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Satellite Communication Systems

Sandeep Singh[1], Prof. (Dr.) Janak kumar B. Patel[2]

M.Tech. Student, Department of Electronics and Communication Engineering,
Amity University Haryana, Gurugram, India[1]

Head, Department of Electronics and Communication Engineering
Amity University Haryana, Gurugram, India[2]

Abstract: Communication has revolutionized by the Satellites. Its importance and services to human race cannot be neglected. A communication satellite may be looked upon as a big microwave repeater body, where the satellite consists of so many numbers of transponders. Where transponders receive the incoming signal, modifies them and sends back them to the earth station at the receiver end. The satellites work in the operating frequency range of 1 GHz to 50 GHz. The technique with on the satellite communication operates is the FDM. This is the oldest technique but nowadays TDM is also being used, where FDM stands for frequency division multiplexing and TDM for time division multiplexing. As we all know satellite is a heavenly body which moves around the earth in an elliptical or circular orbit to carry on the motion of satellite in circular orbit. The various applications of satellite are weather forecasting, television, radio broadcasting, GPS & internet Communication, etc. Satellite can be used for point-to-point or point-to-multipoint communication is supported.

Keywords: Satellites communication, GPS system, Ground Segment, Control Segment, Space Segment, Telemetry and Tele command.

I INTRODUCTION

Satellite is a body which consists of number of transponders in it. The number of transponders may vary from 12 to 20 transponders in a satellite, with the bandwidth limited to 30 to 50 megahertz. The main function of transponder is to amplify the signal& process it after that sends it back to the receiver for broadcasting purposes. Satellite can be used for point-to-point transmission to transfer large volume of data, so satellite is not just for broadcast. The satellite has a wider band of the spectrum; it amplifies the incoming signal and broadcast it. So, it takes the incoming signal amplifies and broadcasts back. It has to broadcast in a different frequency, so as to avoid interference with the incoming signal.
There are different kinds of satellites and one of the most commonly known geostationary satellite, they remain above the equator at a height of 20 mm 300 miles approximately, which is the geosynchronous orbit travel down the earth in exactly the time the earth takes to rotate. When some signal is going one particular transponder in the satellite, it amplifies their signal and sends it back to earth.

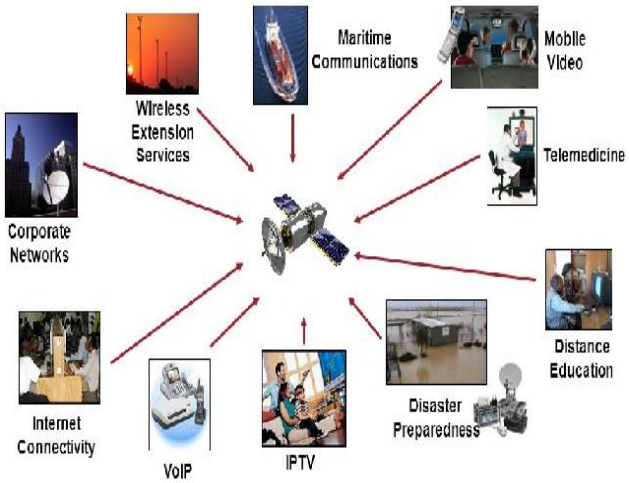

Fig.1 Application of Satellite

Many of our television channels unless it is coming through some cable it comes from some satellite, when satellite is beaming it back it is the signal reaches a very wide geographical area and all the receivers around can receive this signal and then amplify and use it. Application of satellite over long distances like weather forecasting, television broadcast, Internet communication & global positioning system so these are various applications of satellite shown on fig.1.

