

## Wireless Communication

Wireless communication is a type of data communication i.e. performed and delivered wirelessly. Wireless communication generally works through electromagnetic signals that are broadcast by an enable device within the air, physical environment or atmosphere. It involves the transmission of information over a distance without the help of wires, cables or any other electrical conductors. The main features are:

- i) The transmitted distance can be anywhere between the few meters ( $TV_{remote}$ ) and thousands of kilometers (Radio communication).
- ii) It can be used for wireless access to the Internet, wireless home networking, GPS units, remote control, door openers, wireless keyboards, wireless mouse, wireless headphones, cordless telephones, satellite TV and radio channels. It includes satellite communication, Bluetooth communication, Wireless LAN (WLAN), etc.
- iii) In this case, the sender is responsible for sending the signals which are captured by intermediate device creating a wireless communication bridge between the sender and the receiver.

### Advantages of WC?

Wireless communication involves transfer of information without any physical connection between two or more points.

- i) Cost effectiveness: These networks do not require any physical infrastructure and maintenance practices. Therefore the cost is reduced moreover it is able to charge cheaply with regard to its customer fees.

- ii) Flexibility: This enables to communicate regardless of their location.
- iii) Convenience: They are easy to use anywhere and anytime with no network cables for the movement of the devices. For example, WiFi speed. A wireless remote can reprogram a system faster than a wired one, which improves its speed and accuracy.
- iv) Accessibility: This technology helps easy accessibility as the remote areas where ground lines can't be properly laid, are being easily connected to the network. For example, rural areas. Online education is now possible through wireless technology.
- v) Constant connectivity (Mobility): One can move from place to place by using wireless mobile whereas wired landline cannot do the same.
- vi) Ease of installation: It can be easy to install. User need not worry about the hassle of cables. As the setup for wireless communications can be easily installed.
- vii) Reliability: Since there are no cables and wires involved. Therefore, no chance of communication failure due to damage of these cables which may be caused by environmental conditions.

### Disadvantages:

- i) Interference of signals (e.g. Radio Signals): WCS use open space as the medium for transmitting the signal. So, there is a huge chance that radio signals from one wireless communication system or network might interfere with other.

ii) Security: Since the signals are transmitted in open space it is possible that an intruder/third party can intercept the signal and copy sensitive information.

iii) Health Concerns: Continuous exposures to any type of radiation is harmful for health so, the radio frequency can cause the damage.

- In case of WC, the transmitter and the receiver can be placed anywhere between few meters to hundred of kilometers.

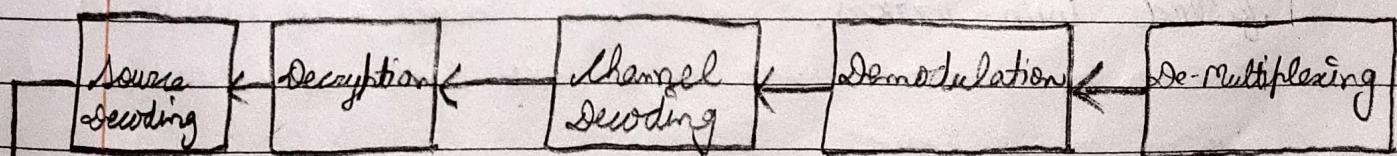
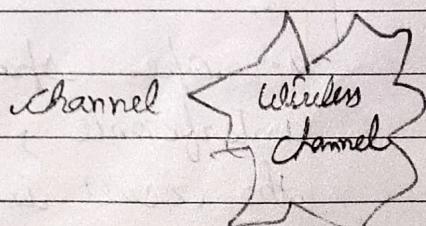
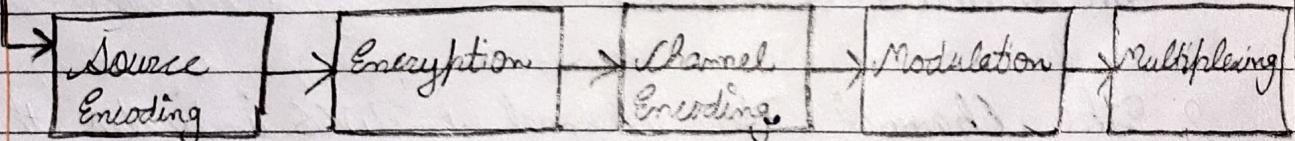
### Elements of Wireless Communication System

A typical wireless communication system can be divided into three elements:

- 1) The Transmitter
- 2) The Channel
- 3) The Receiver.

