireless Networking equipment

WAPs use the wireless infrastructure network mode to provide a connection point between WLANs and a wired Ethernet LAN. WAPs also typically have several ports allowing a way to expand the network to support additional clients.

Depending on the size of the network, one or more WAPs may be required. Additional WAPs are used to allow access to more wireless clients and to expand the range of the wireless network.

Each WAP is limited by a transmissions range, the distance a client can be from a WAP and still get a useable signal. The actual distance depends on the wireless standard being used and the obstructions and environmental conditions between the client and the WAP. Figure 1 shows an example of a WAP in a network configuration.

Wireless Access Points: A WAP can operate as a bridge connecting a standard wired network to wireless devices or as a router passing data transmissions from one access point to another.

Wireless Networking equipment

As mentioned, a WAP is used in an infrastructure wireless network design. Used in the infrastructure mode, the WAP receives transmissions from wireless devices within a specific range and transmits those signals to the network beyond. This network may be a private Ethernet network or the Internet. The transmission range a WAP can support and number of wireless devices that can connect to it depends on the wireless standard being used and the signal interference between the two devices.

In infrastructure wireless networking, there may be multiple access points to cover a large area or only a single access point for a small area such as a single home or small building.

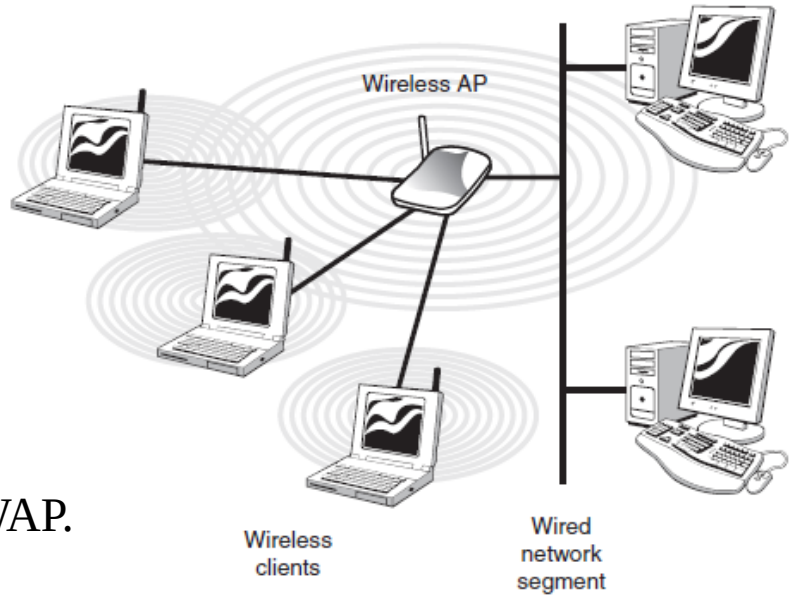
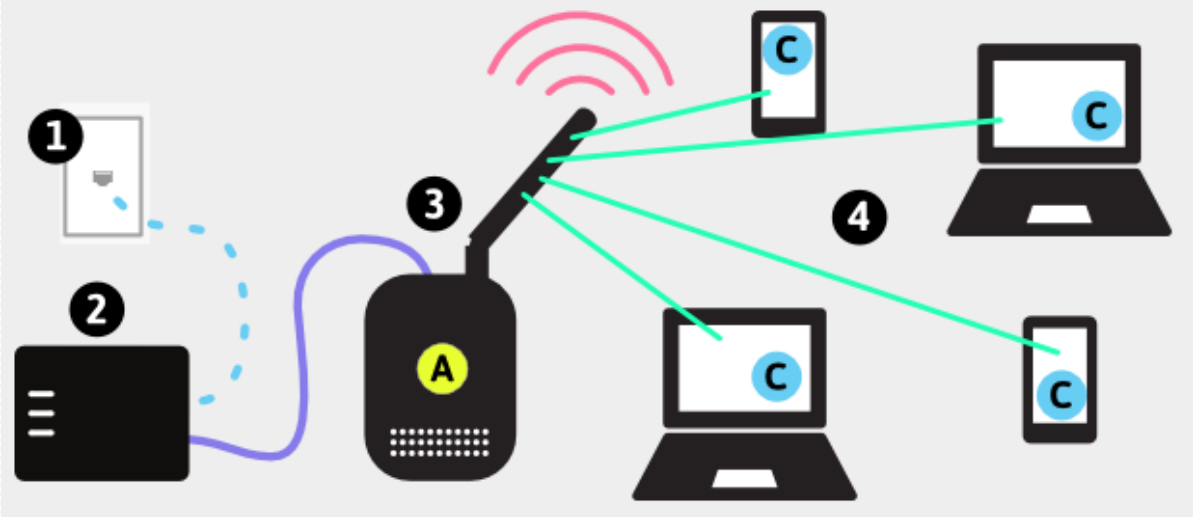


Figure 2: An infrastructure wireless network uses a WAP.

Wireless Networking equipment :Access Point

1. Access Point - Home or Office network:

Wireless networks used in your home or office are generally a combination of a router and a wireless Access Point (AP).



In the diagram above:

1 represents the connection to the Internet (Optional - networks can function without the Internet).

2 represents the router that assigns IP addresses and provides a firewall between your network and the Internet.

3 represents the Access Point, providing a wireless bridge between the router and the users' devices.

4 represent user devices, such as laptops, tablets, and smart phones.

Wireless Networking equipment : Access Point

Point to Point link - Long Distance Connections:

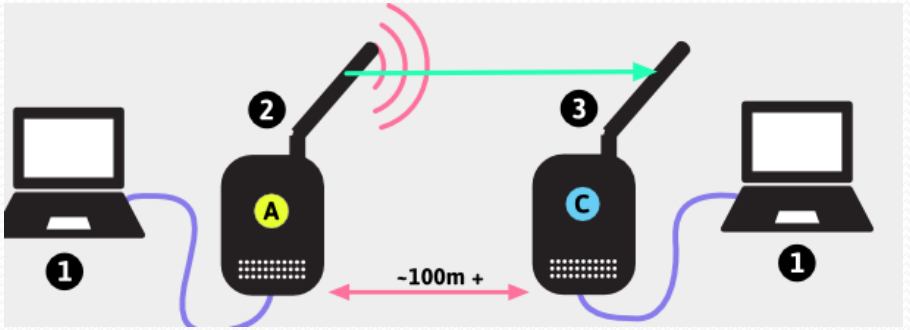
Wireless networks can be used to connect distant buildings or areas. It usually requires very focused antennas - such as a dish antenna - that can send a narrow beam in a specific direction.

A long-distance connection is often called a “point-to-point”, or “PtP” link. The name describes the concept: two points are connected together, and nothing else.

This requires two wireless devices: one configured as an Access Point; the other configured as a Client. In the example below, two wireless devices are configured to create a point-to-point link.

Wireless Networking equipment : Access Point

2. Omni directional Access Point and Client Link:

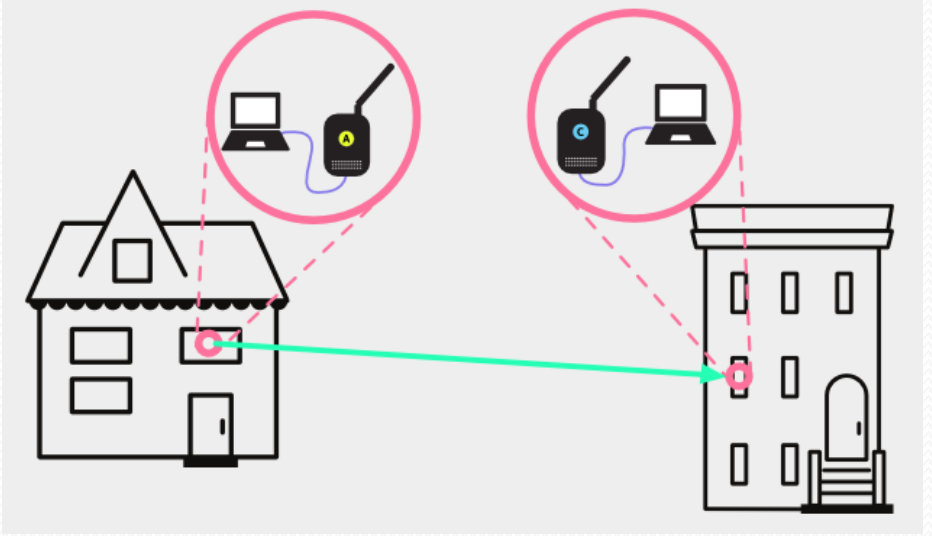


✓Represents computers connected with Ethernet cables to the wireless devices. These computers are connected to each other over the Point-to-Point link.

✓Represents the wireless device setup as an Access Point.

✓Represents the wireless device setup as a Client, connected to the Access Point.

✓This could look like the building-to-building connection, as shown below:



Wireless Networking equipment : Access Point

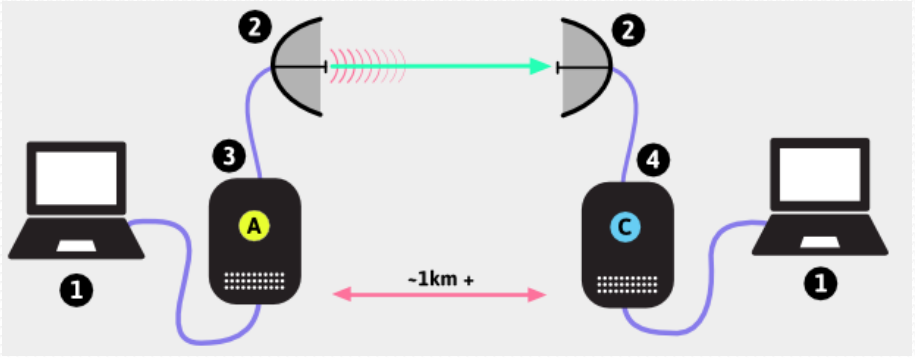
3. Long-distance directional Access Point and Client Link:

✓Represents computers connected with Ethernet cables to the wireless devices. These computers are connected to each other over the Point-to-Point link.

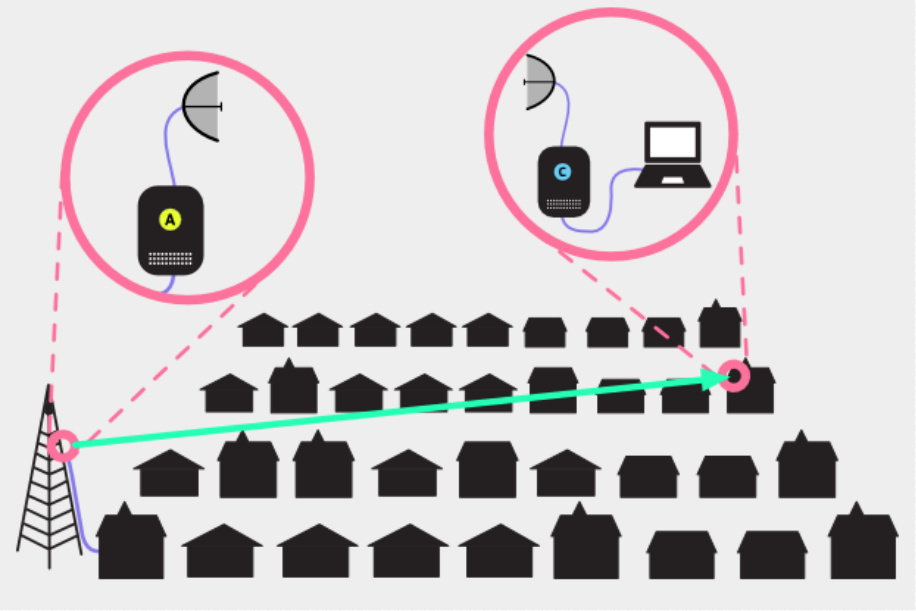
✓Represents the wireless device setup as an Access Point.

✓Represents dish antennas that focus the wireless signal, allowing connections over long distances.

✓Represents the wireless device setup as a Client, connected to the Access Point.



