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Internal Assessment Test 2 – Dec. 2021

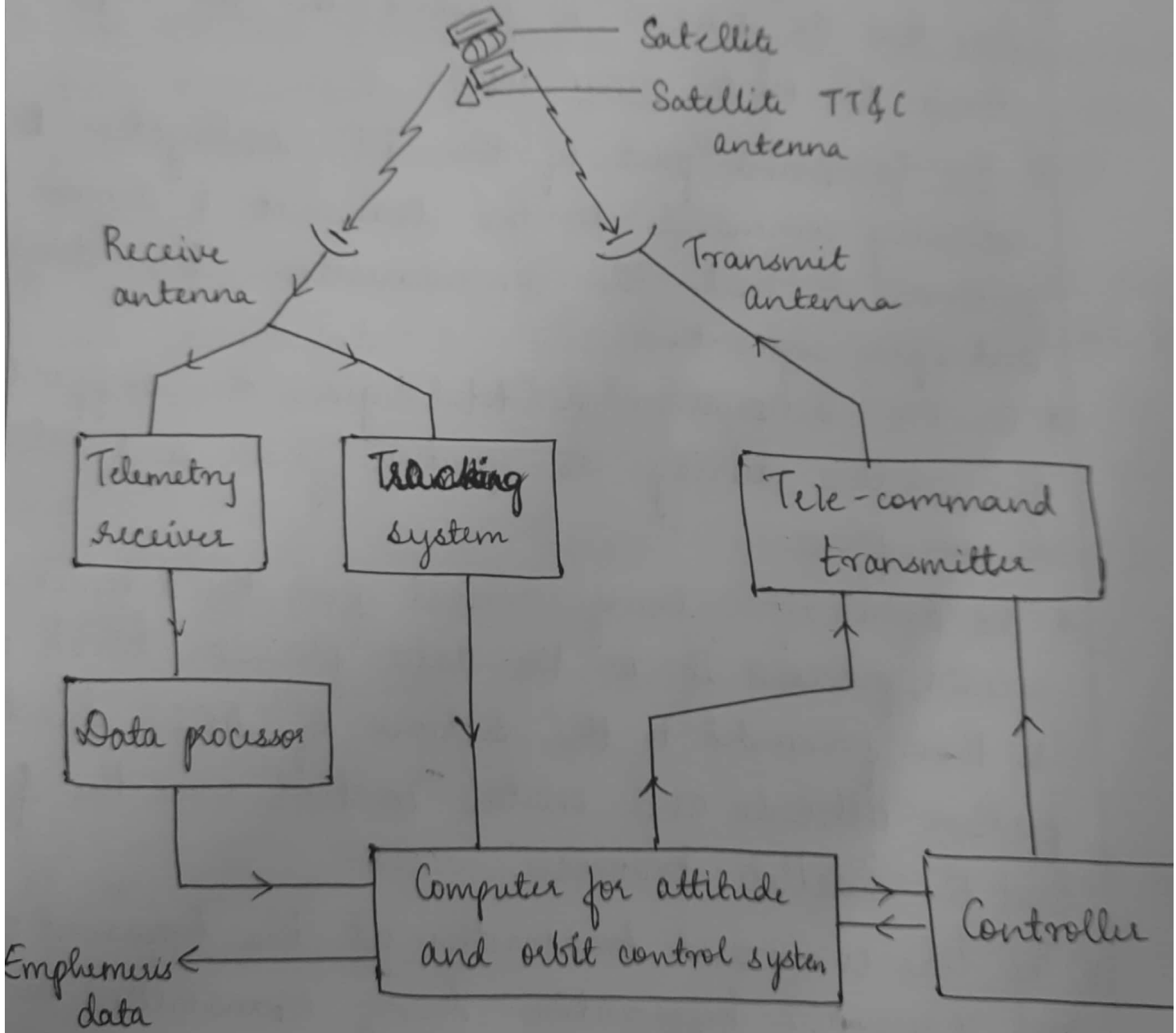
Sub:	Satellite communication					Sub Code:	18EC732	Branch:	ECE
Date:	20-12-2021	Duration:	90 Minutes	Max Marks:	50	Sem / Sec:	7/A,B,C,D		OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1	Describe Telemetry, Tele-command & Tracking control monitoring system of a communication system.	[10]	CO3	L1,L2
2	List and explain the types of Earth station on the basis of service provided by each of them.	[10]	CO3	L2
3	Explain with neat & clean diagram satellite point to point telephone network.	[10]	CO3	L1,L2
4	Discuss the advantages and disadvantages of Satellite communication over Terrestrial communication.	[10]	CO3	L1, L2
5	Name satellite tracking techniques. Explain Mono-pulse tracking in detail with neat and clean diagrams.	[10]	CO2	L2
6	List the frequency bands used in satellite communication. What is Transponder and explain it in detail.	[10]	CO3	L2
7	Explain Earth station Architecture with a neat and clear diagram.	[10]	CO2	L2