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II SATELLITE FUNDAMENTALS

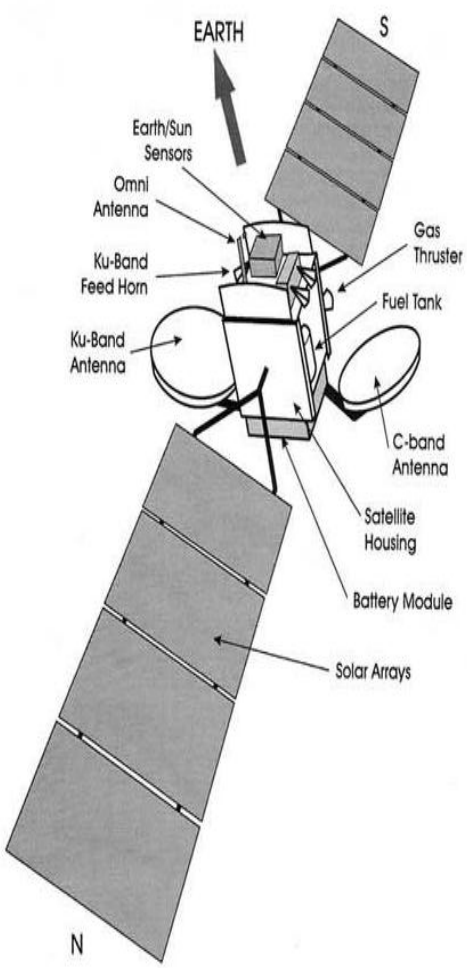

Fig.2 Satellite overview

This is the satellite overview in fig.2& 3. The transmitter side user will send or generates the baseband signal which is nothing but the information carrying signal this signal will go to the earth station with the help of a telephonic link, which will be used in terrestrial link. The earth station processes this signal and with the help of the antenna which is a parabolic dish antenna. It will be sent to satellite. The basement signal is reached to the satellite transponder with the help of this parabolic dish antenna. The signal received at transponder, the transponder will modify do the modulation amplification another analysis processes. It will then after the analysis of this signal and after processing it. The transponder will send by the dish antenna at the satellite end. The antenna will receive the same signal on the receiver side at earth station that again detects the information from signal. Transmitting Antenna Receiving Antenna.

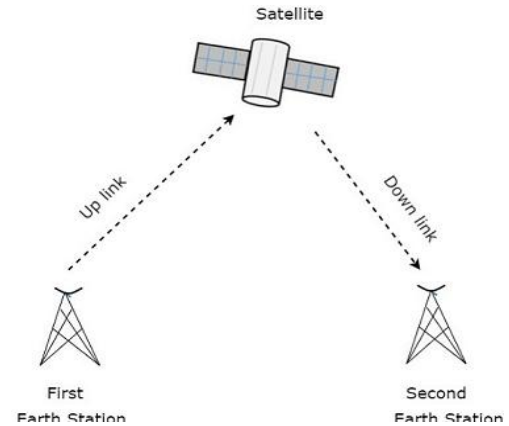

Fig.3Basic Element of Satellite Communication

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Uplink frequency is the frequency sends from the earth station at the transmitter side to the transponder of satellite, shown on fig.2. This frequency is known as uplink frequency and the frequency signal which is sent from transponder to the earth to the antenna of receiver side is known as the downlink frequency. In satellite various band are available. In C band the uplink frequency is designated as 4 & 6 GHz. C band has the frequency of 6 GHz at the uplink and 4 GHz at the down link. Ku band has the uplink frequency of 12 to 14 GHz and downlink frequency of 12 GHz. Ka band has the uplink frequency of 30 GHz and down link frequency of 21 GHz. [2]

The C band is from 3.7 to 4.2 GHz this particular spare part of the spectrum is reserved for the C band communication through satellite so 3.7 to 4.2 GHz for downlink and 5.9 to 6.425 GHz this is for uplink. The uplink is at a higher frequency so capacity is low in the sense that the capacity is not very high by today's standard if compare it with fiber so this is really a low but at the same time at one point of time when transoceanic fibers were not their satellite was the chief medium of communication across continents. So, a capacity is low but still it is useful and terrestrial interference is a problem due to interference is a problem in satellite because if the weather is bad or if there are other kinds of extraneous sources of some electromagnetic noise this interferes with the signal so this is always a problem but still it has got a lot of strong points [2].

