

Introduction to 4G:

- 4G is known as the **fourth Generation of Mobile Communication** or wireless communication technology.
- which is the successor of the 3G network.
- It provides high data transmission speed and is suitable for HD video calling, fast download and upload, live streaming, online gaming, etc.
- Speed upto 100 Mbps.
- It is very well suitable for the transmission of voice, data, signals, multimedia, wireless internet, and other broadband services.

There are 2 standards – LTE , WiMax.

Advantages and Disadvantages:

As compared to 3G , the cost has fallen down and quality has gone up.

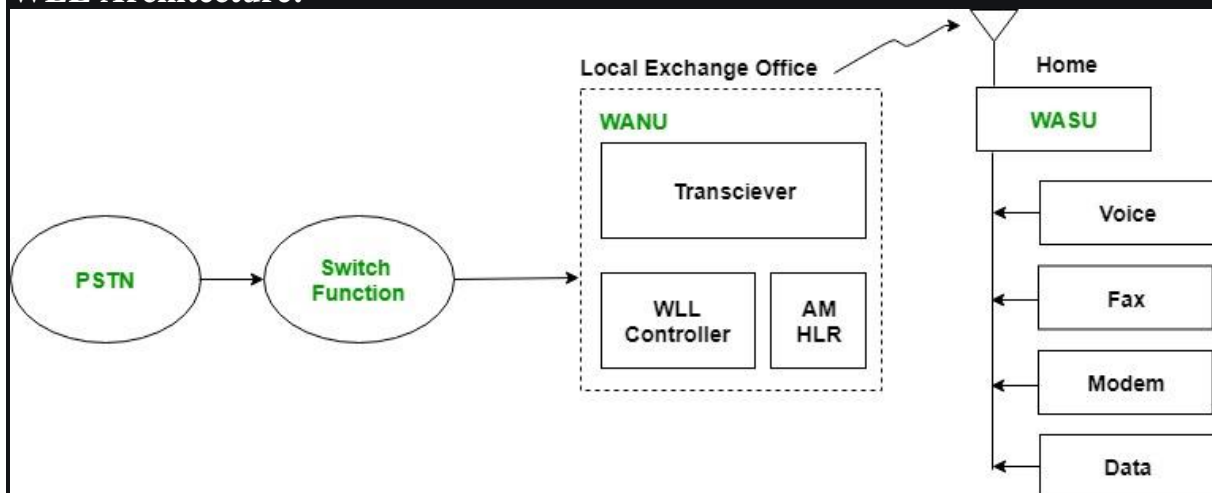
Suitable for accessing cloud services as everything is hosted online.

It has more battery consumption.

Wireless local loop (WLL):

Local loop is a circuit line from a subscriber's phone to the local central office (LCO). But the implementation of local loop of wires is risky for the operators, especially in rural and remote areas due to less number of users and increased cost of installation. Hence, the solution for it is the usage of wireless local loop (WLL) which uses wireless links rather than copper wires to connect subscribers to the local central office. WLL proves to be a dependable solution for telecommunication requirements specifically in remote or rural areas.

WLL Architecture:



WLL components:

1. **PSTN:** It is Public Switched Telephone Network which is a circuit switched network. It is a collection of world's interconnected circuit switched telephone networks.
2. **Switch Function:** Switch Function switches the PSTN among various WANUs.
3. **WANU:** It is short for Wireless Access Network Unit. It is present at the local exchange office. All local WASUs are connected to it. Its functions includes: Authentication, Operation & maintenance, Routing, Transceiving voice and data. It consists of following sub-components:
 - Transceiver: It transmits/receives data.
 - WLL Controller: It controls the wireless local loop component with WASU.
 - AM: It is short for Access Manager. It is responsible for authentication.
 - HLR: It is short for Home Location Register. It stores the details of all local WASUs.
4. **WASU:** It is short for Wireless Access Subscriber Units. It is present at the house of the subscriber. It connects the subscriber to WANU and the power supply for it is provided locally.
5. **Advantages of WLL:**

- It eliminates the first mile or last mile construction of the network connection.
- Low cost due to no use of conventional copper wires.
- Much more secure due to digital encryption techniques used in wireless communication.
- Highly scalable as it doesn't require the installation of more wires for scaling it.