Internal Assessment Test - 02

QUESTION - 1

Telemetry, Tele-command & Tracking Subsystem:



Block schematic representation of TT&C subsystem of satellite.

* The Telemetry part of the TTC subsystem handles all the angle, velocity related perturbations that happens on the satellite
* The Tracking part of the TTC subsystem makes sure that the satellite is present in the right orientation -on in the orbital maneuvear.
* The Command part of the TTC subsystem takes necessary commands to the transmit & receive antennas to make the communication b/w terrestrial and space segment.
* The TTC subsystem in total gives the support to the satellite during its operation phase and also its launch phase.
* The data after being received from the telemetry receiver, processes it in the data processor block and is then forwarded to the section of AOCS block for further attitude and orbital control over the path that the satellite traverses.
* The tele-command transmitter at the transmit antenna part covers the information being transmitted and the controller controls the satellite for its operation to be in a sequenced manner without any loss of information from the space to the Earth station.

* The TTC system together forms a major component for the satellite tracking and hence we have 2 major TTC stations in world, they are:

  ESTRACK by Europe Satellite Station (ESS), Europe

  ISTRAC by ISRO, India

* The satellite from India is mostly being launched from Sriharikota after undergoing TTC process, where data is being processed & all the subsystem level testings are being approved.
* TTC has its major operation during its launch phase with exact satellite injection velocity for satellite to orbit in the exact orbital plane.

QUESTION-2

Ans:- The types of Earth station classification can be broadly classified into two major categories:

Types of Earth station

- On the basis of service provided
- On the basis of usage

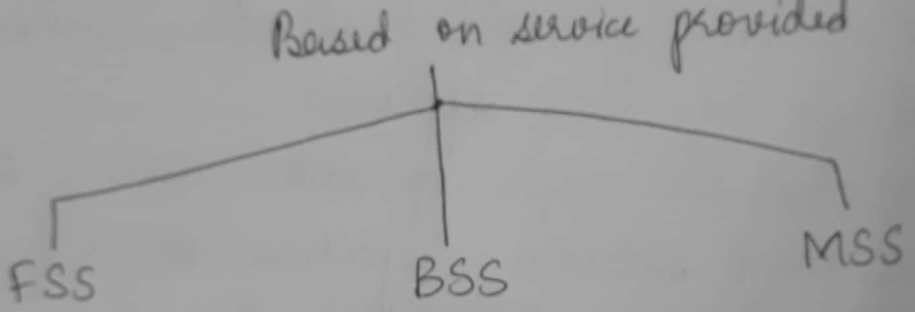
(i) Based on services provided

(ii) Based on usage.