In both of these examples, there are just two wireless devices linked together - and the antennas determine the range at which they can connect. The more focused the signal, the further the point-to-point link can reach. As the distance between the devices grow, it is more an more important to focus the signal with antennas - at both ends of the connection. Otherwise one end may hear the other, but not be loud enough to be heard!



Wireless Networking equipment : Access Point

4. Point to Multipoint - Wireless Internet Service Provider model

If we combine the two principles used in the networks above - many client devices connecting to an Access Point, and more powerful antennas used for outdoor devices to create longer links - we can create Point to Multipoint networks. These are larger-scale Access Point networks, where there is a single device in the "centre", controlling all of the Clients connected to it and bridging those connections to the Internet.

These types of networks are used by Wireless Internet Service Providers (WISPs) to connect homes and businesses to the Internet. Instead of running cables around a neighbourhood or town, they put up one or more powerful Access Points on a tall building or tower. By installing directional wireless devices in a Client role on other rooftops, and pointing them back at the tall building or tower, those buildings can be connected to the WISP's networks, and thereby the Internet.

Wireless Networking equipment : Access Point

The diagram below demonstrates one model for how this works. There is a powerful Access Point mounted on a high building, and several nearby buildings with rooftop wireless Client devices: this forms the Point-to-Multipoint network. Connected to each of the Client devices is an indoor router or Access Point, which allows users to connect their computers, laptops, tablets, or smart phones to the WISP network.

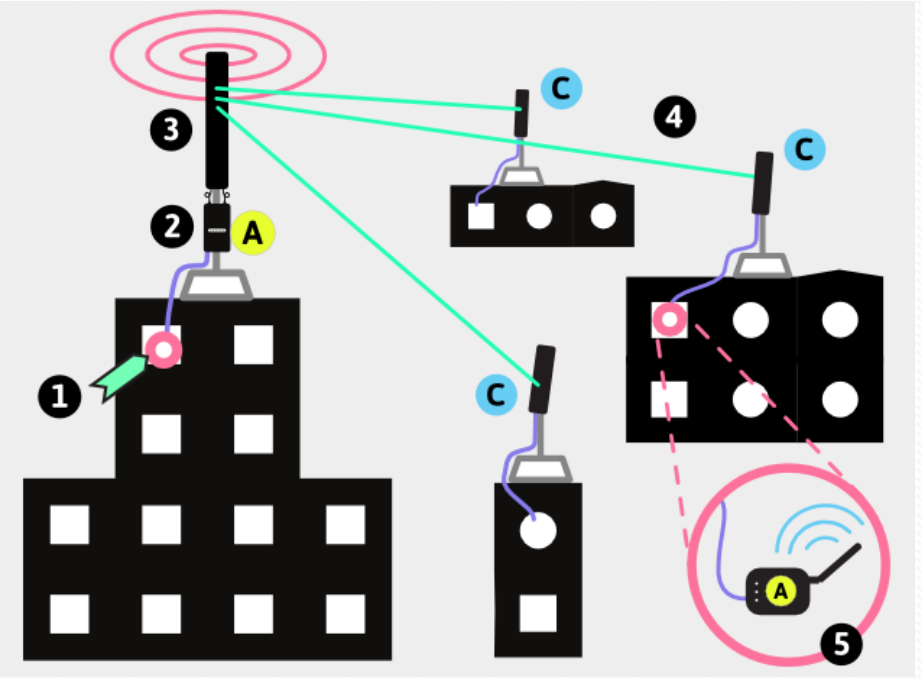
1 represents the connection to the Internet.

2 represents an Access Point providing the signal for Client devices to connect to.

3 represents a powerful omnidirectional (all directions) antenna, sending the wireless signal to a large area around the building.

4 represent Client wireless devices on the roof of other buildings, linking to the powerful Access Point, and able to connect to the Internet through that AP.

5 represents small Access Points distributing wireless service inside the building.



Wireless Networking equipment : Access Point

5. Mesh - Neighbour-to-Neighbour Networks

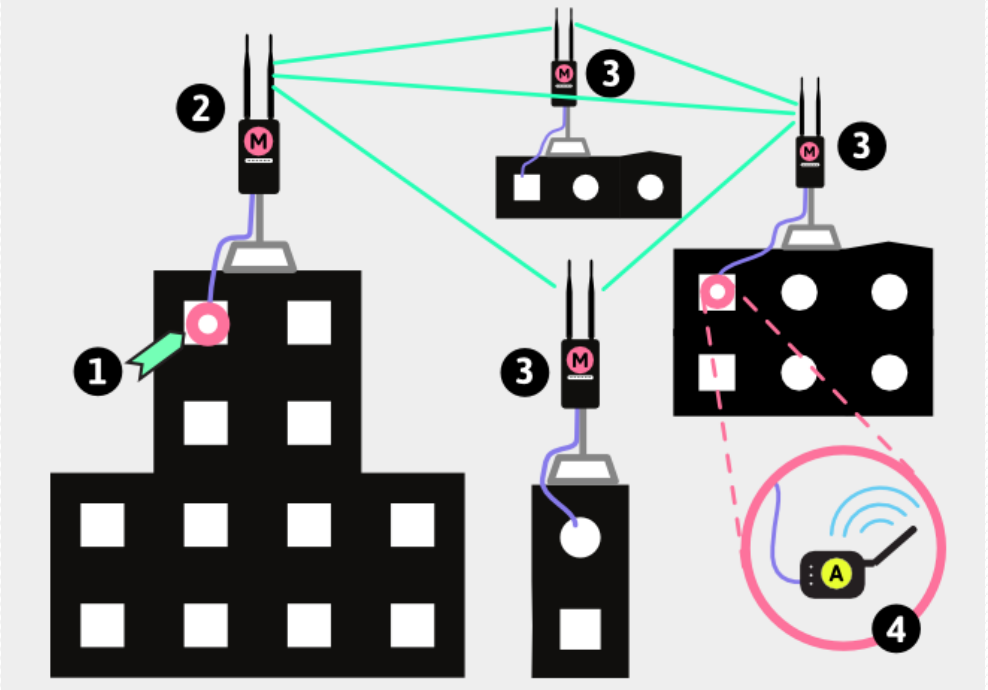
A mesh network takes the principle of Point-to-Multipoint, and extends it to the idea of every node connecting to every other node in range. In effect, this creates a “Multipoint-to-Multipoint” network. Wireless mesh nodes are installed on the rooftops of various buildings, and those nodes that are in range and don’t have anything blocking the signals will connect. These nodes will share all resources connected to them such as local servers hosting applications and connections to the Internet. They can also be connected to computers, Access Points, or routers inside the buildings so users can access the resources anywhere on the network.

1 represents the connection to the Internet.

2 represents a Mesh Node with a connection to the Internet, with an omnidirectional (all directions) antenna.

3 represents Mesh Nodes with omnidirectional (all directions) antennas. These nodes are receiving Internet access from Mesh Node **B**. They may be connected to different devices inside the building.

4 represents small Access Points distributing wireless service inside the building.



Wireless Networking equipment : Access Point

6. Hybrid Networks

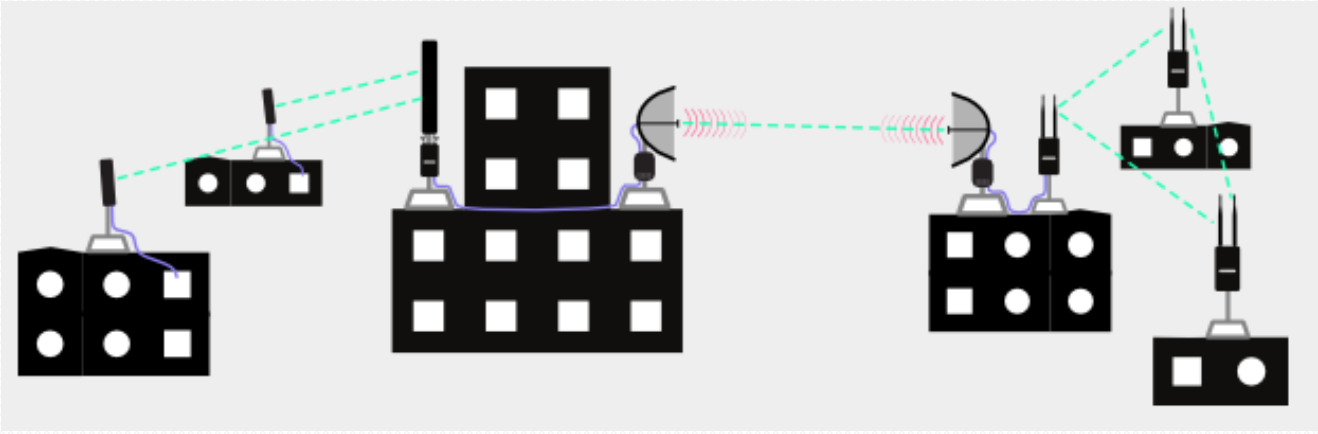
When designing and building town or community-sized networks, it may be difficult or impossible to use a single method to connect everyone. For instance, a single Point-to-Multipoint network may not cover an entire community.

Mesh nodes can be used to extend client sites to nearby buildings. Point-to-point connections can bridge longer distances and join several disconnected networks together.

In the diagram below, we can see an example of a hybrid network. There is no single example that can cover all of the possible uses for a network!

In the activity that follows, you will explore the different ways to build a network by working through scenarios.

One last note before we move on to the activity - in the examples above, and in the activity that follows, the diagrams focus on building networks across rooftops or from building to building. This is generally the best way to build networks that cover neighbourhoods, towns, or communities.



Wireless Network : Wi-Fi

Wi-Fi Working Principle, Types of Technologies and Applications

Wi-Fi is a popular wireless networking technology. Wi-Fi stands for “wireless fidelity”. The Wi-Fi was invented by NCR corporation/AT&T in Netherlands in 1991. By using this technology we can exchange the information between two or more devices.

Wi-Fi has been developed for mobile computing devices, such has laptops, but it is now extensively using for mobile applications and consumer electronics like televisions, DVD players and digital cameras.

Whenever the computer receives the signals with in the range of 100-150 feet for router it connect the device immediately.

Wireless Network : Wi-Fi

Types of WI-FI Technologies:

Currently they are four major types of WIFI technologies.

✓Wi-Fi-802.11a
✓Wi-Fi-802.11b
✓Wi-Fi-802.11g
✓Wi-Fi-802.11n

802.11a is the one of a series of wireless technology. That defines the format and structure of the radio signals sent out by WI-FI networking routers and antennas.

Wi-Fi-802.11b:

802.11b is the one of a series of wireless technology. 802. 11b support bandwidth 11mbps. Signal in unregulated frequency spectrum around 2.4 GHz. This is a low frequency compared with Wi-Fi-802.11a means it is working reasonable distance.

It is interference with micro owns cordless phones and other appliance. It is low-cost; signal range is good using home appliance.

Wireless Network : Wi-Fi

Wi-Fi-802.11g:

In 2002 and 2003, This Technology supporting a newer slandered products. It is best technology of 802.11a and 802.11b. The 802.11g support bandwidth up to 54 mbps and it use a 2.4 GHz frequency for greater range. This cost is more than 802.11b. It is fast accessing and maximum speed.