### Block diagram of a Wireless Communication System

Information



Estimated  
information

1) The Transmission Path: A typical transmission path of a WCS consists of Encoder, Encryption, Modulation and Multiplexing. The signal from the source is passed through a Source Encoder, which converts the signal into a suitable form of for applying signal processing techniques.

The redundant information from signals is removed in this process in order to maximize the utilization of resources. This signal is then encrypted using an Encryption Standard so that the signal and the information is secured and doesn't allow any authorized access.

- Channel Encoding is a technique that is applied to the signal to reduce the impairments like noise, interference, etc.
- Then the signal is modulated using a suitable Modulation technique (like PSK, FSK and QPSK etc), so that the signal can be easily transmitted using antenna.
- The modulated signal is then multiplexed with other signals using different Multiplexing techniques like Time Division Multiplexing (TDM) for FDM to share the valuable bandwidth.

2) The Channel: The channel in WCS indicates the medium of transmission of the signal i.e. open space. A channel may be subject to interference, distortion, noise, scattering etc. and the result is that the received signal may be filled with errors.

3) The Reception Path: The job of the Receiver is to collect the signal from the channel and reproduce it as the source signal. The reception path of a WCS comprises of Demultiplexing, Demodulation, Channel Decoding, Decryption and Source Decoding.

The signal from the channel is received by the Demultiplexer and is separated from other signals. The individual signals are demodulated using appropriate Demodulation Techniques and the original message signals is recovered. The redundant bits from the message are removed using the Channel Decoder. Since the message is encrypted, decryption of the signals removes the security and turns it into simple sequence of bits. Finally, this signal is given to the Source Decoder to get back the original transmitted message or signal.

### Types of WCS

People need Mobile Phones for many things like talking, internet, multimedia, etc. With the help of these WC services, we can transfer voice, data, videos, images, etc.

- WCS also provide different services like video conferencing, cellular telephone, TV, Radio, etc. Due to the need for variety of communication services, different types of WCS are developed. Some of the important WCS available today are:
- TV and Radio Broadcasting
  - Satellite Communication

- Radar
- Mobile Telephone System (Cellular communication)
- Global Positioning System (GPS)
- WLAN
- Infrared communication
- Bluetooth
- Cordless Phones
- Paging
- ZigBee

⇒ WCS can be again classified as Simplex; Half and Full Duplex

- Simplex communication is one way communication.  
eg Radio Broadcast system.
- Half Duplex is two way communication but not simultaneously one. eg. Walkie-Talkie.
- Full Duplex is also two way communication and it is a simultaneous one. eg. Mobile Phones.

### Television and Radio Broadcasting

Radio is considered to be the first wireless service to be broadcast. It is an example of Simplex communication, where the information is transmitted only in one direction and all the users receiving the same data.

- Satellite Communication: It is an important type of W.C. Satellite communication networks provide worldwide coverage independent to population density.

It offers telecommunication.

positioning and navigation (GPS), broadcasting, internet, etc. Other wireless services like mobile, TV broadcasting and other radio systems are dependent of satellite OS.

### • Mobile Telephone Communication System:

The development of mobile cellular device changed the world like no other technology. Today's mobile phones are not limited to just making calls but are integrated with numerous other features like Bluetooth, Wi-Fi, GPS and FM Radio.

• GPS: GPS is solely a subcategory of satellite communication. GPS provides different wireless services like navigation, positioning, location, speed, etc. with the help of dedicated GPS receivers and satellites.

• Bluetooth: It is another important low range wireless communication system. It provides data, voice and audio transmission with a transmission range of 10 meters. Almost all mobile phones, tablets and laptops are equipped with Bluetooth devices. They can be connected to wireless Bluetooth receivers, audio equipment, cameras etc.

• Paging: Although it is considered an obsolete technology, paging was a major success before the wide spread use of mobile phones. Paging provides information in the form of messages and it is a simplex system i.e. the user can only receive the message.

Wireless LAN: It is an internet related wireless services. Using WLAN, different devices like laptops and mobile phones can connect to an access point (Wi-Fi router) and access internet.