(i) On the basis of Service provided:

The Earth stations are further classified into 3 major types, they are:

(a) FSS (Fixed Satellite Service) Earth Station
(b) BSS (Broad Satellite Service) Earth Station
(c) MSS (Mobile Stellite Service) Earth Station



(a) FSS:

- FSS uses, *large earth station ($G/T \cong 40$ dB/k)
  *medium earth station ($G/T \cong 30$ dB/k)
  *small earth station ($G/T \cong 25$ dB/k)
  *very small terminals with transmit/receive function ($G/T \cong 20$ dB/k)
  *very small terminal with receive-only function ($G/T \cong 12$ dB/k)
- FSS operates majorly in Geostationary satellite and is used for data communication and in radio and television broadcast, and FSS is mainly used in North America.

- FSS uses a frequency band of:
  (3.7 - 4.2) GHz in C-band
  (11.7 - 12.2) GHz in Ku band
  (12.2 - 12.75) GHz in Ku band } in Europe.

(b) BSS:

- BSS uses, * large earth station ($G/T \cong 15$ dB/k)
  * small earth station ($G/T \cong 8$ dB/k)
- large earth station is used for community recep
  whereas, small earth station is used for individual
  reception.
- BSS usage has classified it into 3 different region
  * ITU-Region 1 (Europe, Russia, Africa) (10.2-12.75
  * ITU-Region 2 (North & South America) (11.7-12.2
  * ITU-Region 3 (Asia, Austria) (12.2 - 12.75 GHz)

(c) MSS:

- MSS uses, * large earth station ($G/T \cong -4$ dB/k)
  * medium earth station ($G/T \cong -12$ dB/k)
  * small earth station ($G/T \cong -28$ dB/k
- MSS are mainly used for satellite telepho
  communication services.

- Large and medium Earth stations are used for satellite tracking, whereas small Earth station is not used for tracking in MSS.

(ii) On the basis of usage:

The Earth station are further classified into three major types, they are:

(a) Single function station
(b) Gateway station
(c) Teleports.

(a) Single function station:

- They perform only 1 or single function at a time ie, either transmit or receive at a time only
- Ex: TVRO

(b) Gateway station:

- They act as an interference b/w satellite and the terrestrial n/w
- Signal processing is the main function of Gateway

(c) Teleports:

- Two or more gateways together constitute the teleport and are hence the connecting link b/w the satellite and the Earth station.

QUESTION - 4.

Ans Satellite communication over Terestrial communication

ADVANTAGES:

The advantages of using satellite than terrestrial networks for communication are as follows:

(i) Broadcast property
(ii) Wide bandwidth
(iii) Geographical flexibility
(iv) Ease of installation of ground station
(v) Uniform service characteristics
(vi) Immunity to natural disasters
(vii) Independent from terrestrial interference
(viii) Cost aspects.

(i) Broadcast property:

- The broadcasting property of satellite is more secure and comparitively efficient than terrestrial as they have a finite detecting system on board the satellite to catch the data being observed at the space segment.
- Also, this data from processing, is being tra back to the Earth station with high frequency.

QUESTION - 4.

4 Any Satellite communication over Terestrial communication.

ADVANTAGES:

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(ii) Wide bandwidth
(iii) Geographical flexibility
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(ii) Wide bandwidth:

- Bandwidth measured for satellites are comparitively more than terrestrial n/ws, because in terrestrial ones have point-to-point communication, but for satellite, communication happens within a range.
- Hence, satellites require wider bandwidth than terrestrial n/w communication

(iii) Geographic flexibility:

- For terrestrial communication, at times, it may happen than very tall building may interrupt the communication link & hence may loose the path for transmission.
- But in satellite flexibility, since it operates for wide bandwidth, it is geographically flexible

(iv) Ease of installation of ground station:

- The installation of ground station is comparitively easier when it comes for satellite communication, but for terrestrial communication, it is not so convinient to form stations at every location as needed.

(v) Uniform service characteristics:

- The services provided by earth station seem to be surplus for the station or satellite as they form a continous link uniformly, once established till the time they last in space segment.

(vi) Immunity to natural disasters:

- The satellites are being immune to all natural disasters that it may occur, but being showcased to all such unconventional conditions, in case of Terrestrial n/w
- When some disaster happen, there is no means by which we can protect the terrestrial n/w.