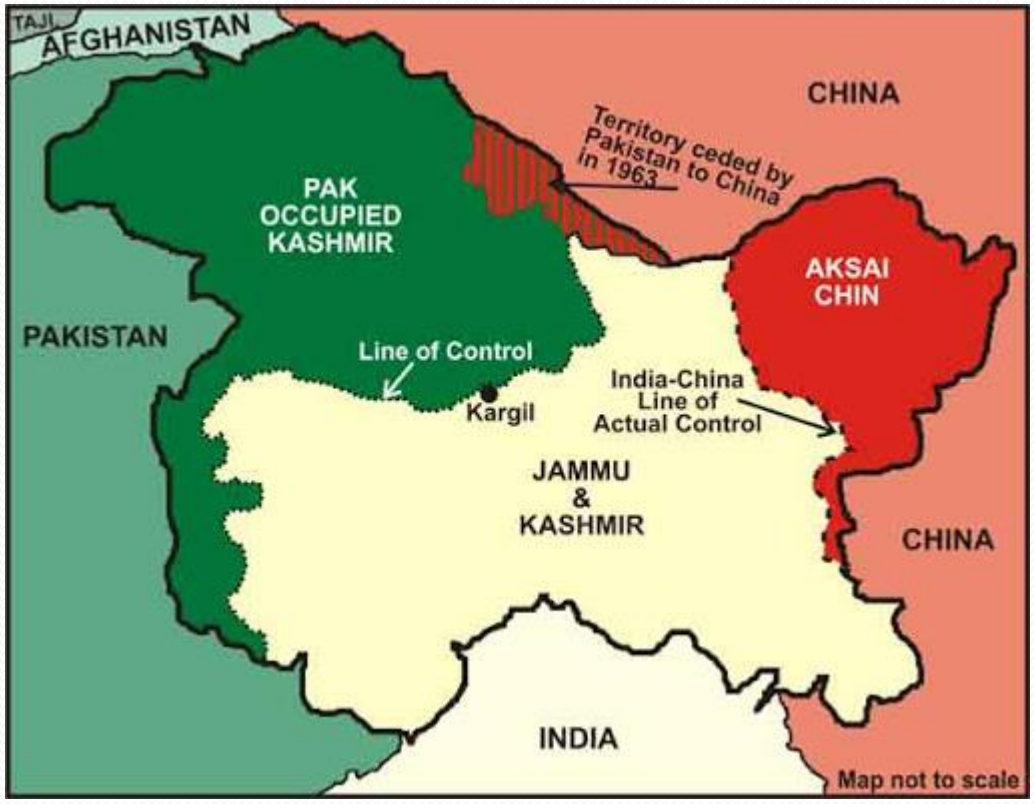
Wi-Fi-802.11n:

The 802.11n is the newest WIFI technology. It was designed to improve on 802.11g .The amount of bandwidth supported by utilizing multiple wireless signals and antennas instead of one. It supports 100 mbps bandwidth and increased signal intensity.

Applications:

Mobile applications, Business applications, Home applications, Computerized application, Automotive segment, Browsing internet, Video conference

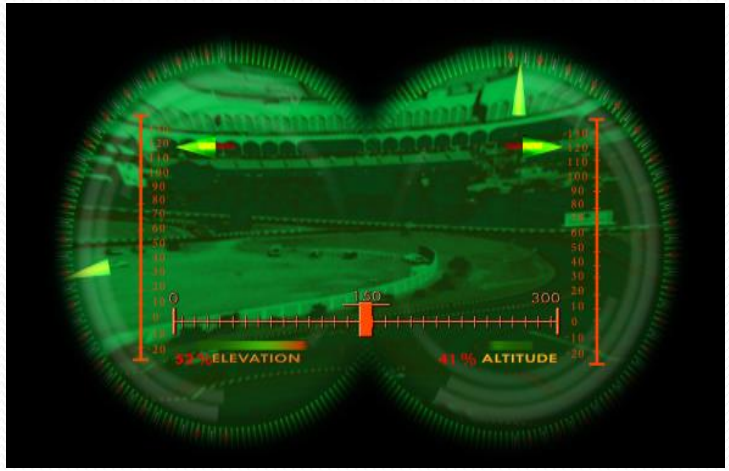
IoT Case Studies



An Unmanned Vehicle for Military Application

Objective :

To Control, Monitor and Locate the Global Position of an Unmanned Vehicle.



Code Explanation

```
1 #include <ESP8266WiFi.h>
2 WiFiClient client;
3 WiFiServer server(80);
```

Library and WIFI client

```
4 const char* ssid = "Mahi";
5 const char* password = "87654321";
6 String  command =""; // Command received from Android device
```

WIFI User ID, Password Assigning

```
8 // Set Motor Control Pins
9 int rightMotor2 = 13;     // D7 - right Motor -
10 int rightMotor1 = 15;     // D8 - right Motor +
11 int leftMotor2 = 0;     // D3 - left Motor -
12 int leftMotor1 = 2;     // D4 - left Motor +
13 int eneLeftMotor = 12;  // D6 - enable Mortor Left
14 int eneRightMotor = 14; // D5 - enable Mortor Right
```

Pin Assigning

Code Explanation

```
/* command motor forward */
void forwardMotor(void)
{
  digitalWrite(eneLeftMotor,HIGH);
  digitalWrite(eneRightMotor,HIGH);

  digitalWrite(leftMotor1,HIGH);
  digitalWrite(leftMotor2,LOW);
  digitalWrite(rightMotor1,HIGH);
  digitalWrite(rightMotor2,LOW);
}
```

```
/* command motor turn left */
void leftMotor(void)
{
  digitalWrite(eneLeftMotor,HIGH);
  digitalWrite(eneRightMotor,HIGH);

  digitalWrite(leftMotor1,LOW);
  digitalWrite(leftMotor2,HIGH);
  digitalWrite(rightMotor1,HIGH);
  digitalWrite(rightMotor2,LOW);
}
```

```
/* command motor stop */
void stopMotor(void)
{
  digitalWrite(eneLeftMotor,LOW);
  digitalWrite(eneRightMotor,LOW);

  digitalWrite(leftMotor1,LOW);
  digitalWrite(leftMotor2,LOW);
  digitalWrite(rightMotor1,LOW);
  digitalWrite(rightMotor2,LOW);
}
```

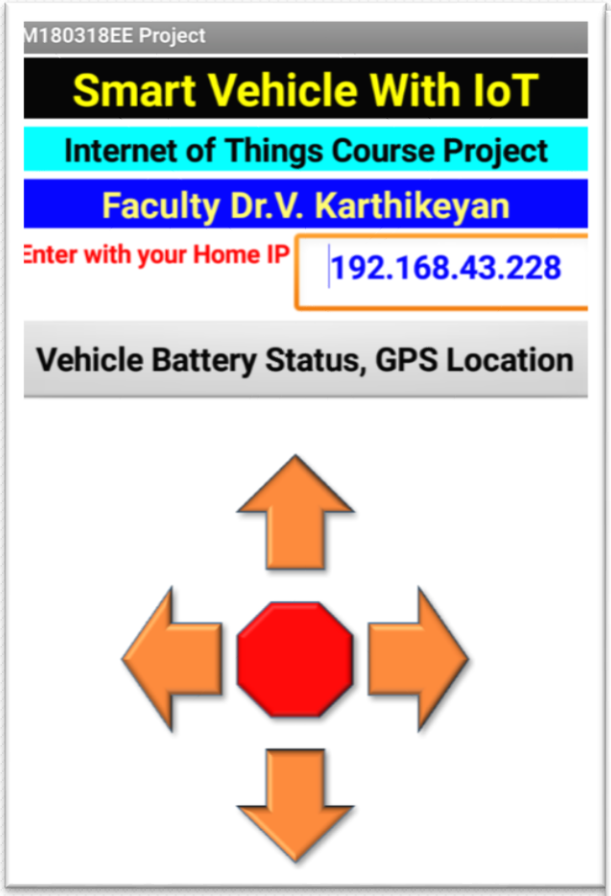
```
/* command motor backward */
void reverseMotor(void)
{
  digitalWrite(eneLeftMotor,HIGH);
  digitalWrite(eneRightMotor,HIGH);

  digitalWrite(leftMotor1,LOW);
  digitalWrite(leftMotor2,HIGH);
  digitalWrite(rightMotor1,LOW);
  digitalWrite(rightMotor2,HIGH);
}
```

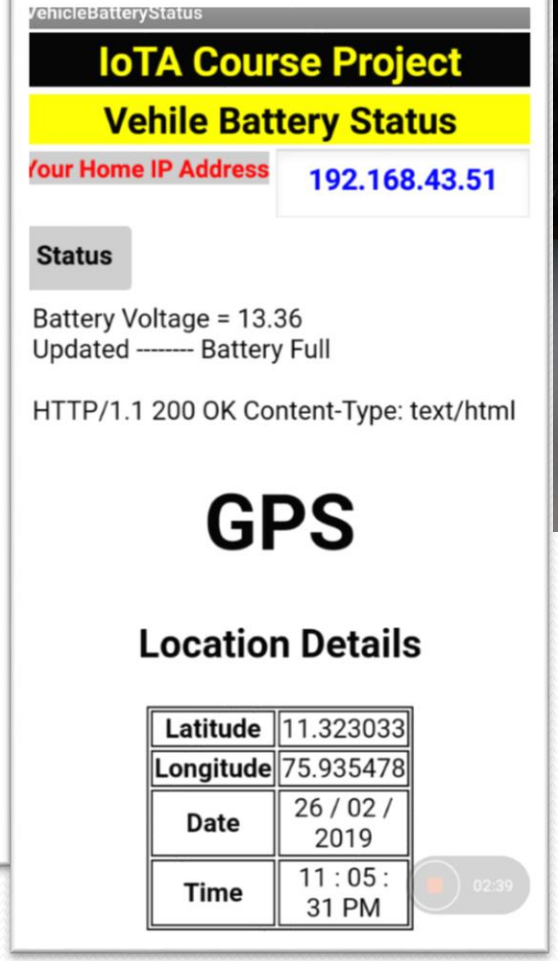
```
/* command motor turn right */
void rightMotor(void)
{
  digitalWrite(eneLeftMotor,HIGH);
  digitalWrite(eneRightMotor,HIGH);

  digitalWrite(leftMotor1,HIGH);
  digitalWrite(leftMotor2,LOW);
  digitalWrite(rightMotor1,LOW);
  digitalWrite(rightMotor2,HIGH);
}
```

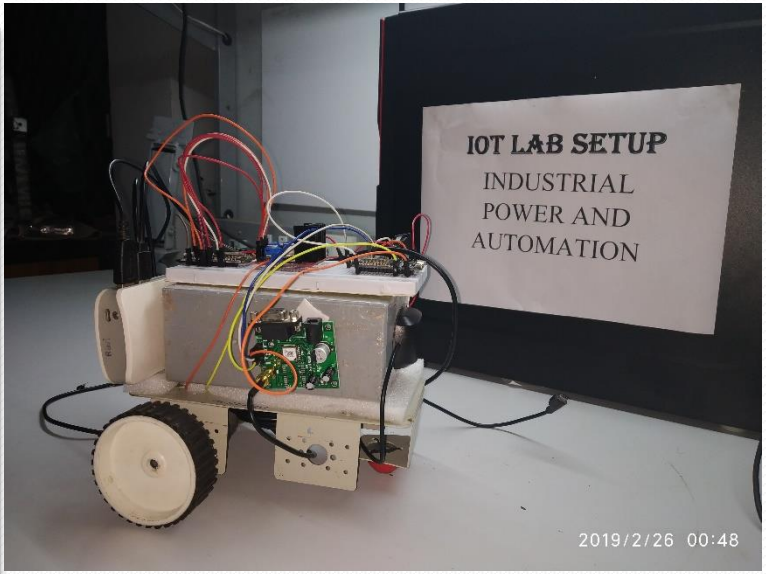
```
for(unsigned int i=0;i<10;i++){
Vvalue=Vvalue+analogRead(BAT);
delay(5);
}
Vvalue=(float)Vvalue/10.0;
Rvalue=(float)(Vvalue/1024.0)*5;
Tvoltage=Rvalue*RatioFactor;
```

```
client.println("Battery Voltage =");
client.print(Tvoltage);
client.println("<br>");
if(value == HIGH) {
  client.println("Updated");
} else {
  client.print("Not Updated");
}
client.println("--------");
if(Tvoltage<=5){
  client.println("Battery dead OR disconnected");
  }
else if(Tvoltage>5 && Tvoltage<=10){
  client.println("Need Imediate recharge");
  }
else if(Tvoltage>10 && Tvoltage<=12){
  client.println("Recharge");
  }
else{
    client.println("Battery Full");
    }
```

