CHAPTER I :

PRINCIPALE OF SATELLITE COMMUNICATIONS

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I.1. SATELLITE COMMUNICATION

I. Principale of satellite communications

I.1. Satellite Communication

A. Introduction:

→ *Satellite is a smaller object that revolves around a larger object in space.*

(Natural Satellite: Moon)

→ *Satellite Communication:* Communication takes place *between any two Earth stations through communication*

Satellite

→ *A communication satellite is an artificial sabellite used to provide the communication links between various points on Earth.*

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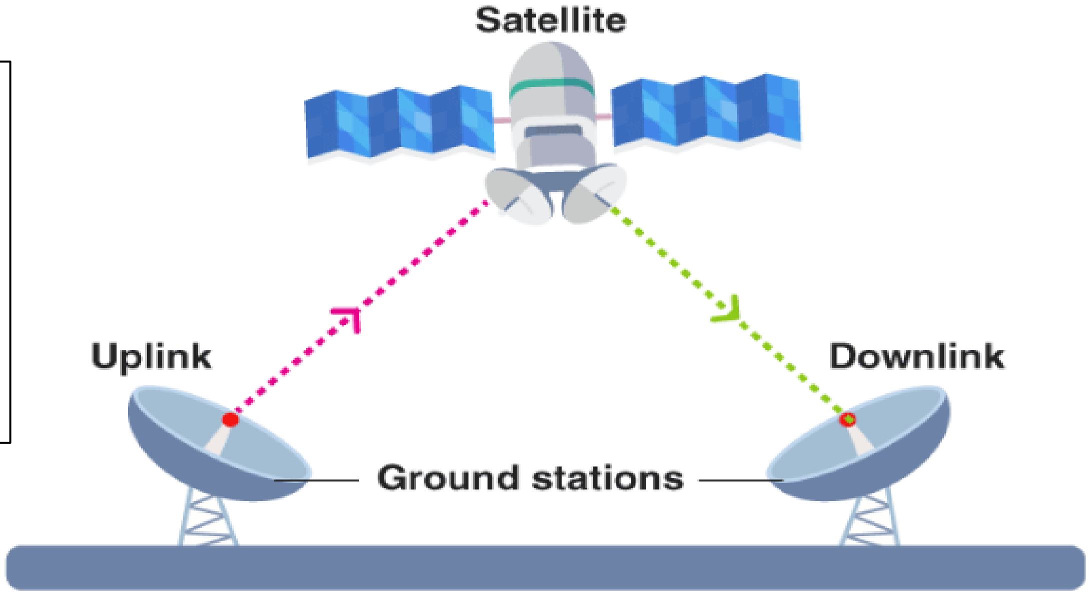
I.1. Satellite Communication

Communication Satellite transmits the radio telecommunication signal via transponder



Ex: *World's first satellite*

Sputnik 1: launched by Soviet Union in 1957.

Aryabhata : launched by India in 1975.

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I.1. Satellite Communication

- *Transponder :*

→ Radio receivers, amplifier & transmitters

→ It amplifies the incoming signal and changes its frequency for downlink.

- *Uplink:*

→ The channel through which the signal transmitted from Earth station to is Satellite.

→ Uplink frequency is the frequency of signal Sent into the space.

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I.1. Satellite Communication

- *Downlink:*

→ The channel through which the signal is transmitted from satellite to ES.

→ Downlink frequency is the frequency C at which ES receiving a satellite Signal).

(Uplink frequenues are always higher than The downlink frequency)

Ex: Indian National Satellite (INSAT)

One of the largest domestic communication Systems placed in Geo-stationary orbit.

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I.1. Satellite Communication

B. Applications :

→ *Global belecommunication system Radio and TV Broadcasting*

→ *Internet applications such as GPS, data transfor, Internet surfing, etc.,*

→ *Weather forecasting*

→ *Military applications & Navigations*

→ *Remote Sensing applications Disaster management rescue operations*

I. Principale of satellite communications

I.1. Satellite Communication

C. Advantages :

→ *Every corner of the Earth covered.*

→ *Maximum bandwidth and reliable.*

→ *Communication over a longer distance.*

D. Disadvantages :

→ *Costly process.*

→ *Interference (or) congestion of frequences.*

→ *More free space loss.*

→ *difficult to provide repairing activities.*

I.2. FREQUENCY ALLOCATION FOR SATELLITE SERVICES

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I.2. frequency allocation for satellite services