(vii) Independent from terrestrial infrastructure:

- The satellites are being independent when setting up their communication link b/w the satellite in space segment to the ground station
- This ensures than there's no dependency of all the infrastructure that the earth has, for satellite communication to happen

(viii) Cost aspects:

- Comparing the cost aspect, it would be much cheap to design a satellite than the terrestrial n/w and hence the cost aspect supports the design of a satellit
- The terrestrial n/w occupies a wider geographical area than compared to satellites.

DISADVANTAGES:

The earth station also have some disadvantages of satellite communication over Terrestrial

communication, which are listed as below:

(i) Transmission delay

(ii) Echo effect

(iii) Launch cost of a satellite.

(i) Transmission delay:

- For the information to be transmitted from the earth station to the satellite or vice-versa, it takes some amount of time to process and hence it is inconvenient as compared to terrestrial communication
- There is a much less transmission delay for ~~terrestrial~~ point-to-point communication.

(ii) Echo effect:

- One of the drawback of satellite communication is the echo effect, where one hears their voice only after transmission from the Earth station
- But terrestrial communication do not have this drawback

(ii) Launch cost of a satellite:

- The launching of a satellite requires, much much amount or is very costlier than setting up a terrest fw station.

QUESTION-6

Ans: **Frequency bands used in Satellite Communication:**

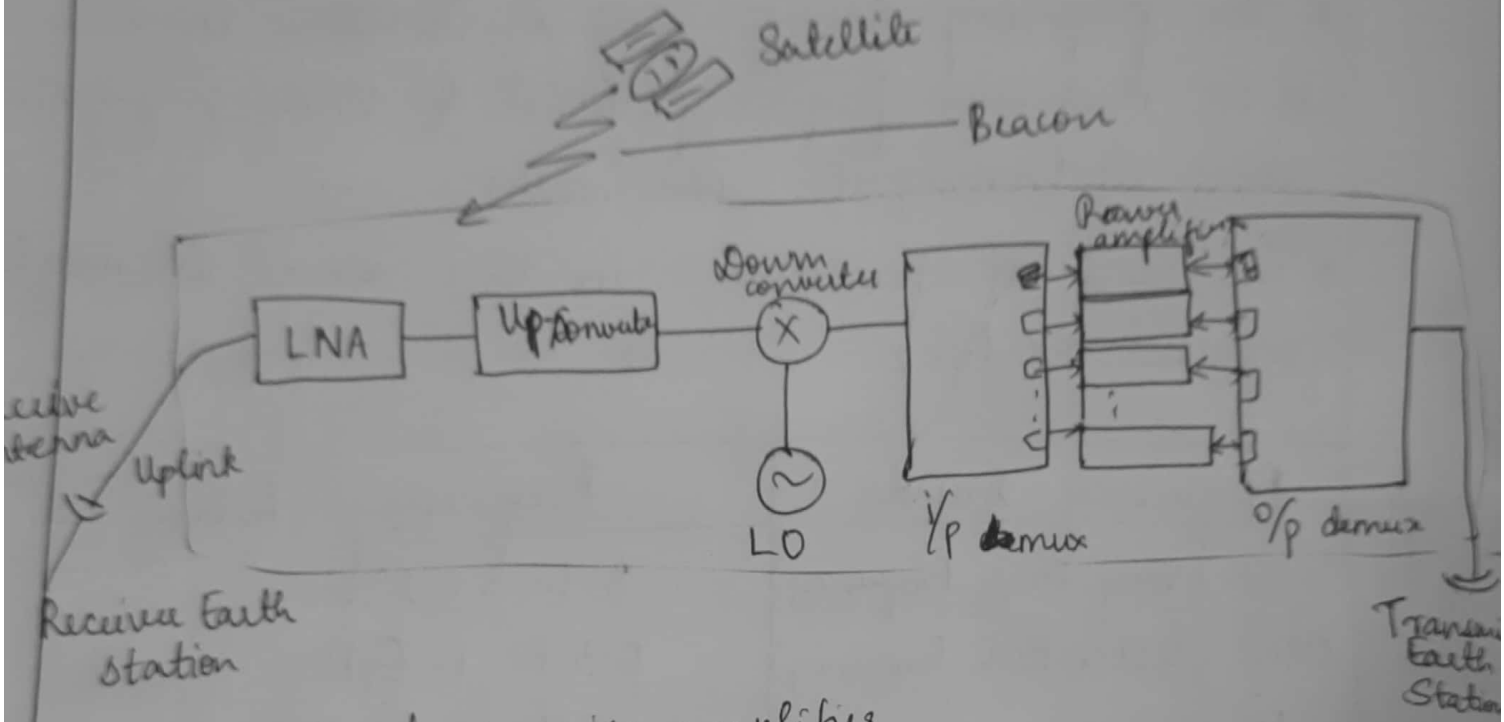
* The frequency range used in satellite communication is in microwave frequency band & they propagate using electromagnetic ~~rang~~ waves
* The range of frequencies in this band is roughly around 100 GHz.