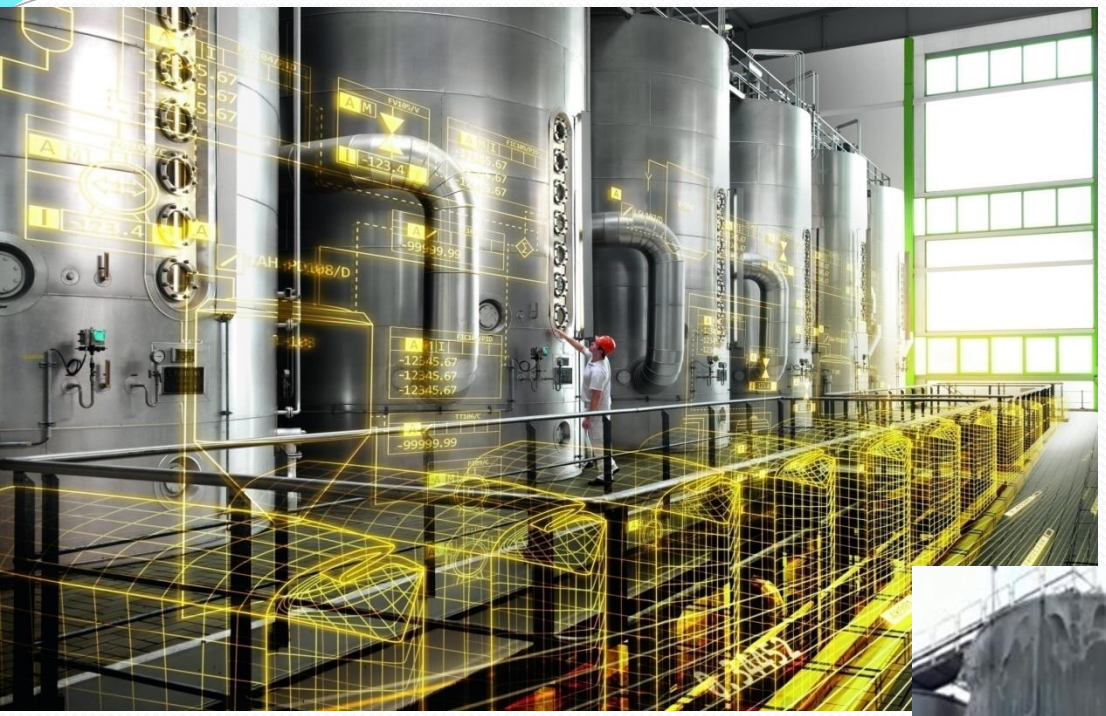
An Unmanned Vehicle for Military Application







Industrial Applications



India's water crisis is forcing farmers to finally rethink what they grow

Water crisis has forced Modi govt to try & turn around established farming practices & convince farmers to shift f water-guzzlers like rice and wheat.

BIBHUDATTA PRADHAN and PRATIK PARIJA 22 July, 2020 8:47 am IST

THIS STORY IS FROM SEPTEMBER 18, 2019

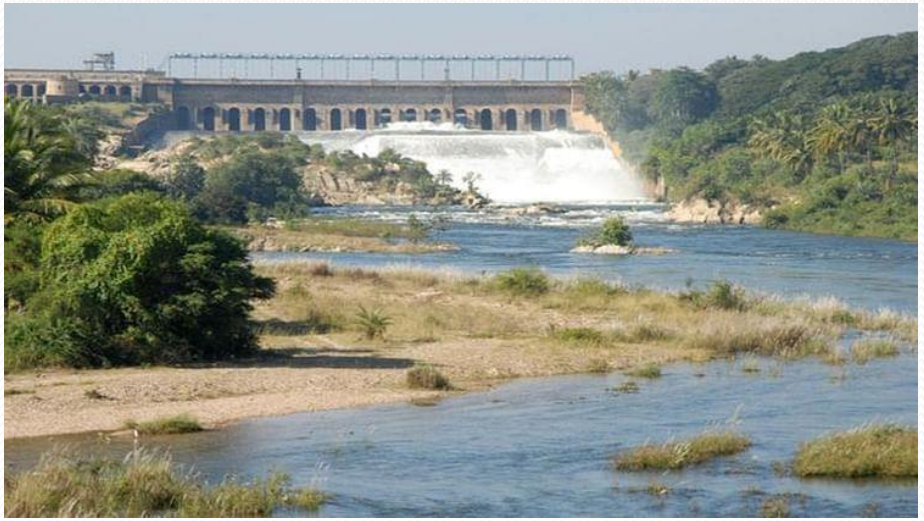
Why 80% of Cauvery water was wasted in past 10 days

D Vincent Arockiaraj | TNN | Sep 18, 2019, 08:41 IST

Updated on : Friday, February 16, 2018, 4:40 PM IST

Cauvery Water Dispute: All you need to know about the 100-year war

Both the sides remain unsatisfied



River Water Management

Nearly 1,900 dead in monsoon rains, floods across India

Last Updated: Oct 04, 2019, 03:39 PM IST

SHARE FONT SIZE SAVE PRIN

868 people killed in floods in 11 states: Govt

According to IMD's Sunday bulletin, parts of Chhattisgarh, Odisha, Konkan and Goa recorded very heavy to extremely heavy rains on Saturday and Sunday morning.

INDIA Updated: Aug 17, 2020, 06:31 IST

Code Explanation

Declaration Part

```
void setup()
{
  Serial.begin(115200);

  // declaring buzzer and LED as output
  pinMode(buzzer, OUTPUT);
  pinMode(LED, OUTPUT);

  // declaring trigger & echo pin as output & input resp
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);

  // declaring L293D control pins as output
  pinMode(a2, OUTPUT);
  pinMode(a3, OUTPUT);
```

```
  // Connect to WiFi network
  Serial.println();
  Serial.println();
  Serial.print("Connecting to ");
  Serial.println(ssid);
  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED)
  {
    delay(500);
    Serial.print(".");
  }

  Serial.println("");
  Serial.println("WiFi connected");
```

```
  // Start the server
  server.begin();
  Serial.println("Server started");

  // Print the IP address on serial monitor
  Serial.print("Use this URL to connect: ");
  Serial.print("http://");    //URL IP to be typed in mobile/desktop browser
  Serial.print(WiFi.localIP());
}
```

Code Explanation

Definition Part

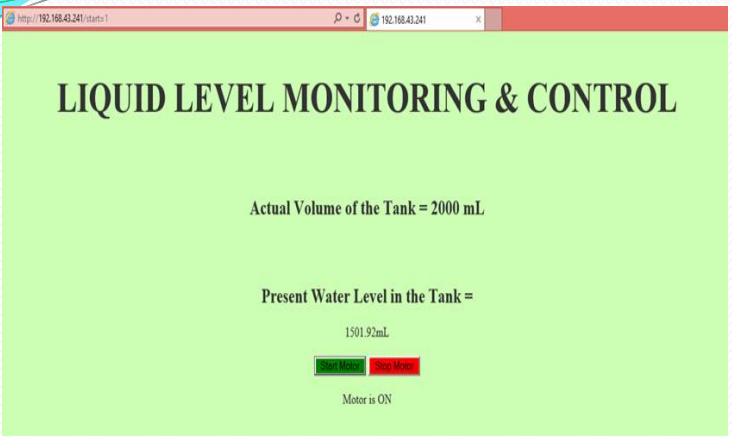
```
void loop()
{
  // Check if a client has connected
  WiFiClient client = server.available();
  if (!client)
  {
    return;
  }

  // Read the first line of the request
  String request = client.readStringUntil('\r');
  Serial.println(request);
  client.flush();
```

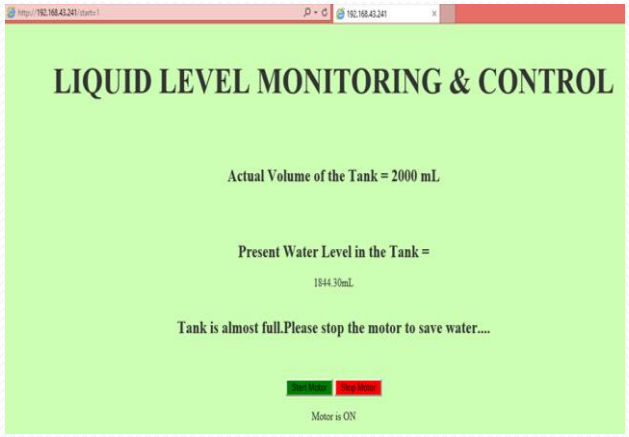
```
// Match the request
if (request.indexOf("/start=1") != -1)
{
   digitalWrite(a2, HIGH); //Start motor
   digitalWrite(a3, HIGH);
   Ms=1;
}

if (request.indexOf("/stop=1") != -1)
{
  digitalWrite(a2, LOW); //Stop motor
  digitalWrite(a3, LOW);
  Ms=0;
}
```

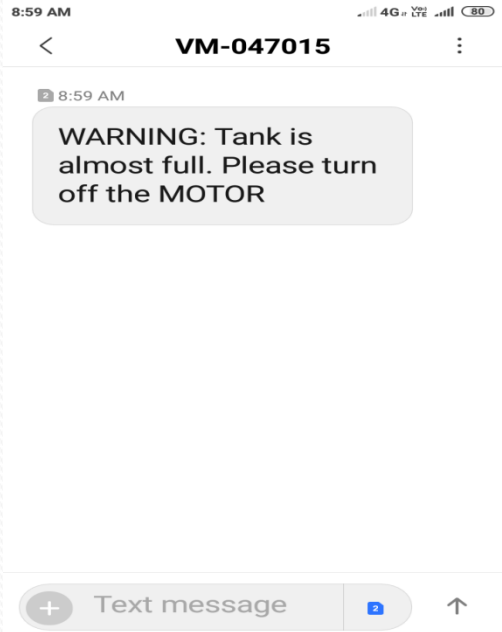
```
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(3);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
microseconds = pulseIn(ECHO_PIN, HIGH, 100000);
seconds = microseconds / 1000000;
m = seconds * 343/2;
height=.45-m;
presentvolume=(3.14*.0425*.0425*height*1000*1000);
if(presentvolume<1800 && presentvolume>1600 && Ms==1)
{
 digitalWrite(LED, HIGH);
 digitalWrite(a2, LOW); //Stop motor
 digitalWrite(a3, LOW);
}
```

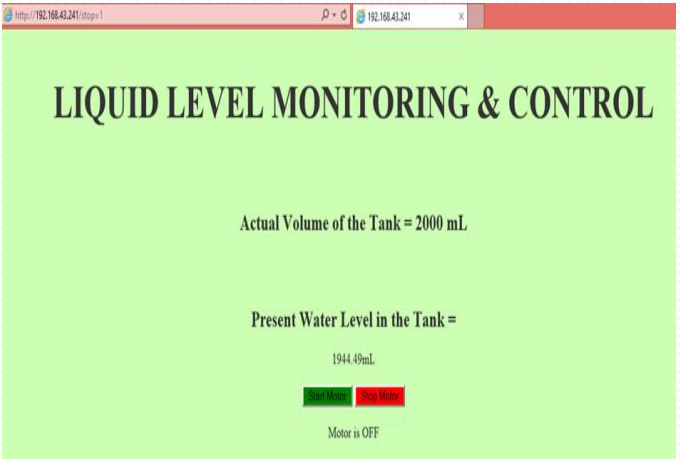
```
if(presentvolume>1800)
{
 tone(buzzer, 1000); // Send 1KHz sound signal...
  if(Ms!=1)
  {
   noTone(buzzer);
  }
}
else
{
 noTone(buzzer);     // Stop sound...
}
```