6. Features of WLL:

- Internet connection via modem
- Data service
- Voice service
- Fax service

WLL technologies:

WLL systems are based on following technologies:

1. Satellite based systems
2. Cellular based systems
3. Low-tier PCS or micro-controller based systems
4. Fixed wireless access systems

Satellite based systems:

The WLL systems based on satellite are meant for providing services for the isolated areas like islands and rural areas.

Advantage:

Low cost mobile terminals.

Disadvantage:

Handover capability is needed for LEO and MEO satellites who move relative to earth's surface for all fixed and cellular applications.

Cellular based systems:

Expands basic telephony services.

It has large power, large range and median subscriber density, median circuit quality.

Advantage:

Can be deployed rapidly in urban and rural areas.

Disadvantage:

Not suitable for deployment indoors and in pico-cells.

Low-tier PCS or microcontroller based systems:

It has small **power**, small range, high subscriber density **and high circuit quality** (Advantages).

Rapid market entry and infrastructure development.

More base stations required than cellular based WLL.

Disadvantage:

Tx cost is more.

Fixed wireless access system:

Proprietary radio systems for fixed wireless applications.

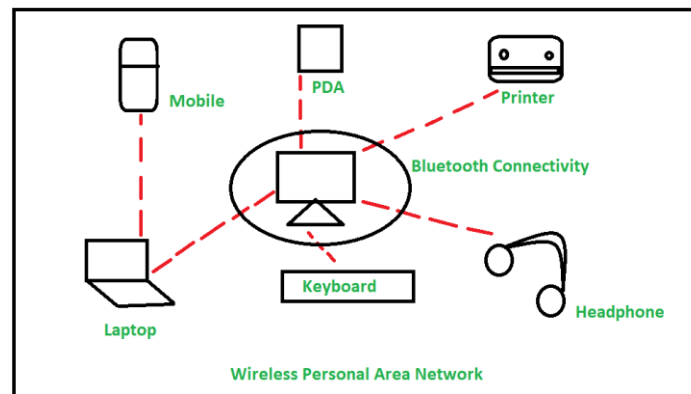
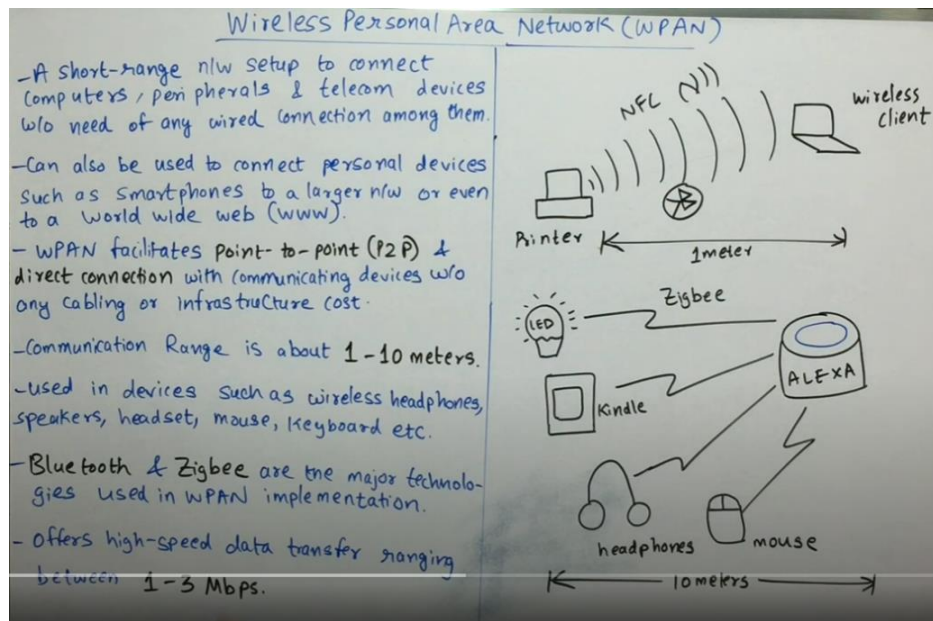
Advantage:

It has easy installation.