Frequency bands	Frequency Range
VHF (Very High Frequency)	3 to 30 MHz
UHF (Ultra High Frequency)	0.3 to 1 GHz
L	1 to 2 GHz
S	2 to 4 GHz
C	4 to 8 GHz
X	8 to 12 GHz
Ku	12 to 18 GHz
K	18 to 26 GHz
Ka	26 to 40 GHz.

Transponders:

The transponders are generally the payloads in satellite, that can either transmit or receiver or both transmit & receive at the same time.

The below diagram shows the block schematic of a transponder / payload.



LNA : Low noise amplifier

PA : Power amplifier

LO : Local oscillator.

- The satellite transmits the data and is received by the receiver antenna
- The uplink frequency of the receiver Earth station is activated and sends the signal to the low noise amplifier
- The low noise amplifier sends it to a down converter which contains a mixer and a local

oscillator.

- The uplink portion of satellite involves the LO, LNA & the mixer
- The downlink portion of satellite involves the i/p muxers, Power amplifiers and o/p demultiplexers.
- The data from being amplified is being sent to the transmit earth station with a downlink frequency
- This is the general operation of a payload for communication.
- There are two types of payloads, they are:
  * Transparent or bent-pipe transponder
  * Regenerative transponder.
- The transparent or bent-pipe, the name is so because the data gets reflected back to the Earth

The regenerative transponders are called digital transponders because these signal undergo multiple digital transformations before undergoing re-transmission.