Ku band accommodate a greater number of transponders 12 on a downlink on 14 on the uplink rain interference is a major problem here so KU band is from 11.7 to 12.2 GHz and 14.0 to 14.5 GHz and in this band, rain is a problem, though it has higher capacity and is less crowded than the C band. If use about say a 1-meter kind of antenna they are possibly using the C band whereas for the Ku band the antenna size is much smaller it's a pizza shape that was something like 18 to 20 inches so those are Ku band antennas[3].

Different –different bands for frequency allocation is every complicated process, which leads the coordination and proper planning at the international level and it will be done as per the ITU. It is the international telecommunication union, which decides the range of frequencies for the particular band. There are several satellite services, which we can get from the satellite, these some services are fixed satellite service which is dedicated to telephonic connections setting service, which we get from satellite, mobile satellite service, navigational satellite service which is used by the military or defense sectors, internet satellite service and metrological satellite service which is used basically in case of disaster [6].

III SATELLITE ORBITS

There are three types of orbits, first one is GEO (geostationary Earth orbit), second one is an LEO (Low Earth orbit) and third one is MEO(medium Earth orbit) shown on fig. 4.

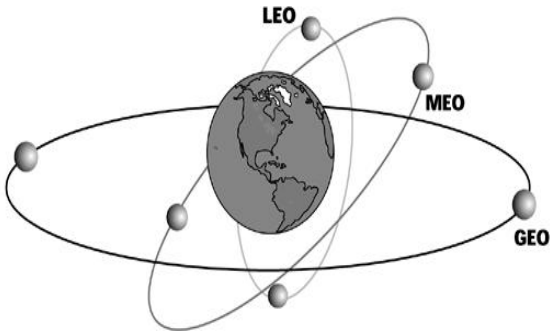

Fig.4 Satellite Orbit

LEO = Low Earth Orbit: Up to 2.000 km altitude.
MEO = Medium Earth Orbit: 2000 – 35000 km altitude.
GEO = Geostationary Earth Orbit: 35786 km altitude.

Table 1 Satellite Orbit Parameter

Parameters	LEO	MEO	GEO
Satellite Height	500-1500 km	5000-12000 km	35,786 km
Orbital Period	10-40 min.	2-8 hours	24 hours
Number of Satellites	40-80	08 – 20	3
Satellite Life	Short	Long	Long
Number of Handoffs	High	Low	Least (none)
Gateway Cost	Very expensive	Expensive	Cheap
Propagation Loss	Least	High	Highest

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A. GEOSTATIONARY SATELLITES: -

The satellites which are placed in GEO which is just stationary earth orbit and synchronous to the earth, if we looked upon them from the fixed point on earth we can find the disk, this satellite this orbit is fixed. In GEO around 3 satellites are placed and the lifetime period of such orbits such a light is 15 years shown on fig. 5. LEO satellite placed in LEO low-earth orbits has the life expectancy of 3 to 8 years which is very low and it requires 20 to 200 or even more satellites for their functionality [3].

Fig. 5GEO tri state satellite system

The GEO (geostationary Earth orbit), they have huge coverage as one fourth of the earth and have good tracking properties. It can track very easily but their signal weakens over great distance and the propagation delay can be large so the propagation delay 0.2 4 seconds usually, we talk in terms of milliseconds but here we are forced to talk in terms of seconds which is not a very good thing. It can also be hard to get coverage at the Polar Regions because these geostationary satellites have to be over the equator so to get coverage at the Polar Regions is difficult. They provide footprint, means that area of art which is covered by one particular transponder let us say on one particular satellite so, it covers all that area at the same time so that is called the footprint.