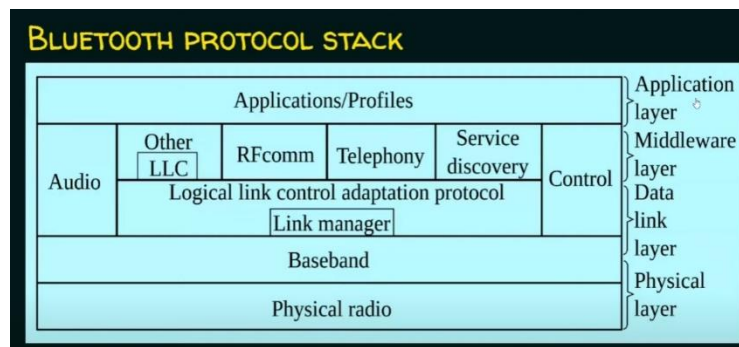
Disadvantage:

Not extensible to PCS or cordless.

WPAN:



Bluetooth Protocol stack:



Physical Radio (RF) layer: It performs modulation/demodulation of the data into RF signals. It defines the physical characteristics of bluetooth transceiver. It defines two types of physical link: connection-less and connection-oriented.

Baseband Link layer: It performs the connection establishment within a piconet.

Link Manager protocol layer: It performs the management of the already established links. It also includes authentication and encryption processes.

Logical Link Control and Adaptation protocol layer: It is also known as the heart of the bluetooth protocol stack. It allows the communication between upper and lower layers of the bluetooth protocol stack. It packages the data packets received from upper layers into the form expected by lower layers. It also performs the segmentation and multiplexing.

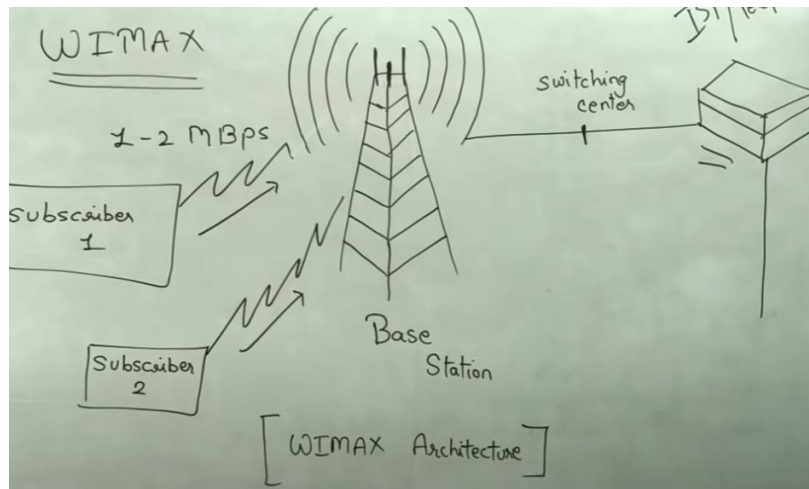
SDP layer: It is short for Service Discovery Protocol. It allows to discover the services available on another bluetooth enabled device.

RF comm layer: It is short for Radio Frontend Component. It provides serial interface with WAP and OBEX.

TCS: It is short for Telephony Control Protocol. It provides telephony service.

Application layer: It enables the user to interact with the application.

WIMAX:



Worldwide interoperability for microwave access.