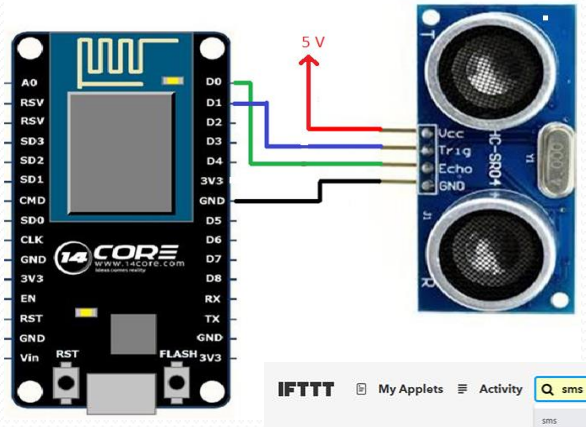
Results



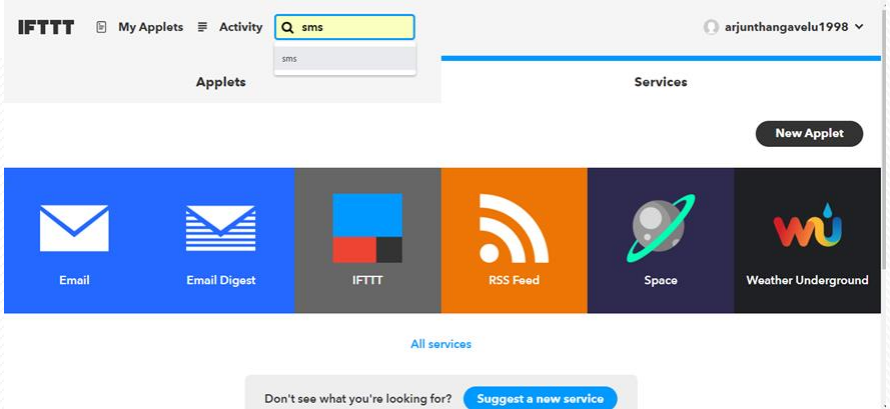








Integration with IFTTT



Role of AIoT in Agriculture

Soil Monitoring

The soil moisture and temperature monitoring in the fields using WSN. Soil test results are monitored through an inductance (L), capacitance (C), and resistance (R) (LCR) meter, and the results are calculated via standard library measurements. Both of these systems are maintained through multiple communication technologies such as GPRS, ZigBee, and the internet, where the user interacts with the system through web applications

Water Monitoring

The studies that have been categorized in this sub-domain intend to monitor water quality or water pollution by sensing PH, temperature, and chemicals, which can change the normal conditions of water. An IoT-based solution has been presented to monitor the water quality by measuring temperature, conductivity, and turbidity. This solution based on WSN combines sensing devices and monitors the multiple parameters of water in urban areas. Moreover, a WSN-based system helps to monitor the rainfall and water level in irrigation systems.

Disease Monitoring

The system protects the crop by analyzing the collected data from fungal diseases.

Crop and Plant Growth Monitoring

In this sub-domain, farmlands have been analyzed by using the mobile sensors. The basic purpose of the system is to decrease the management costs, improve the quality of apples, and protect from pest attacks.

Role of AIoT in Agriculture

Humidity Monitoring

The humidity level is measured in air by using multiple humidity sensors. An inappropriate amount of humidity leaves a negative impact on plants regarding cell growth

Fertilization and Pest Control

In this domain, an IoT solution provides conservation approaches to improve the quality of the crops and amount of nutrients usage. An online climate monitoring system is available for greenhouses to monitor pests, irrigation, fertilization, and climate.

Greenhouse Illumination Control

An automated agriculture system is developed to monitor the growth of cabbages and melons in greenhouses. The designed system monitors the crop growing process and controls the greenhouse environmental conditions such as temperature, ambient light, and humidity.

Location Tracking

This sub-domain referred to the tracking and tracing of animal locations and any unwanted movement all over the field. Different monitoring devices and sensors have been deployed in the field to save the crop from theft and wild attacks..

Role of AIoT in Agriculture

Sample Images of Tomato Leaf



Bacterial Spot



Early Blight



Healthy



Late Blight



Leaf Mold



Septoria Leaf Spot



Spider Mites



Target Spot



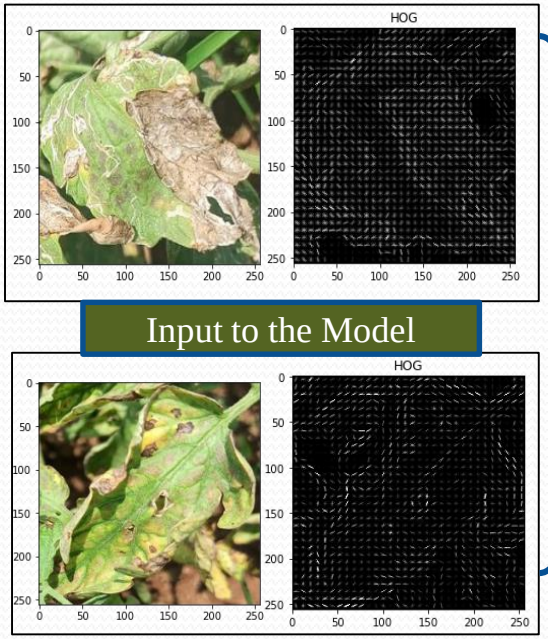
Mosaic Virus

Sample Images of Tomato Leaf Dataset



Yellow leaf Curl virus

Validation of model on Real Tomato leaf images



Input to the Model

```
def create_convolution_layers(input_img):
    x = base_model(input_img, training=False)
    model = Conv2D(128, (3, 3), padding='same', input_shape=input_shape)(x)
    model = LeakyReLU(alpha=0.1)(model)
    model = MaxPooling2D((2, 2),padding='same')(model)
    model = Dropout(0.25)(model)

    model = Conv2D(128, (3, 3), padding='same')(model)
    model = LeakyReLU(alpha=0.1)(model)
    model = MaxPooling2D(pool_size=(2, 2),padding='same')(model)
    model = Dropout(0.25)(model)

    model = Conv2D(128, (3, 3), padding='same')(model)
    model = LeakyReLU(alpha=0.1)(model)
    model = MaxPooling2D(pool_size=(2, 2),padding='same')(model)
    model = Dropout(0.4)(model)
    model = Flatten()(model)

    return model
```

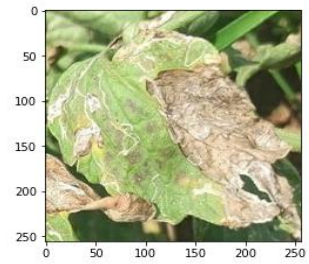
```
def create_convolution_layers1(data_input):
    x = layers.Dense(128, activation='relu')(data_input)
    x = layers.Dropout(0.1)(x)
    x = layers.Dense(128, activation='relu')(x)
    return x
```

```
img_input = Input(shape=(256,256,3))
img_model = create_convolution_layers(img_input)
```

```
data_input = Input(shape=(756,))
data_model = create_convolution_layers1(data_input)

conv = concatenate([img_model, data_model])

conv = Flatten()(conv)

dense = Dense(512)(conv)
dense = LeakyReLU(alpha=0.1)(dense)
dense = Dropout(0.5)(dense)

output = Dense(num_classes, activation='softmax')(dense)

model = Model(inputs=[data_input,img_input], outputs=[output])


model.compile(loss='categorical_crossentropy',
              optimizer=Adam(),
              metrics=['accuracy'])
```

```
for images_batch, labels_batch in dataset_test.take(1):
    first_image = images_batch[1].numpy().astype('uint8')
    first_label = labels_batch[1].numpy()
    plt.imshow(first_image)
    batch_prediction = model.predict(images_batch)
    print("predicted label:",class_names[np.argmax(batch_prediction[1])])
```

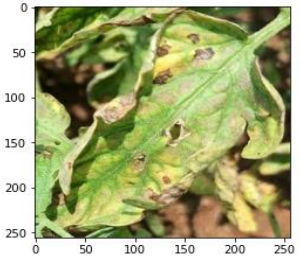
```
predicted label: Tomato___Late_blight
```



Disease Detection by the Model

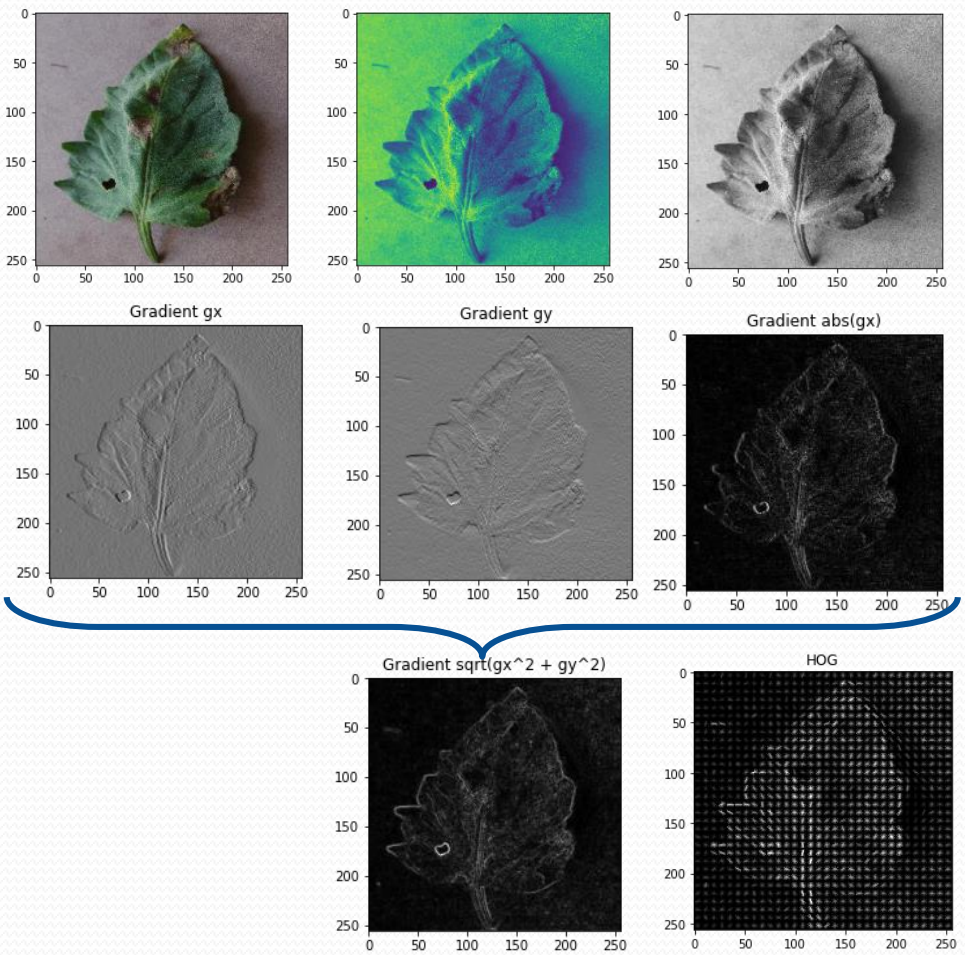
```
for images_batch, labels_batch in dataset_test.take(1):

    first_image = images_batch[0].numpy().astype('uint8')
    first_label = labels_batch[0].numpy()
    plt.imshow(first_image)
    batch_prediction = model.predict(images_batch)
    print("predicted label:",class_names[np.argmax(batch_prediction[0])])
```

```
predicted label: Tomato___Septoria_leaf_spot
```



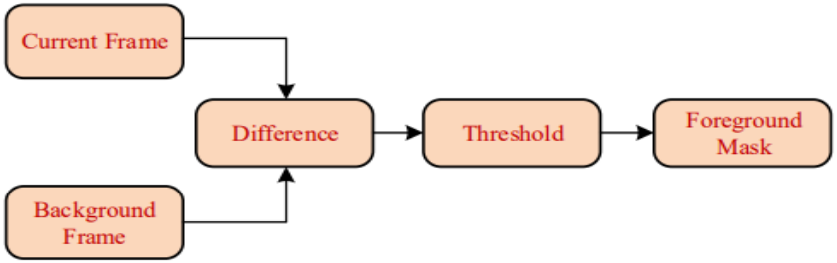
Result of HOG Feature Extraction

```python
def compute_gradient(image: np.ndarray):
    """
    Compute gradient of an image by rows and columns
    """
    gx = np.zeros_like(image)
    gy = np.zeros_like(image)
    # Central difference
    gx[:, 1:-1] = (image[:, 2:] - image[:, :-2]) / 2
    gy[1:-1, :] = (image[2:, :] - image[:-2, :]) / 2

    # Forward difference
    gx[:, 0] = image[:, 1] - image[:, 0]
    gy[0, :] = image[1, :] - image[0, :]

    # Backward difference
    gx[:, -1] = image[:, -1] - image[:, -2]
    gy[-1, :] = image[-1, :] - image[-2, :]

    return gx, gy

gx, gy = compute_gradient(image)
gy_check, gx_check = np.gradient(image)

fig, (ax1, ax2, ax3, ax4) = plt.subplots(1, 4, figsize=(16, 4))
ax1.axis('on'); ax2.axis('on'); ax3.axis('on'); ax4.axis('on')

ax1.imshow(gx, cmap=plt.get_cmap('gray'))
ax1.set_title('Gradient gx')

ax2.imshow(gy, cmap=plt.get_cmap('gray'))
ax2.set_title('Gradient gy')

ax3.imshow(np.abs(gx), cmap=plt.get_cmap('gray'))
ax3.set_title('Gradient abs(gx)')

ax4.imshow(np.hypot(gx, gy), cmap=plt.get_cmap('gray'))
ax4.set_title('Gradient sqrt(gx^2 + gy^2)')

plt.show()
```