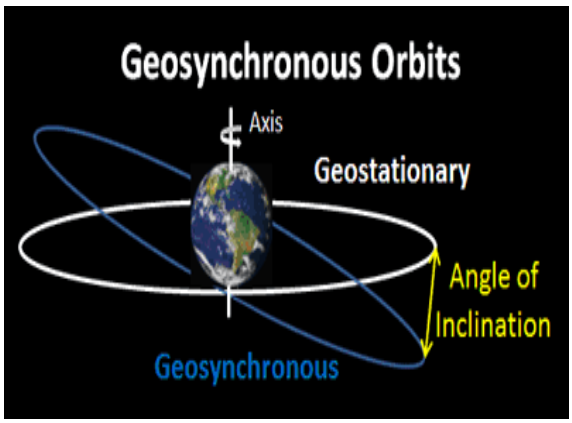

Fig. 6 Geosynchronous & Geostationary Orbit

Many satellites especially the geostationary satellites are thousands of miles above earth so electromagnetic signal is traveling at the speed of light, which is very high but even then, to go all the way up to the satellite and then come all the way back down that takes significant amount of time and this significant amount of time has a lot of implications. It has implications on the MAC; it has other implications like delay and quality of service in some cases.

B. LOW EARTH ORBIT: -

We are using at our homes and LEO is the low earth orbit, which is basically used for remote sensing. An LEO is used where the large population has to be covered. LEOs orbit at about 400 to 1,000 miles (640 to 1,600 kilometers) & they complete one orbit every 90 minutes. So, these are the various application areas for these orbits satellites are using nowadays, at a wide range but the fibers are taking advantage over it. Nowadays fibers are basically preferred over satellites but satellites still on working and they will be there forever because in disaster case when there is flood in all other things satellite is the only thing which can reach to the operations so satellite will be there for all the years ahead [5].

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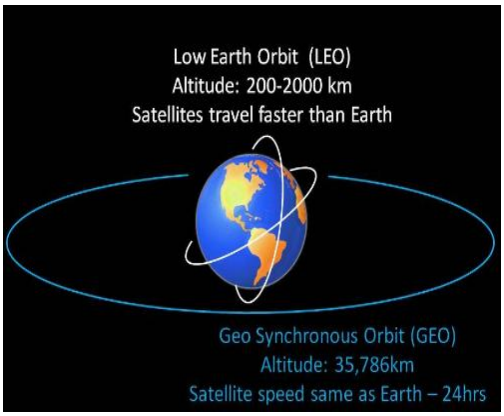

Fig. 7 LEO satellite

C. MEDIUM EARTH ORBIT: -

Medium Earth orbit (MEO), sometimes called intermediate circular orbit (ICO), is the region of space around the earth above low earth orbit (altitude of 2,000 kilometers (1,243 mi) and below geostationary orbit (altitude of 35,786 kilometers
(22,236mi). The most common use for satellites in this region is for navigation communication.MEO is the medium earth orbits, the satellites placed in MEO are about 12 satellites are placed, which are although larger than the GEO but less in quantity than the LEO. So, prefer MEO then LEO [4].

The applications of GEO, LEO and MEO satellites are; GEO geostationary Earth orbits are used for weather forecasting, mobile communication, Internet communication and all the basic Communications. Security can also be an issue because since this medium is open to everybody, so whatever communicating anybody else can listen on to it. So,if trying to send some very sensitive data through satellite and not want other people to listening to what are sending then to take some other measure like encryption etc.

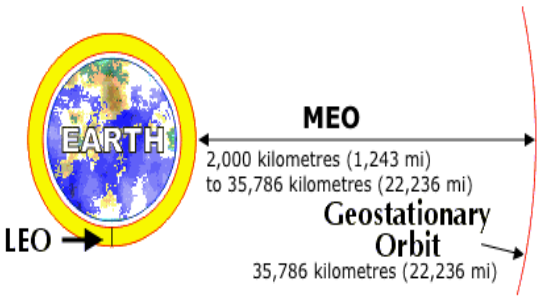

Fig. 8 MEO satellite

IV TELEMETRY TRACKING AND COMMAND

Telemetry tracking and command in short TT&C is monitor the subsystem health and status parameter that is telemetry to support detecting the orbital parameter the tracking and to provide the source for the station through the track satellite also tracking and to receive and execute commands to perform the required function [3].