A. Introduction:

→ *It is a complicated process to allocate frequenues to satellite*

→ *It requires International coordination Planning.*

→ *International Telecommunication Union [ITU]*

 # The world is divided into three regions for frequency allocation.

Region 1 : *Europe, Africa, formerly the Soviet Union , Mongolia.*

Region 2: *North and South America & Greenland Region*

Region 3: *Asia [Excluding region 1], Australia and South-west Pacific.*

I. Principale of satellite communications

I.2. frequency allocation for satellite services

B. Satellite Services :

Within these regions, frequency bands are allocated to various Satellite Services :

- ✓ *Fixed Satellite Services [FSSJ*
- ✓ *Broadcasting Satellite Service [BSS] Mobile*

  Satellite Service [MSS]
- ✓ *Navigational Satellite Service.*
- ✓ *Meterological Satellite Service.*

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I.2. frequency allocation for satellite services

✓ ***Fixed Satellite Services [FSS]***

It provides links for existing telephone 18 is also for transmitting TV networks Signals to cable companies.

→ *C-band is used for FSS , The most widely used subran²:ge is 4 to 6 GHz 6/4 GHz*

✓ ***Broadcasting Satellite Service (BSS)***

for direct broadcast to the home :

* Direct Broadcast Satellite (DBS)

* Direct-to-Home (DTH) in Europe

→ *Band is widely used for DBS Range is 14/12 GHz.*

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I.2. frequency allocation for satellite services

- ✓ ***Mobile Satellite Service***

  Land mobile, Maritime mobile and Aeronautical mobile.

  → *L-Band is used for mobile satellite and navigation service.*

- ✓ ***Navigational Satellite Service***

  Global Positioning System (GIPS).

  → *L-Band & VHF (certain navigations).*

- ✓ ***Meteorological Satellite Service***

  Search and Rescue Service.

  → *VHF band for data transfer from weather satellites.*

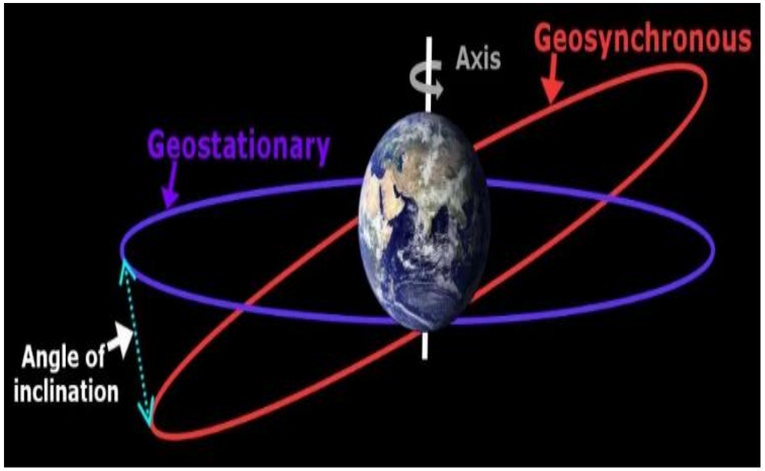
I.3. GEOSTATIONARY AND NON-GEOSTATIONARY ORBIT

I. Principale of satellite communications

I.3. Geostationary & Non-Geostationary Orbit

A. Geostationary orbit:

- It is the orbit in which a satellite orbits the Earth at exactly the same speed as Earth.
- a satellite appears to be stationary with respect to the Earth → called as Geostationary orbit.



B. Conditions for Geostationary orbit:

- ✓ Satellite orbits the Earth Eastward at exactly the same rotational speed as Earth.
- ✓ The inclination of the orbit must be zero i=0
- ✓ Orbit must be circular

