Assignment No.2

<u>Problem Statement:</u>

A fire is to be detected using relevant wireless sensor network installed in a remote location to communicate the data to the central server for the monitoring purpose and detection of the fire. Write a program to implement the system using WSN and Different data communication strategies/ algorithms (at least two) to compare the reliability of the data received and efficient timing.

<u>Theory</u>

A **wireless sensor network (WSN)** of spatially distributed autonomous sensors to *monitor* physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling *control* of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radiotransceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced hop wireless. The propagation technique between the hops of the network can be routing or flooding.

Applications:

Health care monitoring

The medical applications can be of two types: wearable and implanted. Wearable devices are used on the body surface of a human or just at close proximity of the user. The implantable medical devices are those that are inserted inside human body. There are many other applications too e.g. body position measurement and location of the person, overall monitoring of ill patients in hospitals and at homes. Body-area networks can collect information about an individual's health, fitness, and energy expenditure.

Environmental/Earth sensing

There are many applications in monitoring environmental parameters, examples of which are given below. They share the extra challenges of harsh environments and reduced power supply.

Air pollution monitoring

Wireless sensor networks have been deployed in several cities (Stockholm London and Brisbane to monitor the concentration of dangerous gases for citizens. These can take advantage of the ad hoc wireless links rather than wired installations, which also make them more mobile for testing readings in different areas.

Fire detection

A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading. A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading. Etc….

The main characteristics of a WSN include:

- Power consumption constraints for nodes using batteries or energy harvesting
- Ability to cope with node failures
- Mobility of nodes
- Heterogeneity of nodes
- Scalability to large scale of deployment
- Ability to withstand harsh environmental conditions
- Ease of use
- Cross-layer design

Platforms

Hardware

One major challenge in a WSN is to produce *low cost* and *tiny* sensor nodes. There are an increasing number of small companies producing WSN hardware and the commercial situation can be compared to home computing in the 1970s. Many of the nodes are still in the research and development stage, particularly their software. Also inherent to sensor network adoption is the use of very low power methods for radio communication and data acquisition.

In many applications, a WSN communicates with a Local Area Network or Wide Area Network through a gateway. The Gateway acts as a bridge between the WSN and the other network. This enables data to be stored and processed by devices with more resources, for example, in a remotely located server.

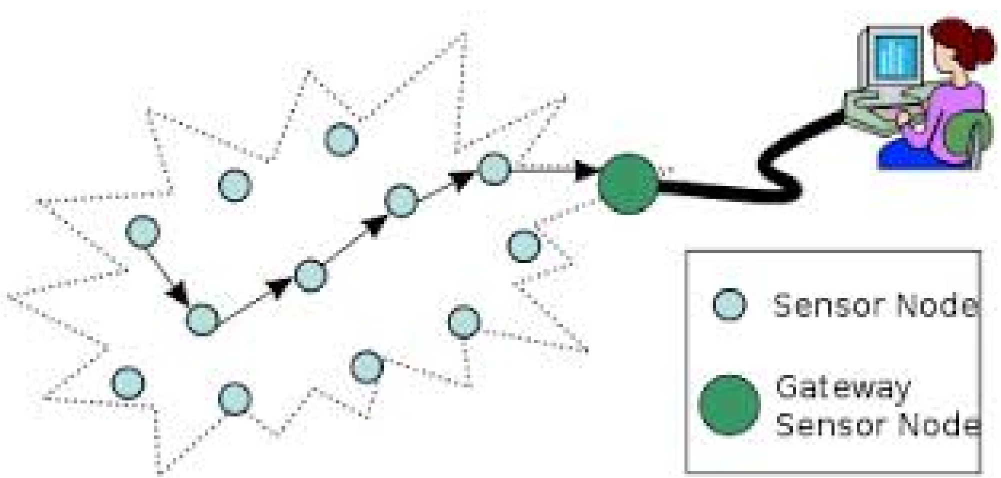
Software

Energy is the scarcest resource of WSN nodes, and it determines the lifetime of WSNs. WSNs may be deployed in large numbers in various environments, including remote and hostile regions, where ad hoc communications are a key component. For this reason, algorithms and protocols need to address the following issues:

- Lifetime maximization
- Robustness and fault tolerance
- Self-configuration

Lifetime maximization: Energy/Power Consumption of the sensing device should be minimized and sensor nodes should be energy efficient since their limited energy resource determines their lifetime. To conserve power the nodes normally turn off the radio transceiver when not in use.

Sensor Node Architecture:



Wireless sensor network for fire detection

Fire detection system consists of nodes deployed random in a forest area. Each node is equipped with a temperature sensor. Nodes periodically sense the environment to decide if there is an emergency situation or not. When a significant change in temperature is detected by some sensor nodes, they broadcast packets which contain their measurements. These packets are received by the nodes which are in the broadcast region of the sender and relayed to the node that acts as the base station. Base station is a special node which is connected to a computer and forwards the received messages to the serial port. An application listens to the serial port and keeps track of the network. Since the nodes are deployed randomly, we do not have information about their coordinates .In addition, a topological infrastructure is needed for the flow of messages from nodes to the base station. We used a simple localization to get coordinates of the nodes and a distributed spanning tree for the messaging infrastructure.

Design Analysis / Implementation Logic:

1) At mega 32A Microcontroller to be programmed using Embedded C to read the data using Temperature Sensor.
2) ZigBee Pro processor is used to transmit data from source node to sink node.
3) Master Sensor node is connected to system to read the changes in Temperature

<u>Pseudo Code</u>

########################Code Begins############################

```
// Variables to store temperature values
unsigned inttempinF, tempinC;
unsigned long temp_value;
void Display_Temperature() {
 // convert Temp to characters
 if (tempinC/10000)
 // 48 is the decimal character code value for displaying 0 on LCD
tempC[0] = tempinC/10000 + 48;
 else tempC[0] = ' ';
tempC[1] = (tempinC/1000)%10 + 48; // Extract tens digit
tempC[2] = (tempinC/100)%10 + 48; // Extract ones digit
 // convert temp_fraction to characters
tempC[4] = (tempinC/10)%10 + 48; // Extract tens digit
 // print temperature on LCD
Lcd_Out(2, 1, tempC);
 if (tempinF/10000)
tempF[0] = tempinF/10000 + 48;
 else tempF[0] = ' ';
tempF[1] = (tempinF/1000)%10 + 48; // Extract tens digit
tempF[2] = (tempinF/100)%10 + 48;
tempF[4] = (tempinF/10)%10 + 48;
 // print temperature on LCD
Lcd_Out(2, 10, tempF);
}
void main ()
{
 ANSEL = 0b00000100; // RA2/AN2 is analog input
 ADCON0 = 0b01001000; // Connect AN2 to S/H, select Vref=1.19V
 CMCON0 = 0x07 ; // Disbale comparators
 TRISC = 0b00000000; // PORTC All Outputs
 TRISA = 0b00001110; // PORTA All Outputs, Except RA3 and RA2
```

```
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // CLEAR display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
Lcd_Out(1,1,message0);
Delay_ms(1000);
Lcd_Out(1,1,message1); // Write message1 in 1st row
```

#########################Code Ends##############################

Conclusion

Nodes in the system periodically sense the environment and send their measurements to the base station through the ZigBee trasnreciever. The coordinates of the nodes are calculated using a simple localization procedure. A hyper terminal is used to read the temperature values.