Role of AIoT in EV

Speed Estimation Using AIoT



Background Subtraction

Morphological Operators:

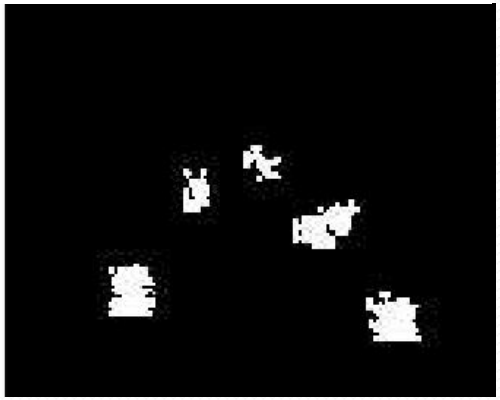
1.Erosion

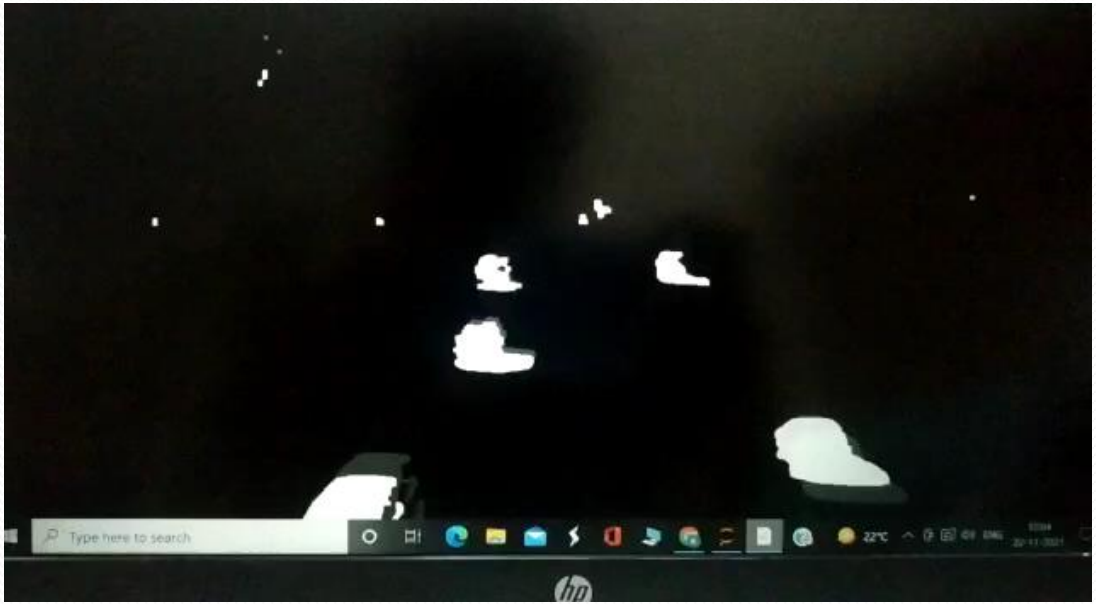
2. Dilation

3. Opening

4. Closing

Limitation: In the stage of detecting features, it is necessary that features are located with precision and good reliability.



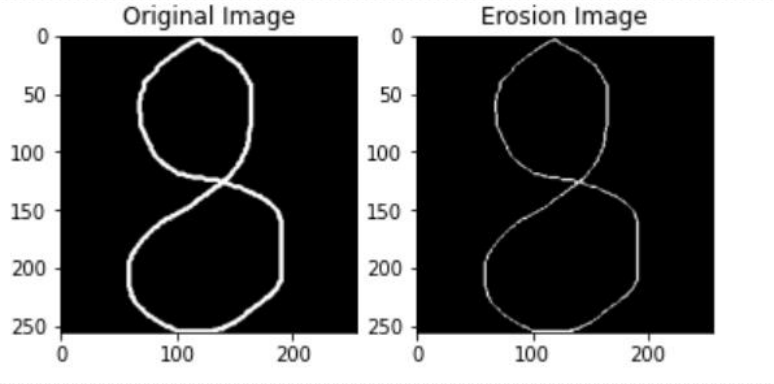


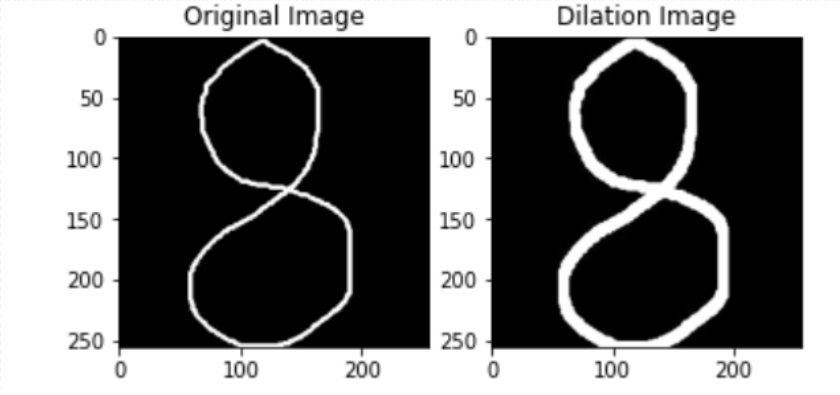
Role of AIoT in EV

EROSION

The basic idea of erosion is just like soil erosion only, it erodes away the boundaries of foreground object. The kernel slides through the image (as in 2D convolution). A pixel in the original image (either 1 or 0) will be considered 1 only if all the pixels under the kernel is 1, otherwise it is eroded (made to zero).

```
[17] kernel = np.ones((3,3),np.uint8)
     erosion = cv2.erode(img,kernel,iterations = 1)

     plt.subplot(121),plt.imshow(img),plt.title('Original Image')
     plt.subplot(122),plt.imshow(erosion),plt.title('Erosion Image')
```





DILATION

It is just opposite of erosion. Here, a pixel element is '1' if atleast one pixel under the kernel is '1'. So it increases the white region in the image or size of foreground object increases. Normally, in cases like noise removal, erosion is followed by dilation. Because, erosion removes white noises, but it also shrinks our object. So we dilate it. Since noise is gone, they won't come back, but our object area increases. It is also useful in joining broken parts of an object.

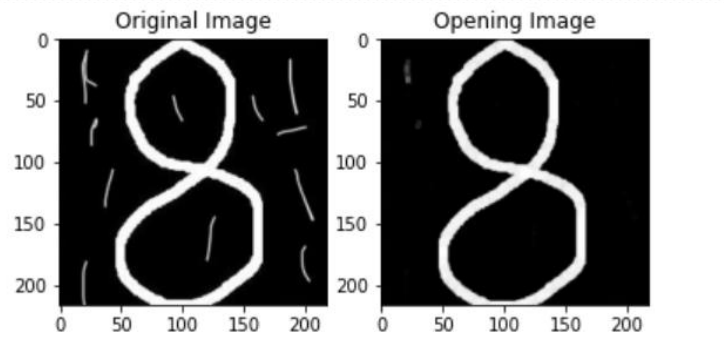
```
[ ]  kernel = np.ones((6,6), np.uint8)
     dilation = cv2.dilate(img, kernel, iterations = 1)

     plt.subplot(121),plt.imshow(img),plt.title('Original Image')
     plt.subplot(122),plt.imshow(dilation),plt.title('Dilation Image')
```

Role of AIoT in EV

OPENING

Opening is just another name of **erosion followed by dilation**. It is useful in removing noise, as we explained above.
Here we use the function, **cv2.morphologyEx().**

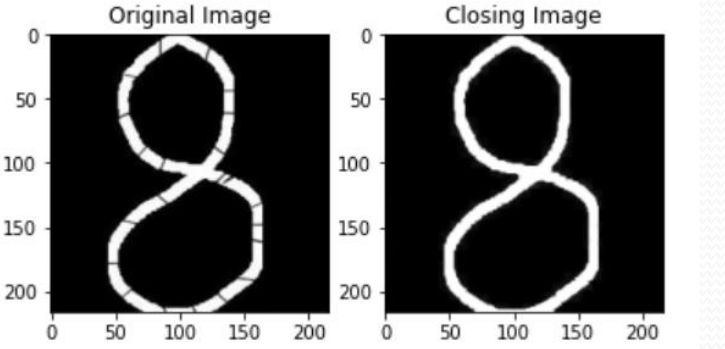
```
[19] img2 = cv2.imread('8a.jpeg')
     kernel = np.ones((4,4), np.uint8)
     opening = cv2.morphologyEx(img2, cv2.MORPH_OPEN, kernel)

     plt.subplot(121),plt.imshow(img2),plt.title('Original Image')
     plt.subplot(122),plt.imshow(opening),plt.title('Opening Image')
```



CLOSING

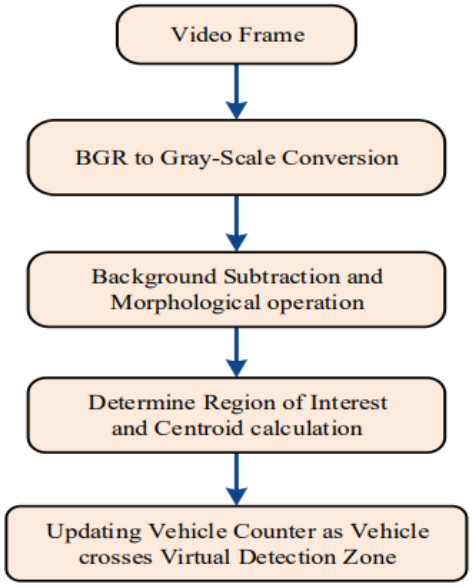
Closing is reverse of Opening, **Dilation followed by Erosion**. It is useful in closing small holes inside the foreground objects, or small black points on the object.