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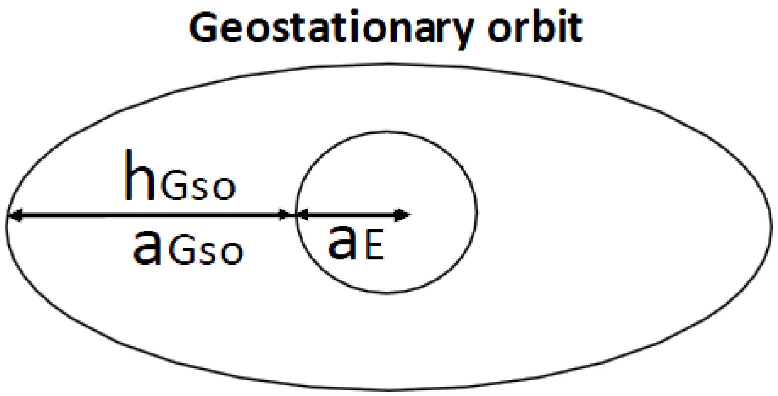
I.3. Geostationary & Non-Geostationary Orbit

C. Radius & Height (Geostationary orbit):

- According to the Kepler's third law, the radius of the Geostationary orbit (a_{GSO}) is given as,



$$a_{Gso} = \left(\frac{\mu p}{4\pi^2}\right)^{1/3}$$

$$\mu = 3.986005 * 10^{14}\, m^3/s^2$$,

P⟶ Period for the geost. (23h, 56min, 4 s)

$$a_{Gso} = 42164\ Km$$

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I.3. Geostationary & Non-Geostationary Orbit

- The equatorial radius of The Earth is, $a_E = 6378\ Km$

- The Geostationary height is,

$$h_{Gso} = a_{Gso} - a_E = 42168 - 6378 = 35786\ km$$

 # Geostationary Satellites are around 36000 km from the Earth.

 # Ex : India's INSAT Series, United states GOES

D. Uses of Geo stationary satellite:

→ Communication.

→ Disaster Management.

→ Climate control.

→ Meteorological operation.

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I.3. Geostationary & Non-Geostationary Orbit

E. Non-Geostationary Orbit (NGSO):

→ The NGSO satellites are located in the Low range of orbital positions.

LEO : 700 km-1500 km from the Earth.

MEO: Around 10,000 km from the Earth.

→ do not maintain a stationary position

→ can move in relation to the Earth's Surface.

→ Ex : Iridium in 1998

→ Applications: Communications, Earth, observation

I.4. LINK POWER BUDGET EQUATION

I. Principale of satellite communications

I.4. Link Power Budget Equation

A. <u>Received Power:</u>

→ It relates the transmitting power is receiving power.

→ The power received at receiver is,

$[P_R] = [\text{ EIRP }] + [\ G_R\ ] - [\text{ LOSSES }]$, in dBw.

- [GR] : Receiver antenna gain.
- [EIRP] : Equivalent Isotropic radiated power in Dbw.

→ is considered as an input power of transmission link.

$EIRP = GP_s$; G : transmitting Antenna Gain.

$[EIRP] = [G] + [P_s]$

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I.4. Link Power Budget Equation

- [LOSSES] : The losses for clear-sky conditions are,

  [LOSSES] = [FSL] + [RFL]+[AML] + [AA]+ [PL]

  [FSL] : free-space spreading loss in dB

  [RFL] : Receiver feeder Loss in dB

  [AML] : Antenna misalignment loss is dB

  [AA] : Atmospheric absorption loss, dB

I.4. Link Power Budget Equation

B. Carrier-to-Noise Ratio (CNR):

→ It is defined as the ratio of carrier power noise power at the satellite receiver input. $C/N = P_R / P_N$

→ It is used to measure the performance of satellite, is to determine the link - power budget calculations,

→ In terms of decibels,

$$[C/N] = [P_R] - [P_N]$$

$$[P_N] = [K] + [T_S] + [B_N] \rightarrow P_N = K.T_S.B_N$$

$$[C/N] = [EIRP] + [G_R] - [LOSSES] - [k] - [T_S] - [B_N]$$

I. Principale of satellite communications

I.4. Link Power Budget Equation

C. [C/No] :

→ It is the ratio of carrier power to noise power density (ie) (P_R/N_0).

$[C/N_0] = [C/N] + [B_N]$

Substitute [C/N] :

$[C/N_0] = [EIRP] + [G_R] - [LOSSES] - [k] - [T_S] - [B_N] + [B_N]$

$$[C/N_0] = [EIRP] + [G_R] - [LOSSES] - [k] - [T_S]$$

D. Combined Uplink and Downlink [C/N] ratio :

$$(N_0/C) = (N_0/C)_U + (N_0/C)_D$$

→ From this, the combined carrier-to-noise ratio (C/N_0) can be obtained by taking the eciprocal of (N_0/C).