UNIT V : Introduction to Communication and Navigation System →

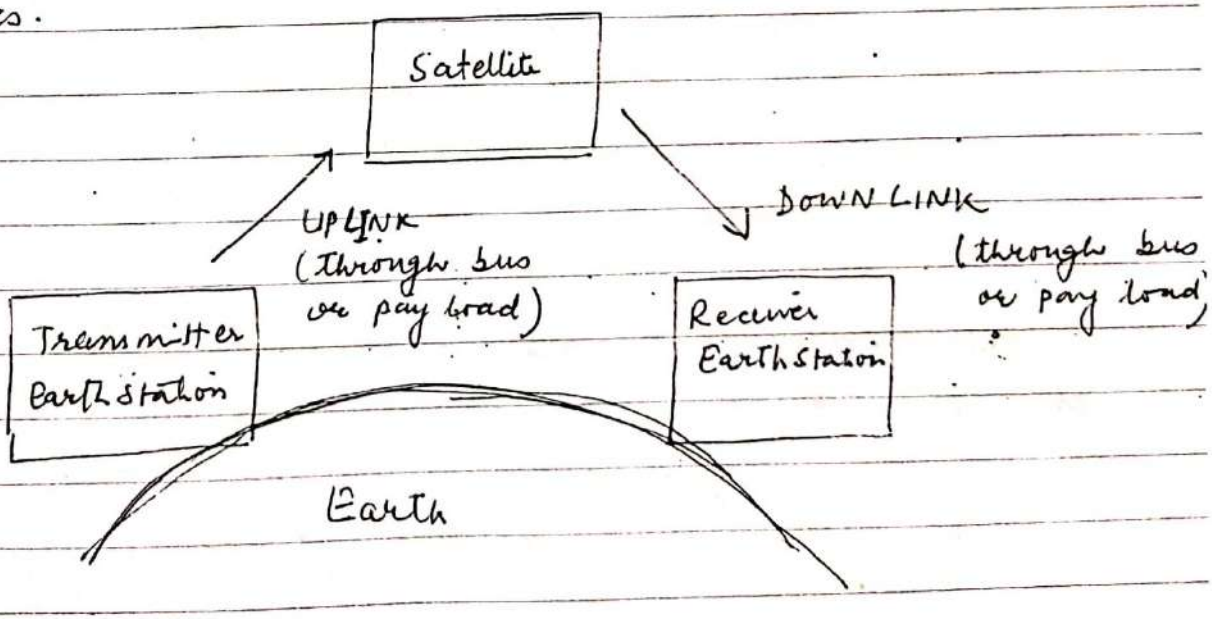
Satellite Communication

A Satellite is a celestial body that orbits around a planet (eg Moon is a satellite of earth)

Communication Satellites are man made satellites which correspond to a microwave repeater in the sky consisting of diverse combination of one or more of the following :- Receiver, Transmitter, Amplifier, Regenerator, Filter, onboard computer, multiplexer, demultiplexer, and Antenna waveguide and any other electronic communication circuit.

OR

A communication satellite is a microwave repeater station that permits two or more users with appropriate earth stations to deliver or exchange information in various forms.



dvantages of Satellite Communication →

1. Mobile / Wireless communication, independent of locat
Any user with an appropriate earth station can employ a satellite for mobile or wireless communication as long as they are within its footprint.

2. Wide Area Coverage: Country, Continent or Globe :-
A satellite can serve any sized region within its boarders that can see it. e.g. A GEO satell can see about 1/3 of the earth's surface.

3. Wide Bandwidth.. Available throughout :-
Frequency spectrum availability for satellite is quite good and satellite users have wide ban width principally for fixed services.

4. Independance from terrestrial Infrastructure :-
Earth stations installed directly at the point of appl allows users to communicate without external connections. This can be attractive in places wh the terrestrial infrastructure is poor or expensive to instal or employ.

5. Rapid installation of ground networks →
Once the satellite is operational, individual earth stations in the ground segment can be activated quickly in response to demand for services.

6. Low ~~Cost~~ Cost Per Added Site :-
Along with rapid installation, the cost of constructing a single site can be quite modest.

7. Uniform Service Characteristics :-
The footprint of the satellite defines the service area, and within that area services are delivered in precisely the same form.

8. Total Service from a single provider →
A satellite can be operated by a single company or by a government agency.

Satellite Applications :-

1. Telecommunications :-
- Global telephone connections
- Backbone for global networks
- Connections for communication in remote places or underdeveloped areas
- Global Mobile communications

2. Other applications :
- Weather
- Radio and TV broadcast satellites
- Earth observation (climate change, agricultural etc)
- Military : surveillance, imaging, intelligence, early warning
- Navegation and localization : aeronautic, nautical etc.