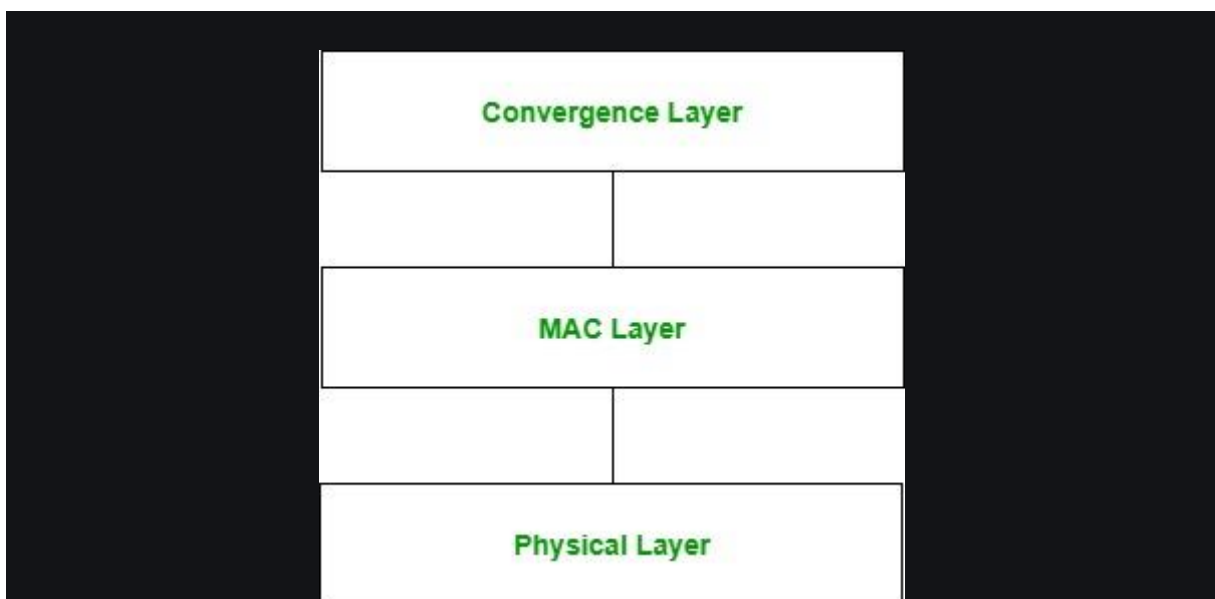
It is an implementation of Metropolitan area network.

It is based on IEEE 802.16 protocol.

It provides data rates upto 75Mbps.

It is cost effective , provides high data rates and efficient.

Layers in WIMAX:



1. **Physical Layer:** Synchronization between transmitter and receiver data rate and multiplexing scheme.

This layer is responsible for encoding and decoding of signals and manages bit transmission and reception. Modulation schemes which are used on this layer includes: QPSK, QAM-16 and QAM-64.

2. **MAC Layer:**

This layer provides an interface between convergence layer and physical

layer of WiMax protocol stack. It provides point to multipoint communication and is based on CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance).

3. Convergence Layer:

This layer provides the information of the external network. It accepts higher layer protocol data unit (PDU) and converts it to lower layer PDU.

Advantages of WiMAX:

1. **Wide Coverage Area:** WiMAX can cover an area of up to 50 kilometers, making it suitable for providing broadband access in rural and underserved areas.
2. **High Data Rates:** WiMAX can provide data rates of up to 75 Mbps, which is higher than many other wireless technologies.
3. **Scalability:** WiMAX can be easily scaled to support a large number of users and devices.
4. **Interoperability:** WiMAX is based on an international standard, which allows for interoperability between different vendors' equipment.
5. **Cost-effective:** WiMAX is a cost-effective solution for providing broadband access in areas where it is not economically feasible to deploy wired infrastructure.

Disadvantages of WiMAX:

1. **Limited Mobility:** WiMAX is designed for fixed or nomadic (semi-fixed) use, not for mobile use.
2. **Security Concerns:** WiMAX uses a shared spectrum, which can make it vulnerable to security threats such as eavesdropping and jamming.
3. **Limited penetration:** WiMAX signals may have trouble penetrating through walls, buildings and other obstacles.

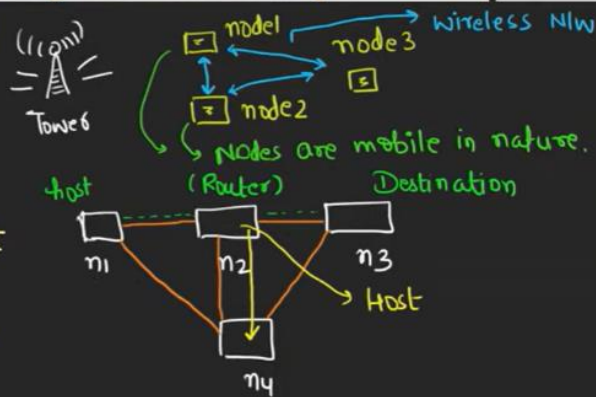
Applications:

Mobile broadband: Provides mobile broadband (high speed internet).