QUESTION-7

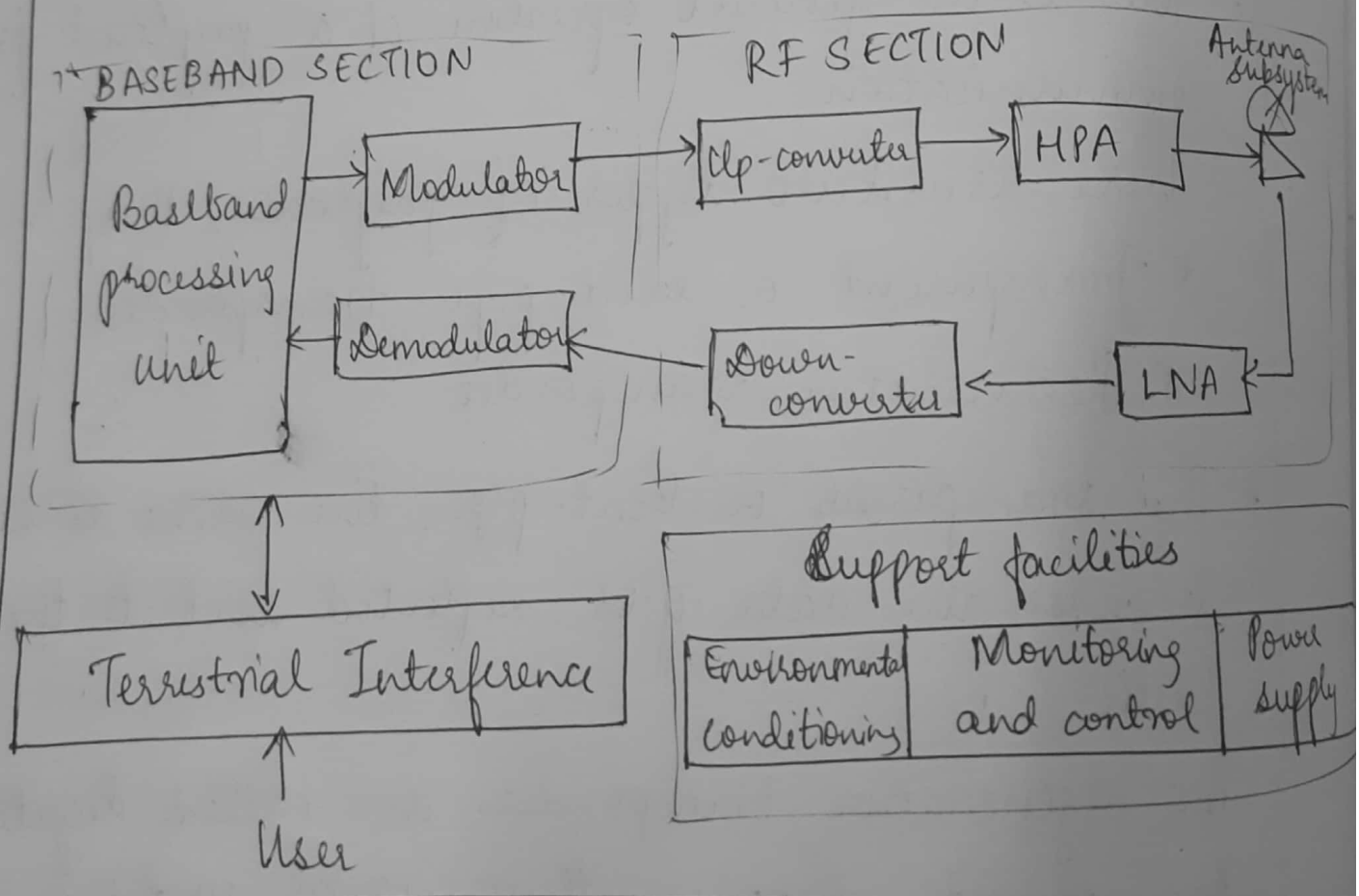
Ans. **Earth Station Architecture:**

The Earth Station consists of three major blocks, namely:

(i) Baseband section

(ii) RF section

(iii) Terrestrial Interface.



Block schematic diagram of Earth station architecture.

• The Earth station architecture comprises of :

(i) Baseband Section :