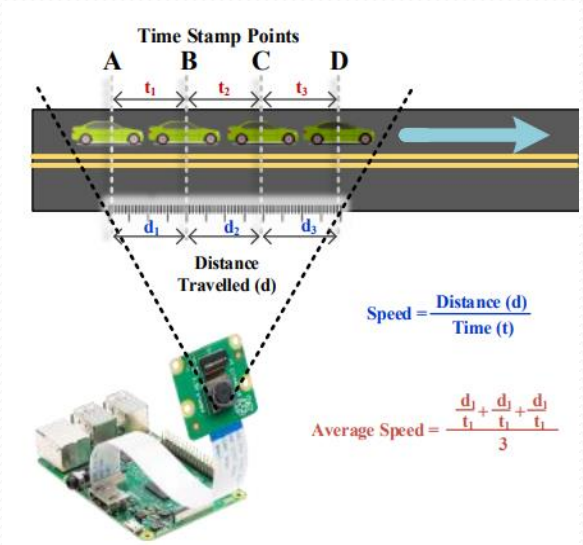
```
[20] img3 = cv2.imread('8b.jpeg')
     kernel = np.ones((4,4), np.uint8)
     closing = cv2.morphologyEx(img3, cv2.MORPH_CLOSE, kernel)
     plt.subplot(121),plt.imshow(img3),plt.title('Original Image')
     plt.subplot(122),plt.imshow(closing),plt.title('Closing Image')
```

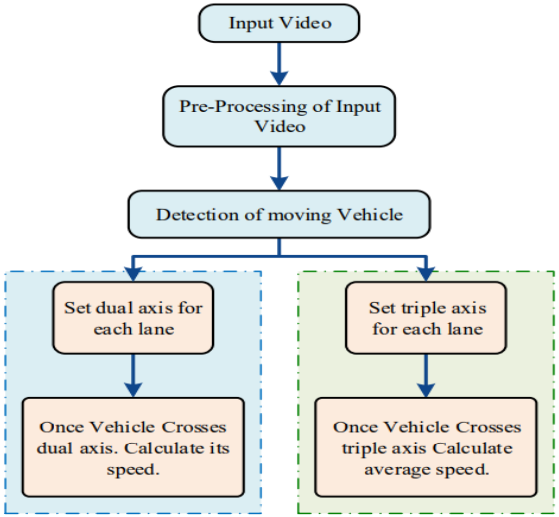


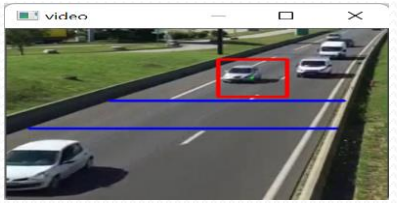
Role of AIoT in EV

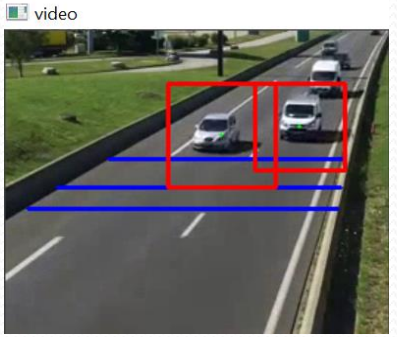
Process involved in speed detection





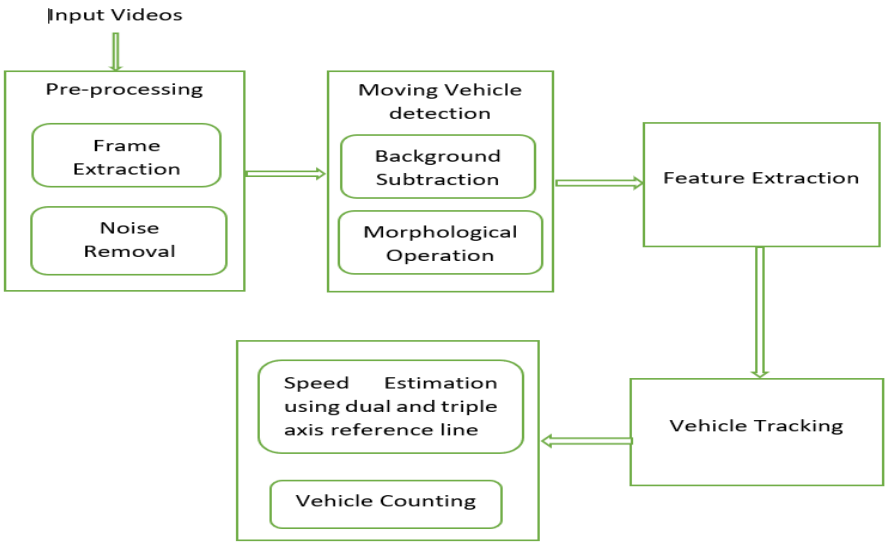


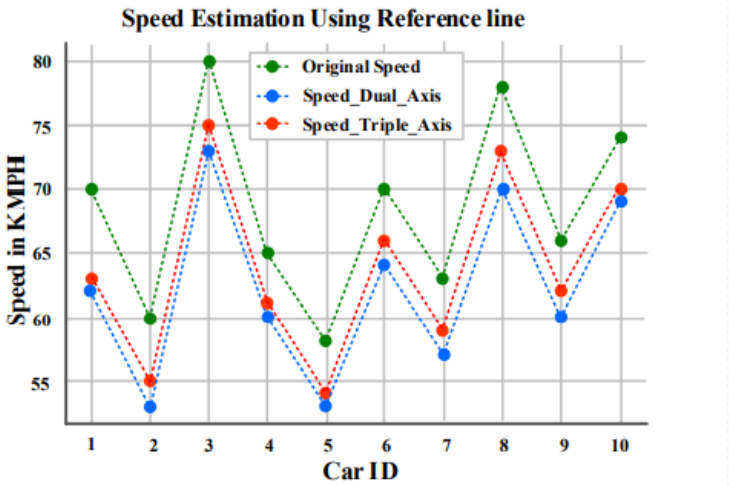


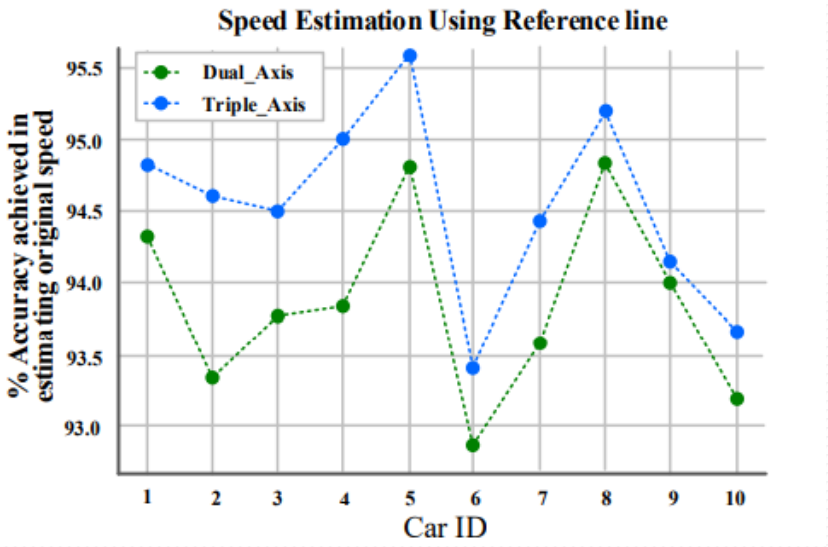


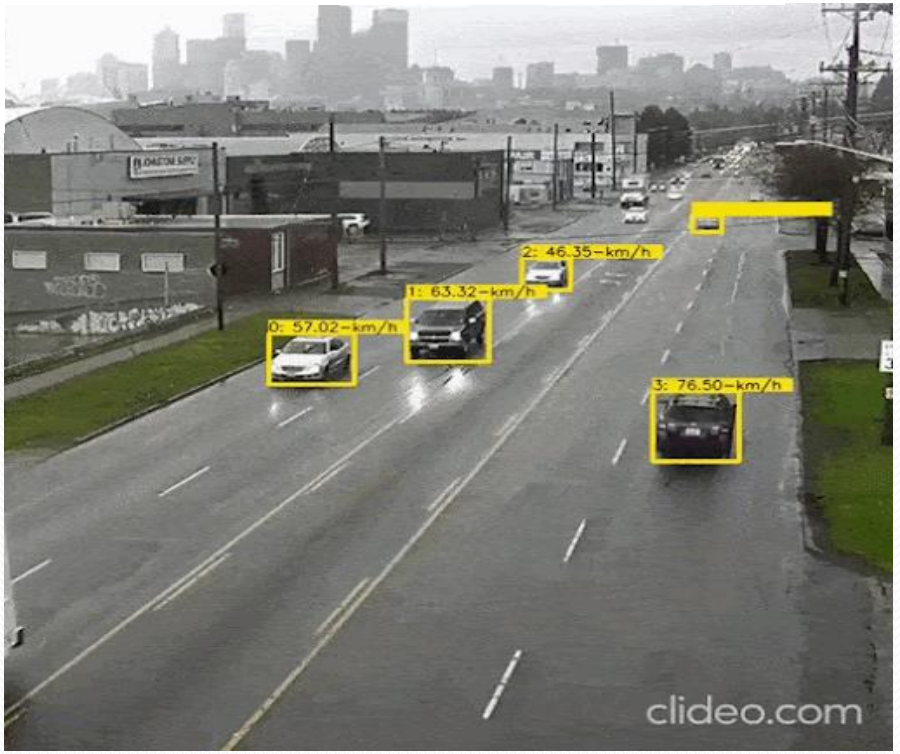
Role of AIoT in EV

Process involved in speed detection



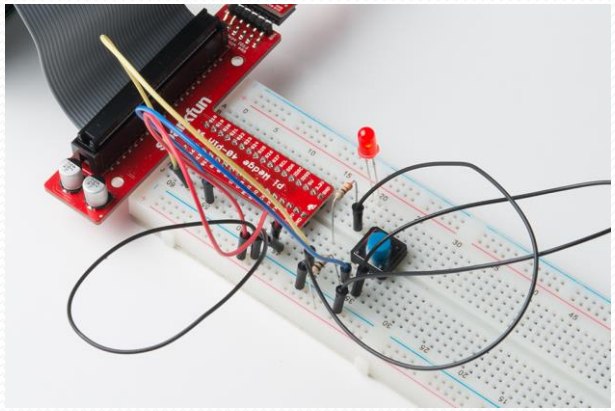




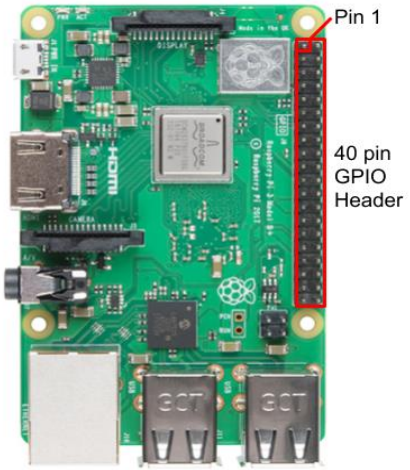


Sample Code for LED

```
import time
import RPi.GPIO as GPIO
# Pin definitions
led_pin = 12
# Use "GPIO" pin numbering
GPIO.setmode(GPIO.BCM)
# Set LED pin as output
GPIO.setup(led_pin, GPIO.OUT)
# Initialize pwm with 50 Hz and
0% duty cycle
pwm = GPIO.PWM(led_pin, 50)
pwm.start(0)
# Set PWM duty cycle to 50%, wait,
then to 90%
pwm.ChangeDutyCycle(50)
time.sleep(2)
pwm.ChangeDutyCycle(90)
time.sleep(2)
# Stop, cleanup, and exit
pwm.stop()
GPIO.cleanup()
```



```
import time
import RPi.GPIO as GPIO
# Pins definitions
btn_pin = 4
led_pin = 12
# Set up pins
GPIO.setmode(GPIO.BCM)
GPIO.setup(btn_pin, GPIO.IN)
GPIO.setup(led_pin, GPIO.OUT)
# If button is pushed, light up LED try:
    while True:
        if GPIO.input(btn_pin):
            GPIO.output(led_pin, GPIO.LOW)
        else:
            GPIO.output(led_pin, GPIO.HIGH)
# When you press ctrl+c, this will be called finally:
    GPIO.cleanup()
```



Role of AIoT in EV

Overall capital outlay by oil and gas PSU's

India Spent almost 1 lakhs Crore at every year

Financial Year	Outlay in Rs cr
2014-2015 (Actual)	**89,180**
2015-2016 (Actual)	97,223
2016-2017 (Actual)	1,04,426
2017-2018 (Actual)	1,32,003
2018-2019 (Actual)	1,00,308
2019-2020 (Revised)	94,974
2020-2021 (Budgeted)	98,522

Source: Budget documents

Indian Scenario in Electric Vehicle

EV- Greener and cleaner way of transport (eco-friendly)