A. TELEMETRY: -

Primarily telemetry of the subsystem that monitors the health and status of the satellite bus as well as payload, each of the subsystems has to be monitored. Remote sensing satellites telemetry term is also used for transmitting observed data collected from the sensors which are looking towards the earth planet a star to the ground system so the data collection is outside the satellite that is also called telemetry but in this case our communication satellites will be confining our self to the health monitoring and status monitoring of the bus and payload that will call telemetry. It's monitoring parameter could be any of the following like circuit voltage, current of the circuit, the temperature, the pressure, the status of as witch, the wheel speed or like that many other things. The analog parameters obviously are transmitted directly by stop carrier modulation or it is more popular nowadays is to digitize the analog parameter encoded format it modulates and transmit to the ground station just like any other RF transmission.

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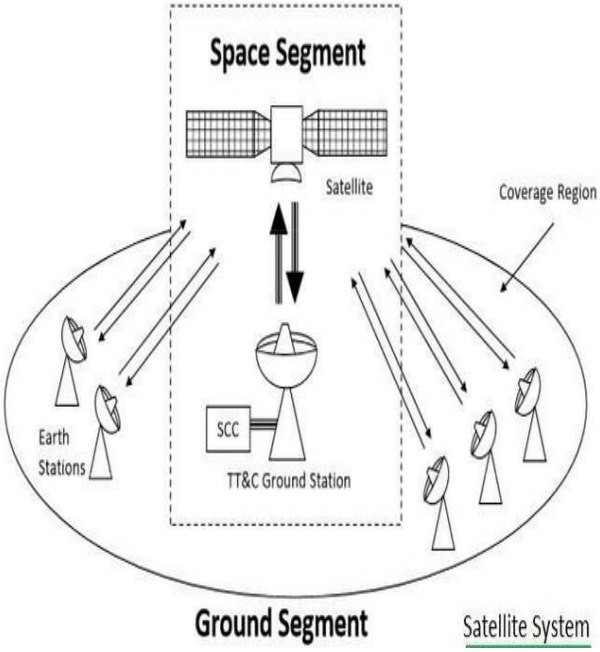

Fig. 9TT&C system

It's short block diagram of this concept is say analog sensors are there have ADC converters and then the digital data comes from the digital sensors all these data from analog converted to digital, as well as digital sensors data are coded formatted and modulation and transmission is done. Now this coding and formatting is generally done in the form of blocks or frames so the frames will be having a header which is it says this is the beginning of the frame is called frame synchronization bits.

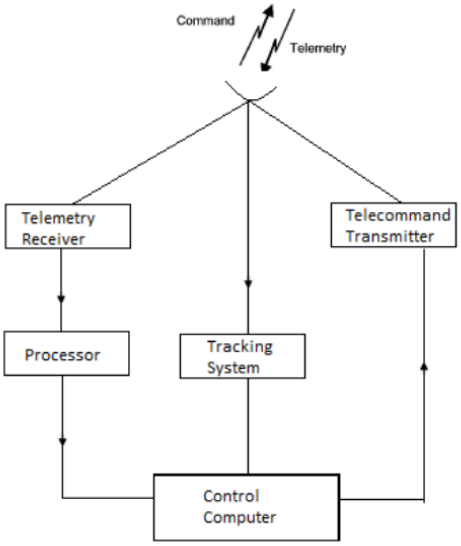

Fig. 10 Block diagram of TT&C system

B. TELECOMMAND: -

Commands are sent from the Earth to manage the working of the satellite. Different types of commands are defined. It should be the possibility of error that can be tolerated by a standards body national standard body call consultative committee on space data systems is CSDs, the error control which is forward error correction or any other error control that can be used. There are other standard techniques, which are used are repeat the command itself and also an echo the since whatever command has gone the satellite will return it back to the ground station and ground station checks whether he has got back that come and what was sent he has got back that one, so make sure that whole thing is correctly received by the satellite. So, there is a frame format for the telecomm and also it starts with the sink just like telemetry. The frame at the beginning sinks world and then the address of the command and control then controller. Three types of command executions are used one is direct execution as soon as command is gone and execute immediately, second is validate the command and then execute and third is they sent the command and it will get

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executed after some time based on certain event [3]. Synchronization word which is common to telemetry frames as well as telecom and frames, if the sink word is not detected the whole frame is lost.