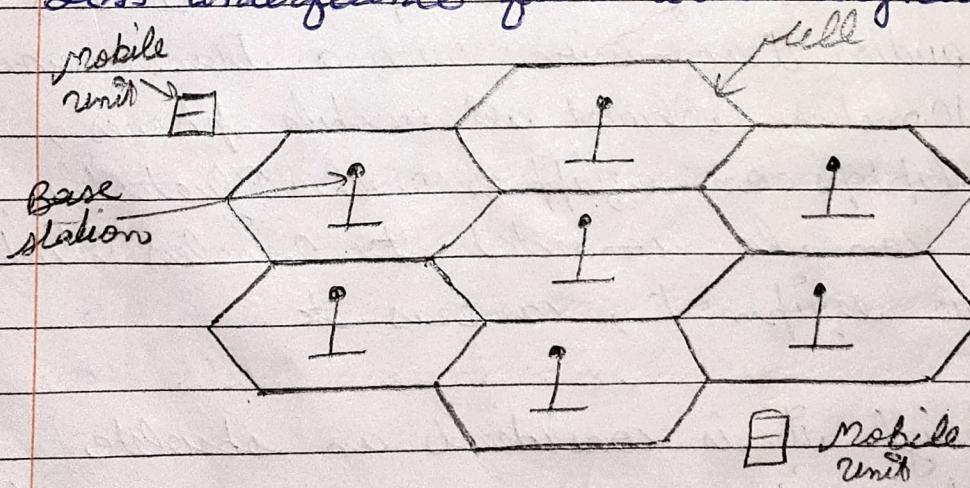
Wi-Fi is one of the widely used wireless networks usually for internet access. It is very difficult to imagine the modern world without Wi-Fi.

## Cellular System (lomerty) (Mobile Telephone System)

Cellular system is a radio network distributed over land areas called cells. Each served by at least one fixed location transceiver known as cellsite / base station.

Advantages : Increased capacity

- Reduced power use.
- Larger coverage area.
- Less interference from other signals.



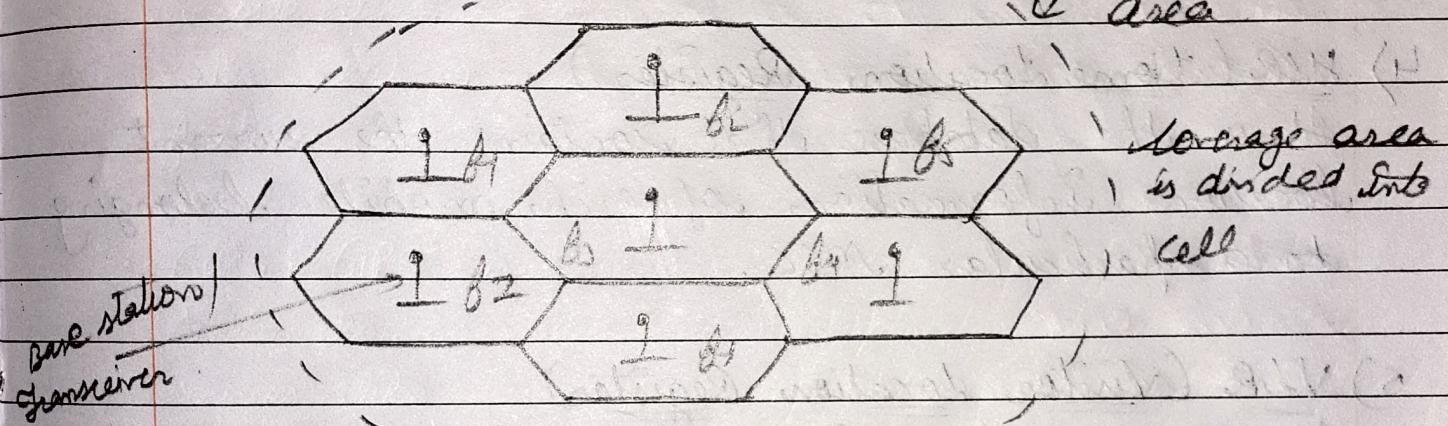
- Cells may operate on different frequencies
- Each cell has base station

# Important terms in cellular network / Terminology

## 1) Cell:

- It is basic geographic unit of cellular system.
- It is hexagonal in shape.
- Each cell has its own antenna.
- Cells are the stations transmitting over a small geographical area.

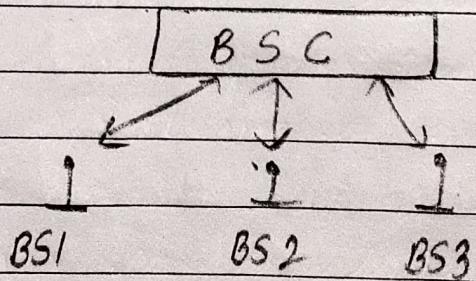
Geographical  
Area



- Adjacent cells are assigned with different frequencies to avoid interference.

## 2) Base stations:

- It provides direct communication with the mobile phones.
- It can transfer or pass the traffic to MSC (Mobile switching centre).
- Base station controller is responsible to control a route traffic between all the base stations.