VOIP: Helps in making voice calls over internet.

Mobile Adhoc Network (MANET)

- Wireless Nlw
- No fixed Infrastructure
- Dynamic Topologies
- NODE in MANET can act as HOST or ROUTER.
- MANET is a autonomous collⁿ of mobile users that communicate over wireless Links.



Mobile Adhoc Network (MANET) is a wireless network with no fixed infrastructure and dynamic topology. It is an autonomous distributed collection/network of mobile nodes which communicate over wireless links.

Eg. of fixed infrastructure is a tower.

- In above diagram we can see that nodes 1, 2 and 3 are connected wirelessly and are mobile (moving) in nature.
- The nodes in a MANET can act as a router or a host. For eg: In above diagram node N1 wants to send N3 data then N2 acts as a router, at the same time when N2 wants to send data to N4, it acts like a host.

Characteristics	Properties	Challenges	Applications
<ul style="list-style-type: none"> → <u>Dynamic Topology.</u> → <u>Energy Constrained nodes.</u> → <u>Limited Security</u> → <u>Autonomous</u> → <u>Distributed.</u> 	<ul style="list-style-type: none"> → <u>Fast Nlw establishment</u> → <u>Peer-to-Peer Connectivity</u> → <u>Independent Computation.</u> → <u>No req. of access point.</u> → <u>Less wireless connectivity Range.</u> 	<ul style="list-style-type: none"> → Topology) <u>Dynamic</u> → Security) <u>Limited</u> → Bandwidth) <u>Limited</u> → Energy) <u>Constrained</u> → Routing) <u>Difficult</u> 	<ul style="list-style-type: none"> → <u>Battlefield :- WAR ZONES</u> → <u>Sensor Nlw</u> → <u>VANET :- Vehicular adhoc Nlw</u> → <u>PAN :- Personal area nlw</u>

Characteristics of MANET:

- Dynamic topology : Because the nodes are mobile in nature.
- Energy constraint : Because the nodes are moving and don't have a power supply to keep it charging. The battery of the node decreases as moves.
- Security: A malicious node can also get access to the MANET and share the infected data within the network.
- Distributed: No central node.

Properties:

- No need of access point : As no central node is there.
- Less wireless connectivity range : As we don't have a fixed infrastructure like tower.
- Peer to peer connectivity
- Fast connectivity among nodes within the network.

Challenges:

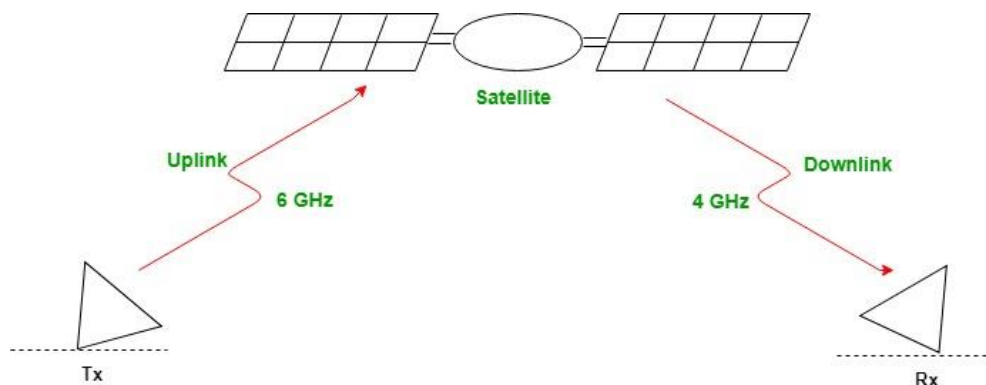
- Routing is difficult as the nodes are mobile so if the data has to be send from node A to B then the routing tables must be updated as fast as the nodes are moving.
- Energy constraint
- Dynamic topology
- Security
- Bandwidth is limited as no fixed infrastructure

Applications:

- Battlefields – As no need to install towers etc.
- Vanet – Vehicular adhoc network to enable communication among vehicles.
- Personal area network : To share resources wirelessly.
- Sensor n/w – Used at borders , of one country intrudes in other country then sensors within the country can send info to the control room/authorities.