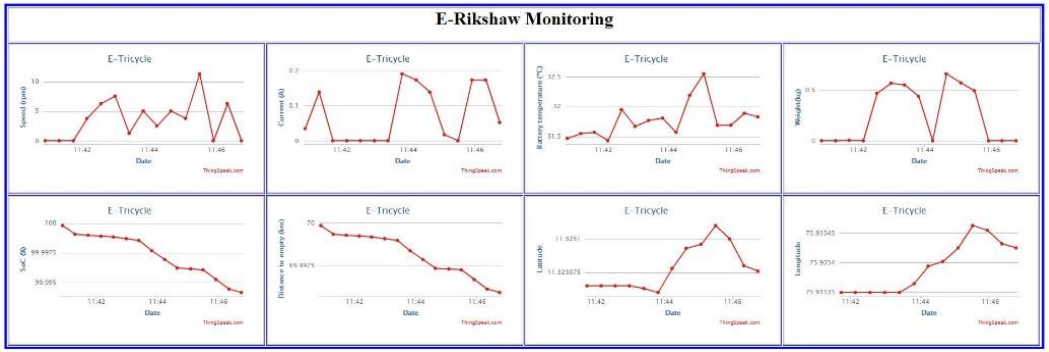
- Air Pollution - %5th large killer in India
- 41% of Delhi air pollution – Vehicle emissions

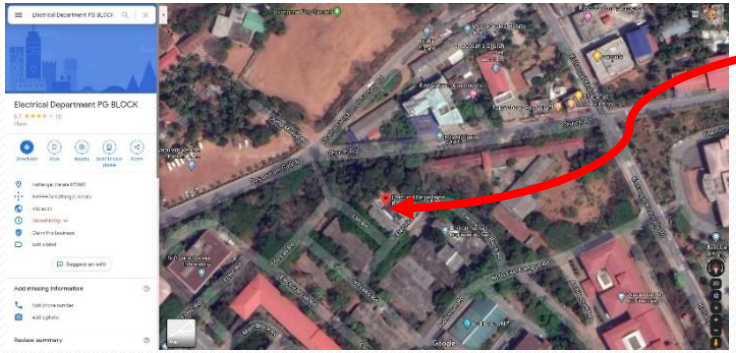
National Electric Mobility Mission Plan (NEMMP)

- FAME Phase I - April 2015 to March 2019
- FAME Phase II - April 2019 to March 2022
- 30% of all vehicles in India all-electric by 2030
- From Department of Heavy Industry introduced in 11 cities
- Tax on Li-ion batteries reduced to 18% last year
- GST on EV reduced from : 12% to 5% & on chargers : from 18% to 5%
- With 20000 EVs on road, petrol consumption reduces by 5 Cr Lt. and annual CO_2 emission reduces by 5.6 lakh tonnes

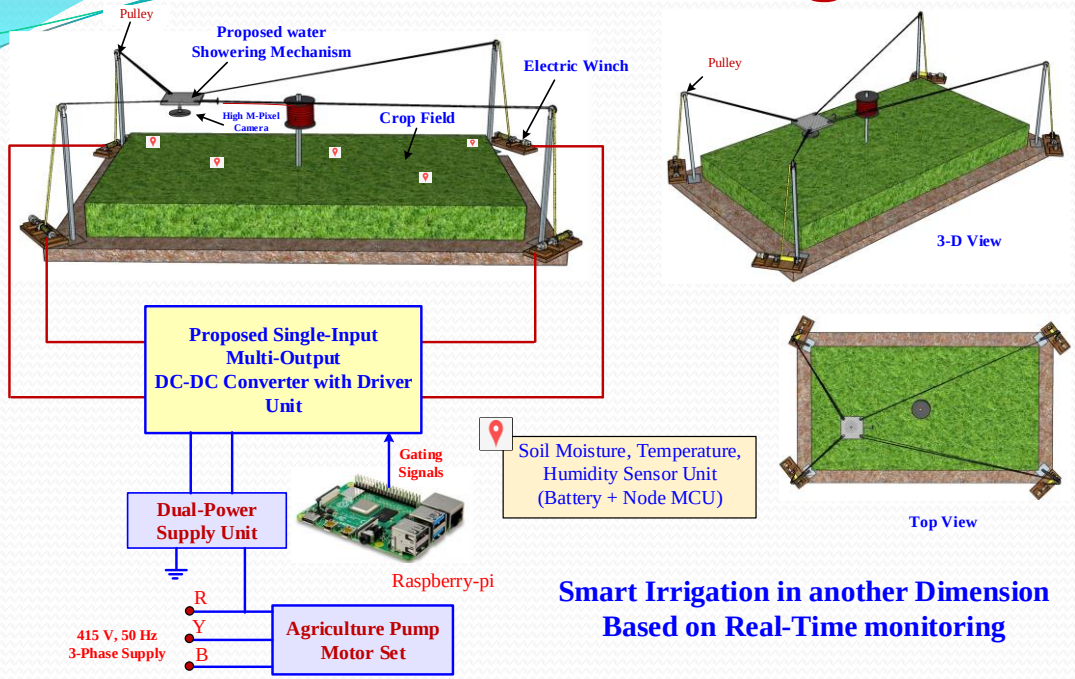
Problems Associated with Commercial E-Vehicle:

- **Lack of Remote Monitoring**
- **Less driving force especially while riding in sloppy regions**
- Reliability issues and much Expensive
- Reduced life of battery (expensive battery replacement)
- Large weight due to which tires get flat easily



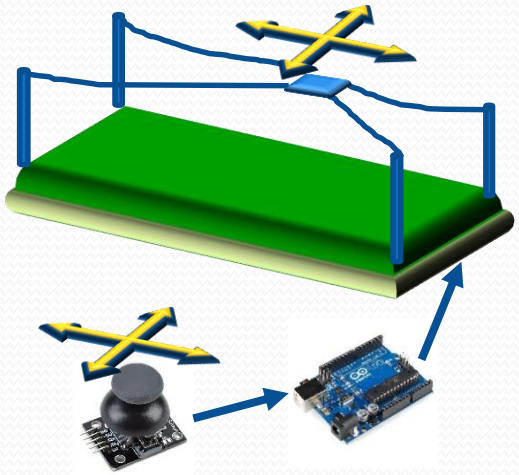


IoT Enabled Water Showering mechanism for nurseries and green houses

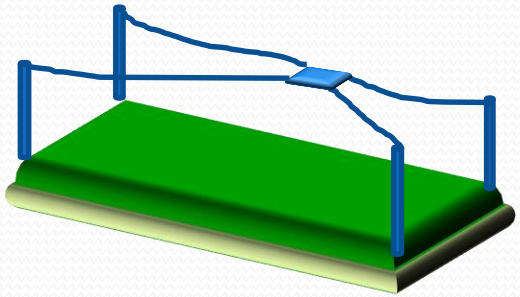


Smart Irrigation in another Dimension Based on Real-Time monitoring

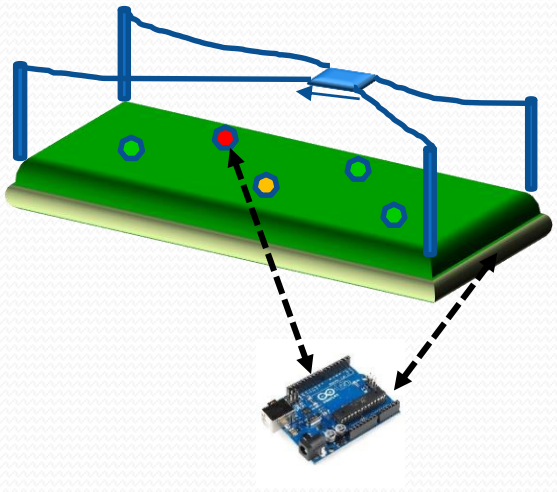
Manual Mode



Automatic Mode



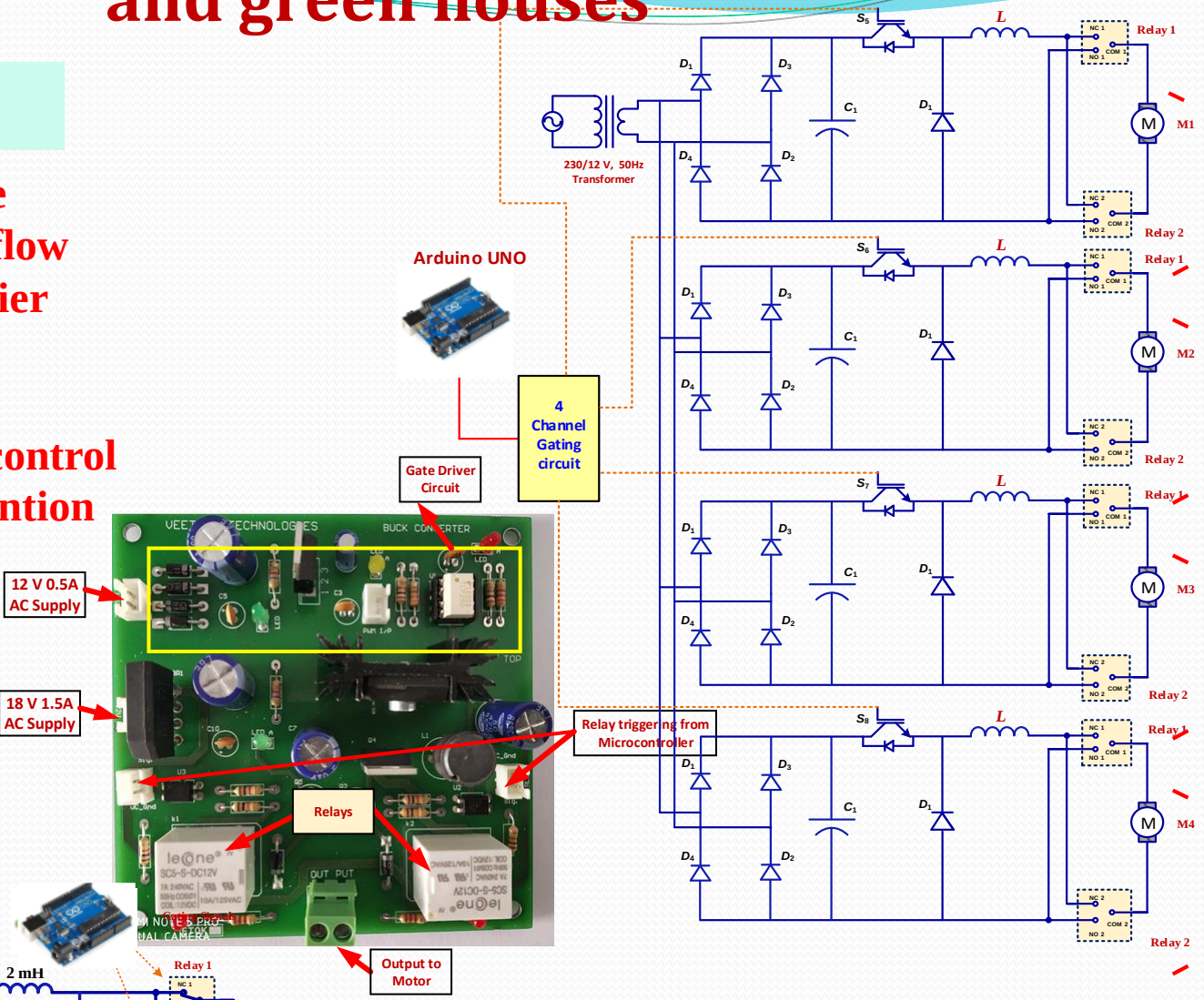
Sensor Oriented

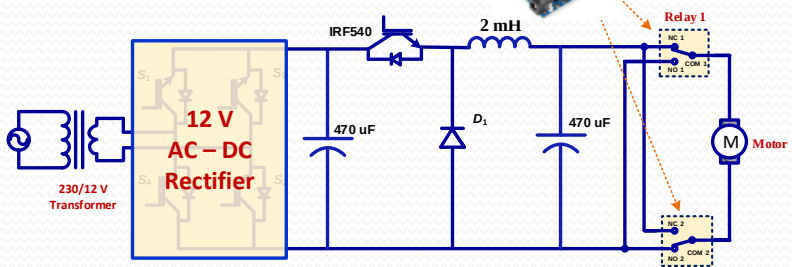


IoT Enabled Water Showering mechanism for nurseries and green houses

Key Benefits

- ✓ Minimum water usage
- ✓ Adjustable the water flow
- ✓ Crops becomes healthier
- ✓ No soil erosion
- ✓ Less evaporation
- ✓ Remote monitor and control
- ✓ Avoids human intervention






Thank
you