### 3) MSC (Mobile switching center)

- It is also known as heart of cellular networks.
- It can perform two tasks: Routing and Switching.
- It controls number of cells.
- It may arrange base station for mobile communication channel and handle all the connections.
- It can handle all the tasks from cell generation to cell termination.

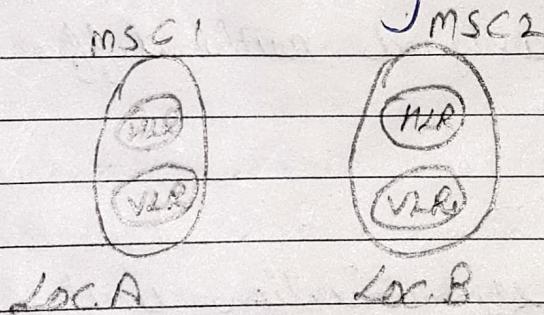
MSC →

### 4) HLR (Home Location Register)

It is the database that contains the current location information of each mobile belonging to a particular MSC.

### 5) VLR (Visitor Location Register)

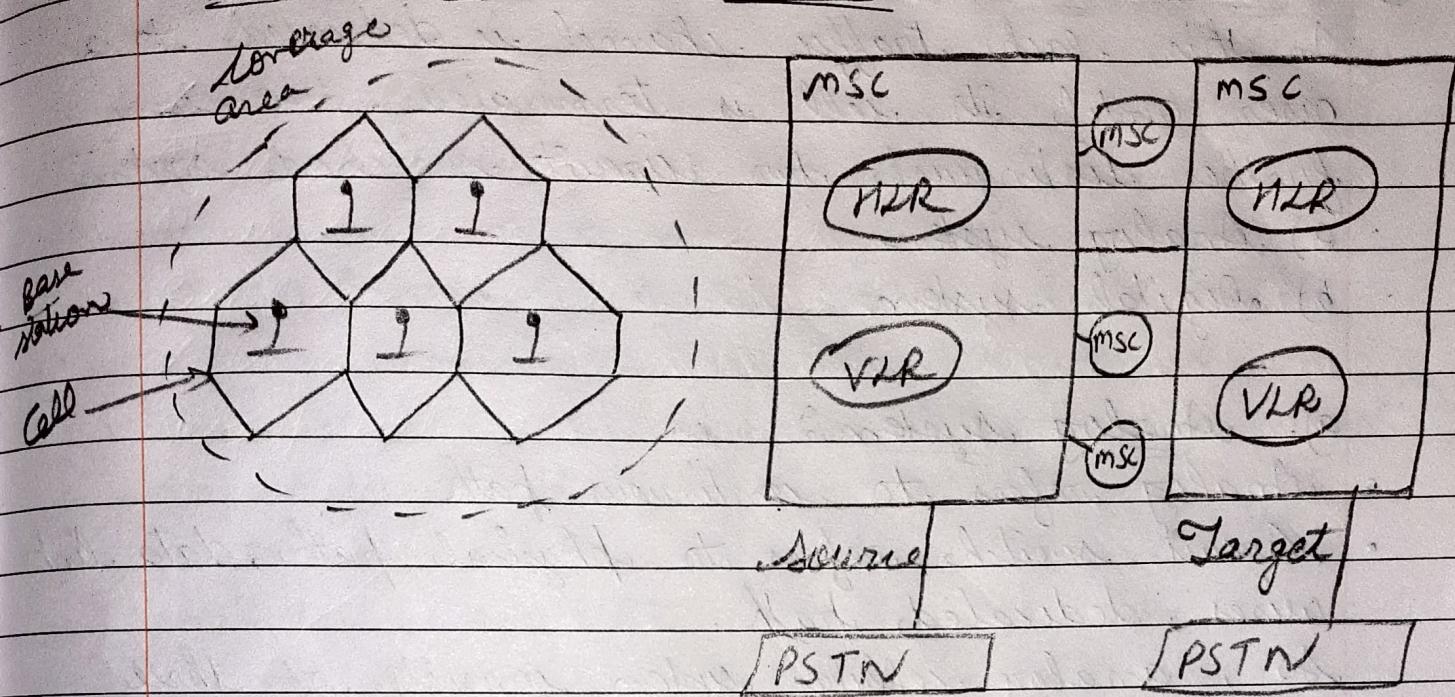
It records the visiting location of each mobile.



VLR can be change  
But HLR can't.

- If A is in its own region then HLR will store the location of A.
- If A moves to another location B, then VLR will store the location information of A.

# Cellular network Architecture



- All the MSCs may communicate with each other.