Global mobile satellite systems:

GMSS is a system which consists of various artificial communication satellites orbiting around the earth for the purpose of communication.

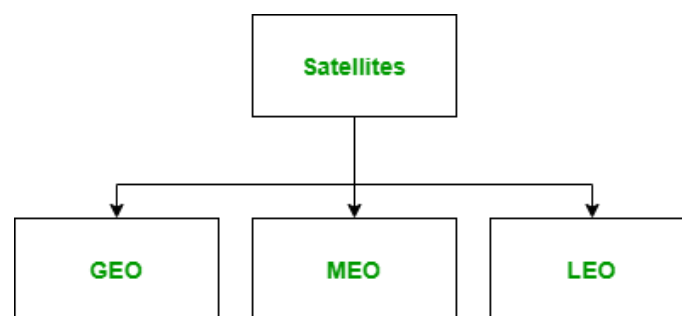


A satellite network is a combination of nodes that provides communication from one point on the Earth to another. A node in the network can be Satellite, an Earth station, or an End-user terminal or Telephone. Satellite networks are like cellular networks, they divide the planet into cells.

Transmission from earth to satellite is uplink and vice-versa is downlink. Uplink and downlink frequencies must be different to avoid interference.

Orbit

An artificial satellite needs to have an orbit, the path in which it travels around the Earth. The orbit can be equatorial, inclined or polar.



GEO:

- GEO stands for Geostationary Earth Orbit.
- The communication satellites in this orbit operates at a distance of about 36000 km above the earth's surface and their orbital time period is about 24 hours.
- Geostationary Orbit Satellites are used for radio broadcasting.
- To ensure constant communication, the satellite must move at the same speed as the earth, so that it seems to remain fixed above a certain spot. So such satellites are called geostationary.

- MEO stands for Medium Earth Orbit.
- The communication satellites in this orbit operates at a distance of about 5000 to 12000 km above the earth's surface.
- A satellite at this orbit takes approximately 6 to 8 hours to circle the Earth.

- LEO stands for Low Earth Orbit.
- The communication satellites in this orbit operates at a distance of about 500 to 1200 km above the earth's surface and their orbital time period generally ranges between 95 to 120 minutes. The Satellite has a speed of

20,000 to 25,000 km/h. Low Orbit Satellites makes global radio coverage possible.

IRIDIUM:

- The concept of Iridium system, a 77-satellite network, was started by Motorola in 1990. The project took 8 years to materialize.
- Finally in 1998, the service was started by 66 satellites. The original name, Iridium, came from the name of the 77th chemical element. A more appropriate name is Dysprosium (the name of 66th element).
- The System has 66 satellites divided into 6 orbits, with 11 satellites in each orbit. The orbits are at an altitude of 750km.
- Iridium is designed to provide direct worldwide voice and data communication using handheld terminals, a service similar to cellular telephony but on a global scale.
- It uses VSAT topology and is LEO satellite.