Satellite history →

- 1962 AT&T TELSTAR (first active satellite) and RELAY launched (MEO) - for voice/television/data
- 1962 Communications Satellite Act (U.S.)
- 1963 SYNCOM launched - first geosynchronous orbit satellite.
- 1964 INTELSAT formed
  International Telecommunications Satellite Organizatio- aim to provide global telecommunications connectivi-
- 1965 COMSAT's EARLY BIRD - 1st commercial communica- satellite: 240 duplex telephone channels or 1 TV channel, 1.5 yrs lifetime
- 1969 INTELSAT - III series plans provide global coverag
- 1972 ANIK - 1st Domestic Communications Satellite (Canada).
- 1974 WESTAR - 1st U.S. Domestic Comm. Satellite.
- 1975 RCA SATCOM - 1st operational body-stabilized satellite.
- 1976 MARISAT - 1st Mobile communication satellite
- 1979 INMARSAT formed

Satellite communication Segment

(1) Space Segment

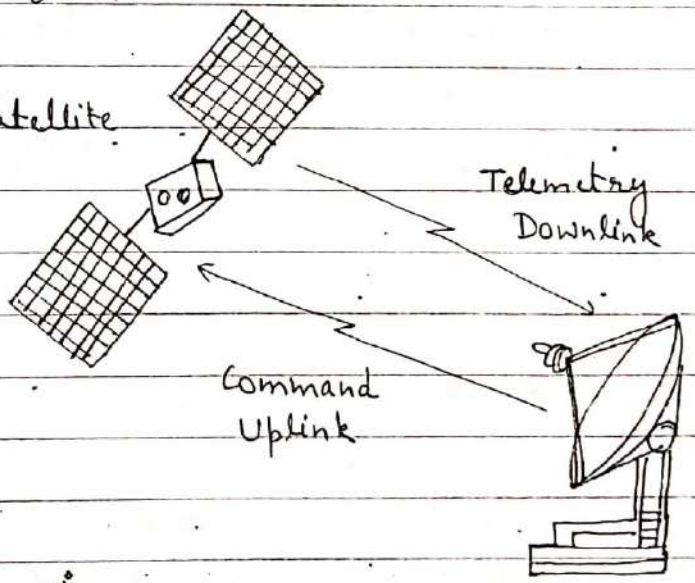
(2) Ground Segment

1) Space Segment

This includes the satellite in orbit in the system, and the ground station that provides the operational control of the satellite in orbit.

Ground station is referred to as Tracking, Telemetry, Command (TT&C) or Tracking, Telemetry, Command and Monitoring (TTC & M) station.

TTC & M station provides essential space craft management and control functions to keep the satellite operating safely in orbit.



Telemetry → Remote area communication process

TT&C (Tracking, Telemetry, Command) & Monitoring (TTC & M) Ground Station

Telemetry Subsystem → Following operations take place telemetry

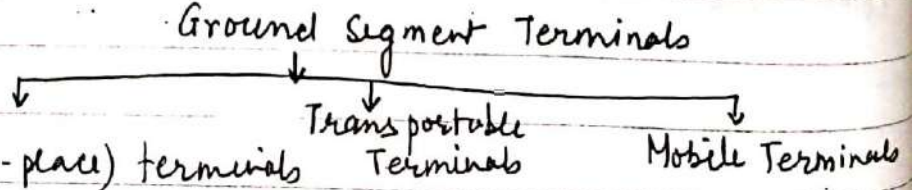
(i) Generation of an electrical signal which is proportional to the quantity to be measured.
(2) Encoding the electrical signal
(3) Transmitting this code to a far distance.

Telemetry performs mainly two functions
(i) Receiving data from sensor
(ii) Transmitting that data to an earth station.
~~(iii)~~

Tracking Subsystem → It is useful to know the position of the satellite and its current orbit.

Commanding Subsystem → To launch the satellite in its orbit and its working in that orbit. This adjusts altitude and orbit of satellite., whenever there is deviation in these values.

2) Ground Segment → This consists of the earth ~~stg~~ surface area based terminals that utilize the communication capabilities of ~~these~~ the space segment. TTC&M ground stations are not included in the ground segment.



1. Fixed Terminals :- Designed to access the satellite while fixed in place on the ground.

eg. Small terminals used in private networks (V-SAT) or terminals mounted on residence buildings to receive broadcast satellite signals.