## PSTN (Public switched Telephone Network)

- Its main objective is to transmit human voice in recognized form.
- It provides infrastructure and services for telecommunication. It is operated by regional, national or local telephony operator. Operators that consists of telephone lines, fibre optic cables, cellular networks, communication satellites, under sea, telephone cables which allow most telephone networks to communicate with each other.

## Basic cellular systems!

There are two basic cellular systems:

- Circuit switched system
- Packet switched system.

## 1) Circuit switched systems:

In this, each traffic channel is dedicated to a user until its call is terminated. We can further distinguish two circuit switched systems:

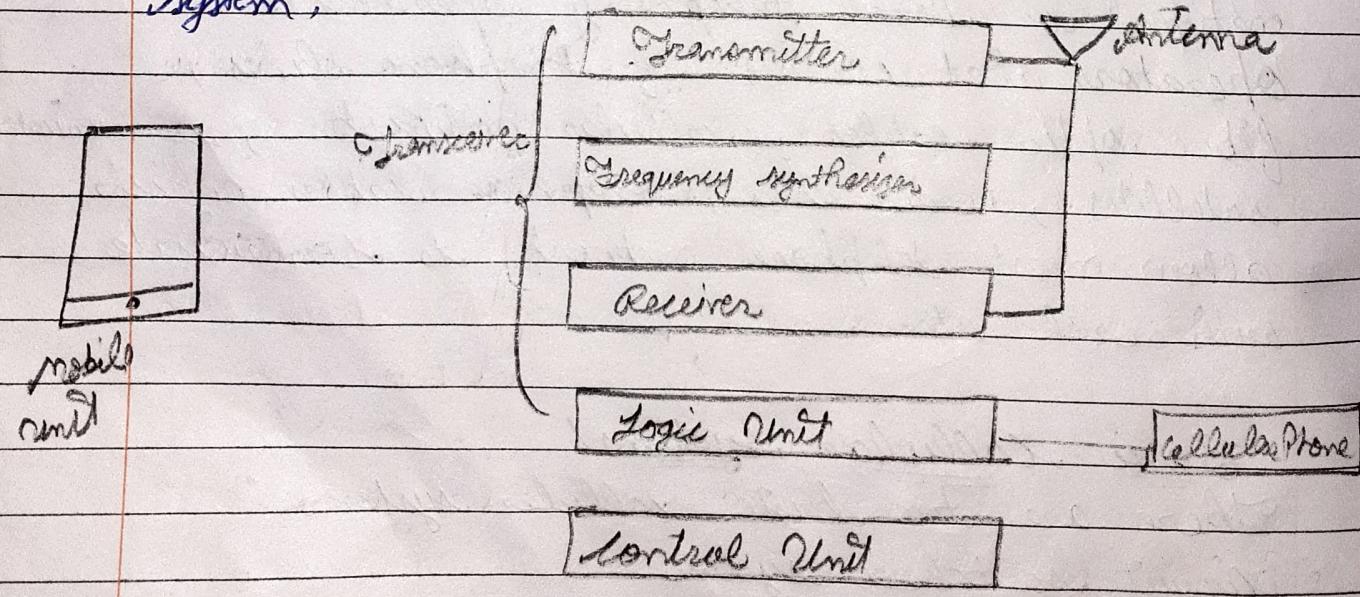
- a) Analog system
- b) Digital system

### a). Analog system:

- analog refers to continuous path.
- circuit switch refers to physical path, data links, wires, dedicated path.