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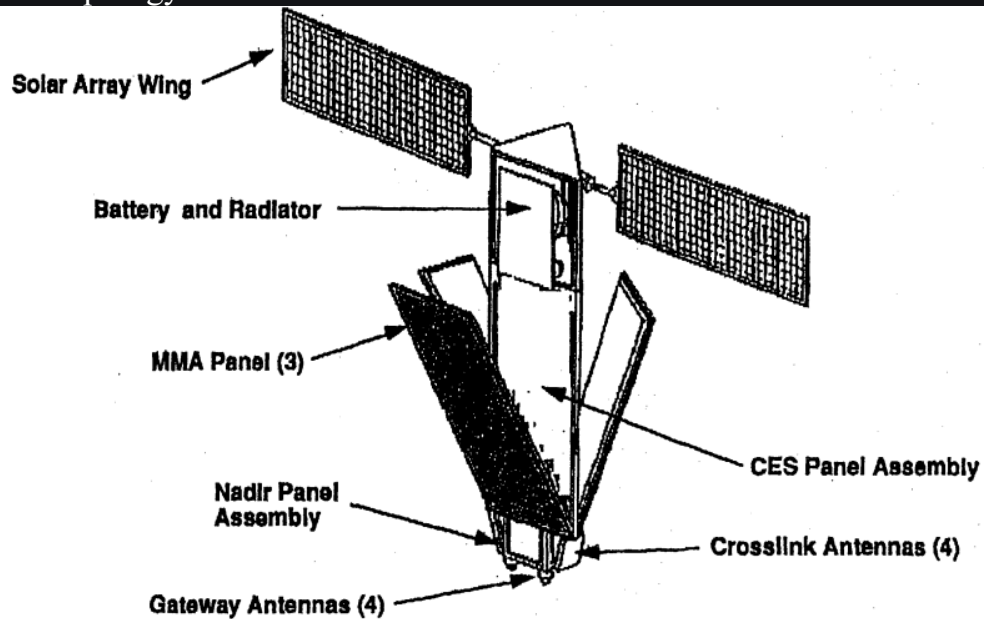
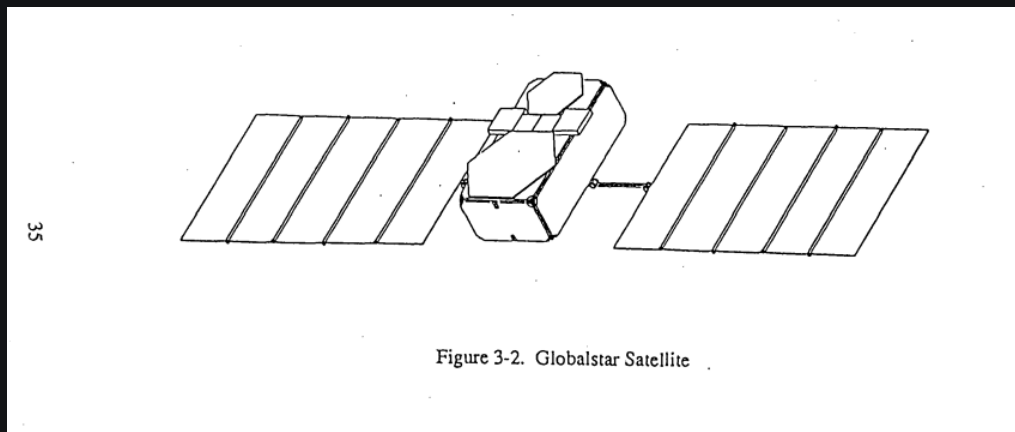


Figure 4-2. IRIDIUM Satellite

Globalstar:

- Globalstar is LEO satellite system.
- It uses 48 satellites in six polar orbits with each orbit hosting eight satellites.
- The orbits are located at an altitude of almost 1400km.
- The Globalstar system is similar to the Iridium system, the main difference is the relaying mechanism.
- Communication between two distinct users in Iridium system requires relaying between several satellites.
- It uses star topology in which mobile terminals communicate with hub stations.
- It chose CDMA as multiple access technique.



Types of Bluetooth

Various types of Bluetooth are available in the market nowadays. Let us look at them.

- In-Car Headset: One can make calls from the car speaker system without the use of mobile phones.
- Stereo Headset: To listen to music in car or in music players at home.
- Webcam: One can link the camera with the help of Bluetooth with their laptop or phone.
- Bluetooth-equipped Printer: The printer can be used when connected via Bluetooth with mobile phone or laptop.
- Bluetooth Global Positioning System (GPS): To use GPS in cars, one can connect their phone with car system via Bluetooth to fetch the directions of the address.

Advantage:

- It is a low-cost and easy-to-use device.
- It can also penetrate through walls.
- It creates an Ad-hoc connection immediately without any wires.
- It is used for voice and data transfer.

Disadvantages:

- It can be hacked and hence, less secure.
- It has a slow data transfer rate: of 3 Mbps.
- It has a small range: 10 meters.
- Bluetooth communication does not support routing.