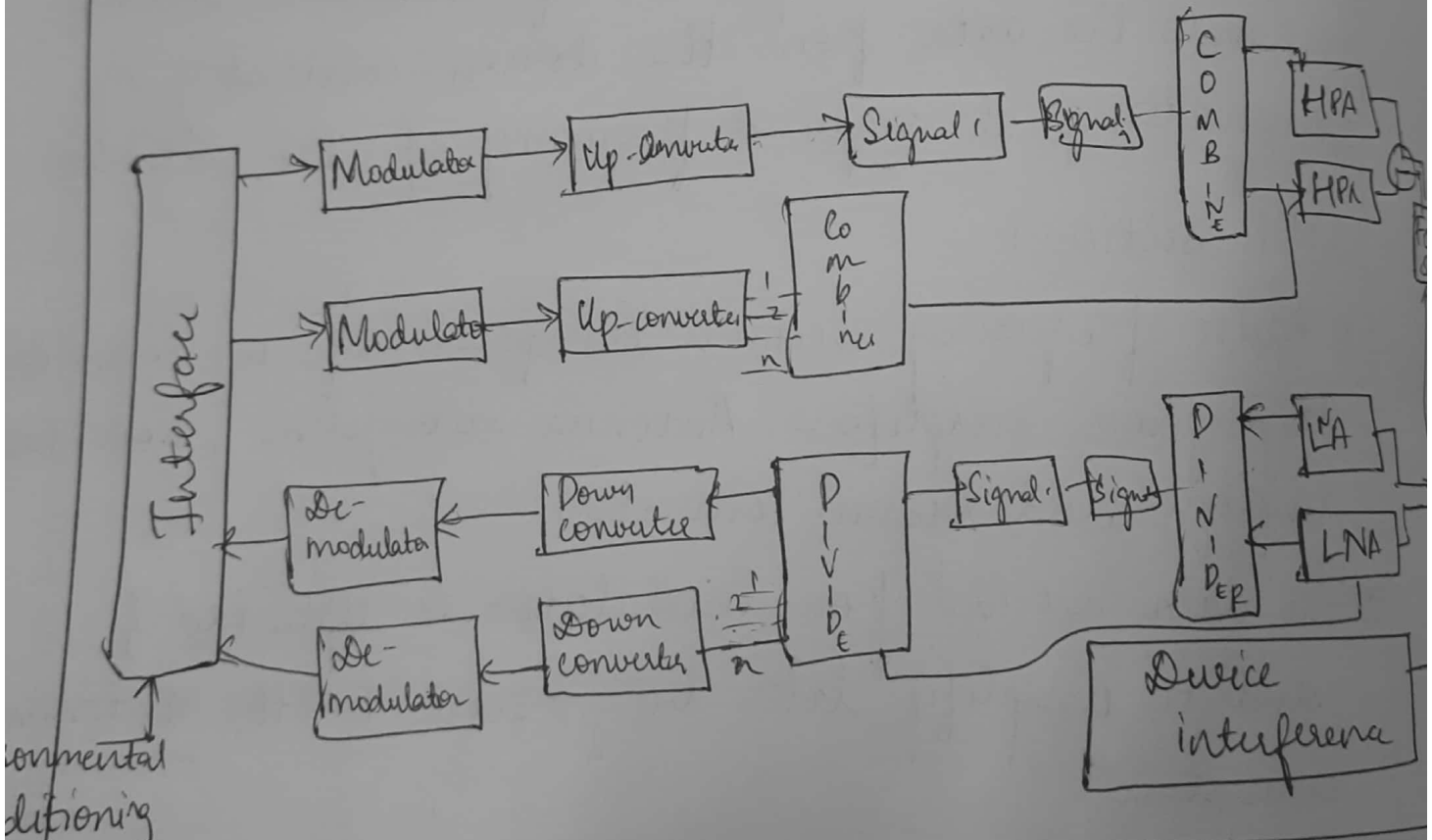
* The baseband processing unit processes the data being available at the source end, processes it and sends it for modulator at the transmitter end for modulation
* This processing unit, carries out the function of uplinking & downlinking the frequencies to the desired value to allow frequency translation process
* The demodulator segment of baseband section transmits the data from the down-converting by transmitting at required frequency of the satellite.

(ii) RF section :

* Radio frequency section comprises of up-converters, High-power amplifiers, Antenna subsystem, Low-noise amplifiers and Down-converters.
* The data received from modulator is uplinked & send to amplify, later being sent to the antenna subsystem.
* The o/p data from antenna subsystem is processed & sent to LNA, which is then down-converted to the required freq.

(iii) Terrestrial Interface:

* Terrestrial interface acts as a connection link b/w the Baseband section and the User
* Also all these three subsystem of Earth station require the support of other facilities like,
  - Power supply
  - Environmental condition
  - Monitoring and control.



Block diagram of a large FSS statio
Earth station