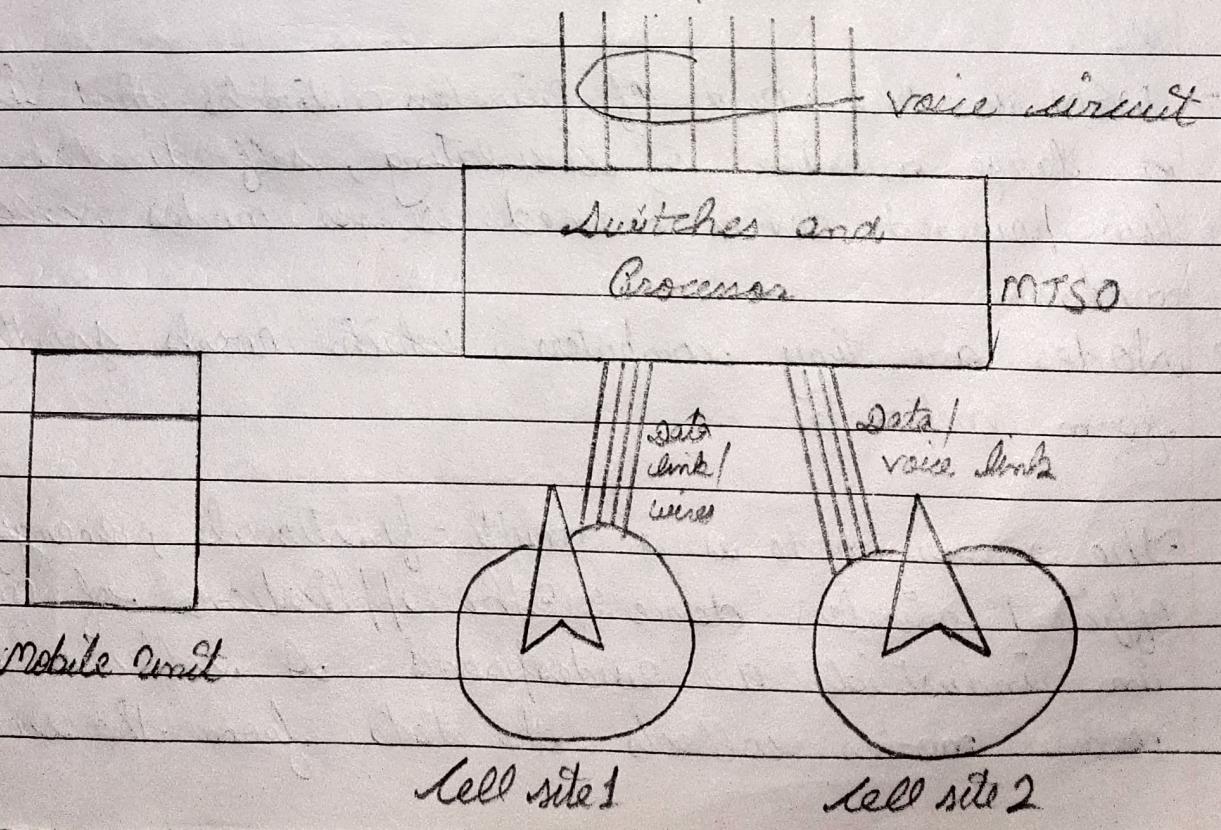
So, analog cellular system consists of three subsystems:

- mobile unit
  - cell site/tower
  - Mobile telephone switching office (MTSO)
  - connections
- Mobile Unit: A mobile unit contains a control unit, a transceiver and an antenna system,



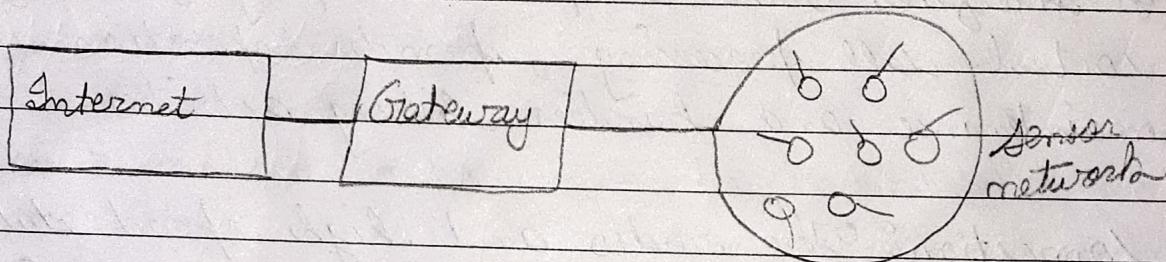
- Cell site: It provides interface between the MTSO and the mobile units. It has a control unit, radio channel cabinets, antennas, a power plant, and data terminals.
- MTSO: the switching office, the central coordinating element for all cell sites, contains the cellular processor and cellular switch. It interfaces with telephone company zone offices, control call processing, provides operation and maintenance and handles billing activities. It controls all cell sites & is responsible for communication among them.
- Connection: the radio and high speed data links connect the three subsystems. Each mobile unit can only use one channel at a time.
  - It has voice trunk data links.
  - It may be wired or wireless.
  - It carries voice and signals between mobile unit and cell site.

Land Telephone Network



# Wireless Sensor Network (WSN)

A wireless sensor network can be defined as a network of devices that can communicate the information gathered from a monitored field through wireless link. The data is forwarded through multiple nodes, and with a gateway, the data is connected to other networks like wireless Ethernet.



WSN is a wireless network that consists of base stations and numbers of nodes (wireless sensors). These nw are used to monitor physical or environmental conditions like sound, pressure, temperature and so-operatively pass data through the network to the main location.

- ⇒ WSN is one kind of wireless network that includes a large number of circulating, self-directed, mobile, low powered devices named. Sensor nodes called nodes.
- Nodes are tiny computers, which work jointly to form networks.