2. Transport Terminals :- Design to be movable, but once on location remain fixed during transmission to the satellite.

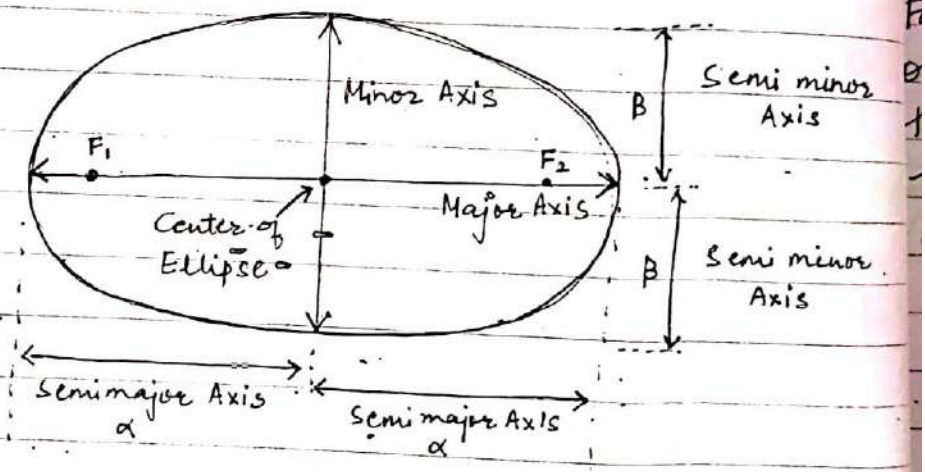
eg. Satellite News gathering trucks which move to places, stop in a place, and then deploy an antenna to establish links to the satellite.

3. Mobile Terminals :- Designed to communicate with the satellite while in motion. They are further defined as land mobile, aeronautical mobile, or maritime mobile, depending on their locations on or near earth surface.

Kepler's Laws → A satellite remain in orbit because Centrifugal force caused by its rotation around earth is counterbalanced by Earth's Gravitation pull.

The laws of Planetary motion describes the shape of the orbit, Velocities of the Planet and the distance of Planet ~~is~~ with respect to the sun.

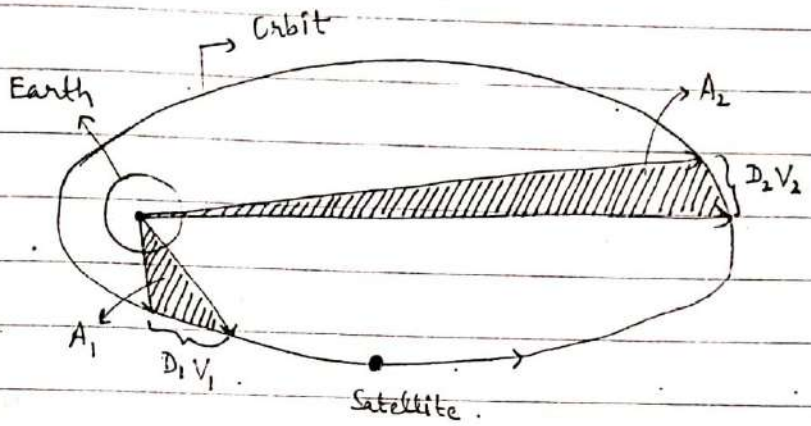
Kepler's first law :— A Satellite will orbit a primary body (like earth) following an elliptical path



F_1 and F_2 are two focal points (Foci) of an Ellipse and the center of mass (or body Centre) of a two body system is ~~always~~ always centred on one the foci. Eccentricity of the Ellipse is defined as,

$$\epsilon = \frac{\sqrt{\alpha^2 - \beta^2}}{\alpha}$$

Kepler's Second Law → For equal intervals of time, a Satellite will sweep out equal areas in the orbital plane, focussed at the barycentre



For a satellite traveling distances D_1 and D_2 metres in one sec, areas A_1 and A_2 will be equal. Because of the equal area law, distance D_1 must be greater than distance D_2 and therefore velocity V_1 must be greater than V_2. The velocity will be greatest at the point of closest approach to earth (known as Perigee) and the velocity will be least at the farthest point from earth (known as Apogee).

Kepler's third law → This is known as harmonic law. The square of the periodic time of orbit is proportional to the cube of the mean distance between the primary body and the satellite. This means distance is equal to the semi major axis thus

$$\alpha = A P^{2/3}$$

where

α = Semi major axis

A = Constant

P = Mean Solar earth days