The sensor node is a multi-functional, energy-efficient wireless device. The applications of nodes in industrial are widespread. A collection of sensor nodes collects the data from the surroundings.

- to achieve specific application objectives.
- The communication between nodes can be done with each other using transceivers.
- In WSN, the number of nodes can be done in the order of hundreds / even thousands.

### WSN Architecture

The most common WSN architecture follows the OSI architecture Model.

The architecture of the WSN includes five layers and three cross layers. Five layers namely: Application layer, transport, m/w and physical layer.

Three cross layers are: power management, mobility management and task management.

### Types of WSN Architecture

The architecture used in WSN is Sensor m/w architecture. This kind of architecture is applicable in different places such as hospitals, schools, road building, etc as well as it is used in different applications such as office security management, disaster management & crisis management, etc.

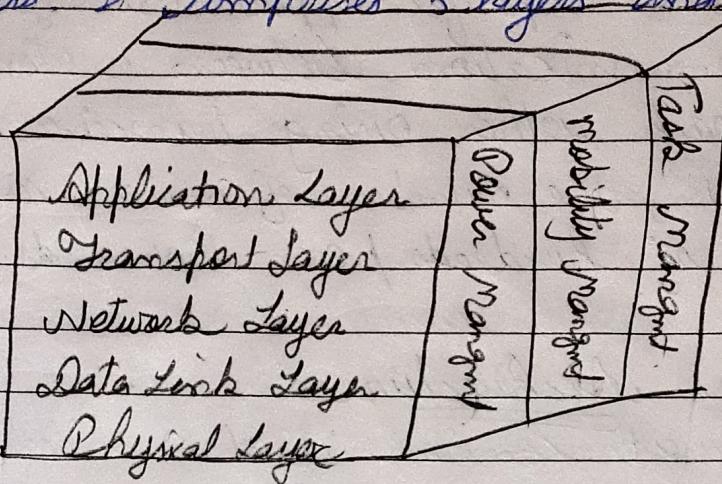
There are two types of architectures used in WSN:

- 1) Layered Network Architecture
- 2) Clustered Network Architecture

### 1) Layered Network Architecture

This kind of m/w uses hundreds of sensor nodes as well as base station. Here the arrangement of m/w nodes can be done into

concentric layers. It comprises 5 layers and 3 cross layers.



Application Layer: This layer is liable for traffic management and offers s/w for numerous applications that convert the data in the clear form to find positive information. Sensor m/w arranged in numerous applications in different fields such as agricultural, military, environmental, medical, etc.

Transport Layer: The function of the transport layer is to deliver congestion avoidance and reliability where a lot of protocol intended into offer this function are either practical on the upstream. The transport layer is exactly needed when a system is planned to connect other networks.

- Providing a reliable loss recovery is more energy-efficient and that is one of the main reasons why TCP is not fit for WSN
- Transport layers can be separated into Packet driven Event driven.

Network Layer: The main function of the m/w layer is routing; it has a lot of tasks based on the applications, but actually,

The main tasks are in power conserving, buffers

Data Link Layer: This layer is liable for multiplexing data-frame selection data streams, MAC, error control confirm the reliability of point-to-point or point-multipoint

Physical Layer: The physical layer provides an edge for transferring a stream of bits above the physical medium. This layer is responsible for the selection of frequency, generation of a carrier frequency, signal detection, Modulation and data encryption.

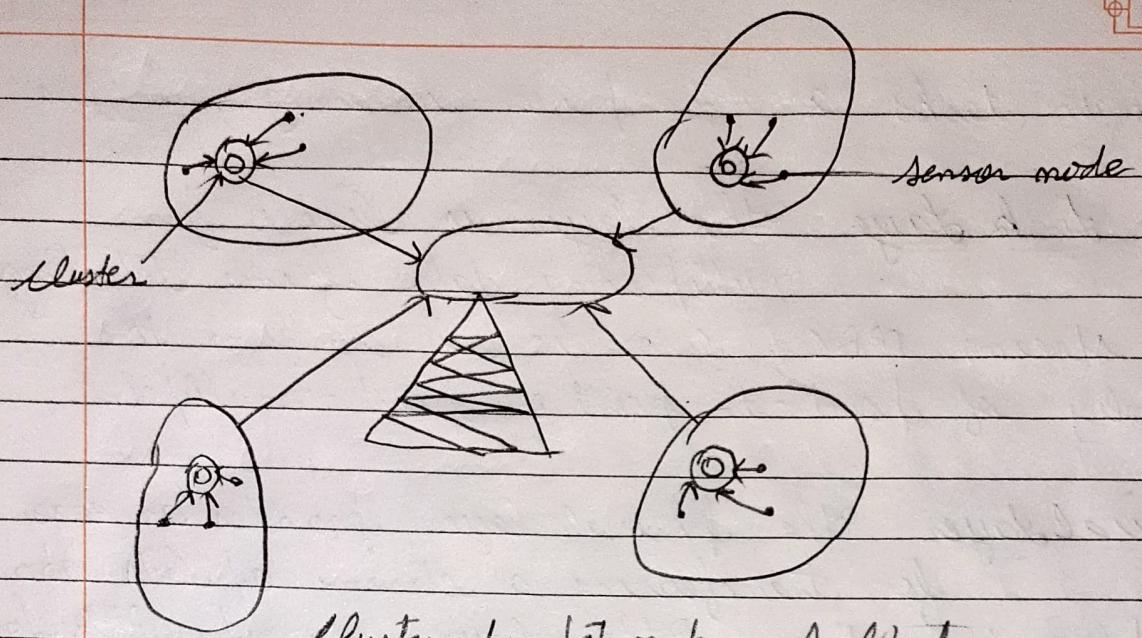
Benefit of WSN architecture: The main benefit of using this kind of architecture in WSN is that every node involves simply in less-distance, low power transmissions to the neighbouring nodes due to which power utilization is low as compared to other kinds of SNA.

- This kind of network is scalable as well as includes a high fault tolerance.

## 2) Clustered Network Architecture:

In this kind of architecture, separately sensor nodes add into groups known as clusters which depend on the "Leach Protocol" because it uses clusters.

The term "Leach Protocol" stands for "Low Energy Adaptive Clustering Hierarchy". The main properties of this protocol mainly include the following:



### Illustrated Network Architecture

- This is star-tier hierarchy clustering architecture.
- This distributed algorithm is used to arrange the sensor nodes into groups, known as clusters.
- In every cluster which is formed separately, the head nodes of the cluster will create the TDMA (Time Division Multiple Access) plans.
- It uses the data fusion concept so that it will make the energy efficient.

In every cluster every node can iterate through the head of the cluster to get the data.  
All the clusters will share their <sup>collected</sup> data towards the base station.

### Design issues of Wireless Sensor Network Architecture

- 1) Energy consumption? In WSN, power consumption is one of the main issue. As an energy source, the battery is used by WSN equipping with sensor nodes. The sensor n/w arranged within dangerous situations so it turns complicated for

changing otherwise recharging batteries. The energy consumption can be avoided at every layer by using efficient routing protocols.

Localization: Sensors nodes are arranged in an ad-hoc manner so they don't know about their location. The difficulty of determining the sensor's physical location once they have arranged is known as localization. This difficulty is resolved by GPS, beacon nodes, localization based on proximity.

Coverage: The sensor node in the WSN utilize a coverage algorithm for detecting data as well as transmit them to sink through the routing algorithm. To cover the whole network, the sensor nodes should be chosen.

Clocks: In WSN, clock synchronization is a serious service. The main function of this synchronization is to offer an ordinary timescale for the nodes of local clocks within sensor nodes.

Computation: The computation can be defined as the sum of data that continues through each node. The main issue within computations is that it must reduce the utilization of resources.

Production Cost: In WSN, the large number of sensor nodes is arranged, so, if the single node price is very high then the overall mfp piece will also be high.

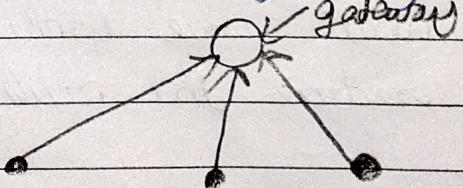
Hardware Design: When designing any sensor networks hardware like power control, micro-controller & communication unit must be energy-efficient. Its design can be done in such a way that it uses low energy.

Quality of service: The QoS is nothing but, the data must be distributed in time. Because some of the real-time sensor-based applications mainly depend on time. So, if the data is not distributed in time towards the receiver then the data will turn useless.

### Structure of WSN / WSN n/w Topologies

For radio communication networks, the structure of a WSN includes various topologies like the ones given below?

Star Topology: It is a communication topology, where each node connects directly to a gateway. A single gateway can send or receive a message to several remote nodes. In this, the nodes are not permitted to send message to each other. This allows low-latency communication between the remote node and the gateway (base-station).



Due to its dependency on a single node to manage the n/w, the gateway must be within the radio

transmission range.

Advantage: It includes the ability to keep the remote nodes power consumption to a minimum and simply under control. The size of the network depends on the number of connections made to the hub.