C. TRACKING: -

Tracking is the act of locating and following the satellite to allow the command segment know. Where the satellite is and where it is going, with a high degree of precision. This system tracks the satellite from the ground. We look angle and range need to be found out look angle for tracking is found with the help of separate beacon signal transmitted by the satellite. It seen orbit control from the ground and transmitted a signal from the satellite. We are trying to look at that ground signal source similarly. Satellite can transmit a signal and the antenna can be pointing to that signal and find out what is the azimuth and elevation angle of the antenna. So, look angle can be found from the beacon signal from the satellite. Its signal is generally the telemetry carrier and ground station use tracking to determine the look angle precisely, thus can find out the angular position settling but the range which is very critical to us. It will give a certain delay of sending some signal from ground to satellite or satellite to ground. It can measure the phase delay that is delay of sending delay from the time of sending to the reception [3].

V GPS SYSTEM

Satellite constellation this is a global positioning system. This is operated by a US Air Force. There are 24 or more than satellites in this and it says got six orbital planes at a height of about 2,200 kilometers but this is not the geostationary orbit. They sort of keep on moving and position and minimum 4 satellites are visible at all times. It can locate any position on the ground. If have a GPS terminal on a car so that car can be tracked anywhere on earth.GPS is an interesting application. This may be used for global wireless communication coverage maintain orbit about eight thousand miles from Earth. So, it orbits are about every 2 to 12 hours depending on it's on these parameters. More satellites are needed and some handoffs are required as the satellites orbit. This is the basic system to detecting the unknown position over the three satellite system shown on fig.11.

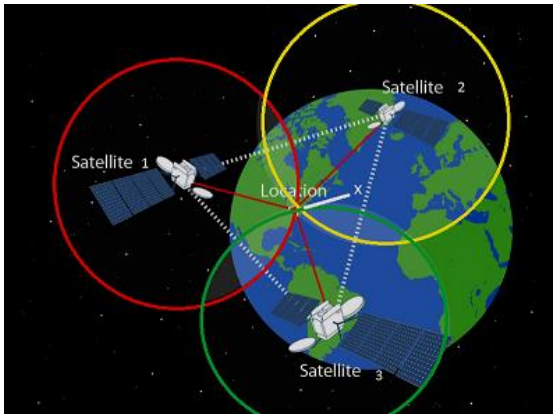

Fig. 11 GPS Determines a Position

Data rate at9.6 kbps to 38 kbps and transmission delay is less than 0.1 seconds. Each satellite is visible to one particular point on earth, for a very short duration of time. To give continuous coverage need a large number of satellites and if want to cover the entire Earth so much more satellite is required. These satellite cell size or the footprints will also become smaller and so in order to cover the entire earth need a very large number of satellites.

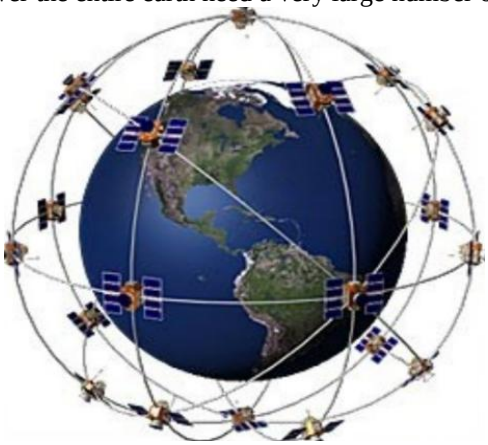

Fig. 12GPS System, 24 Satellites in 6 Orbit planes, 4 satellites in each plane, about 20200Km from earth surface

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VI CONCLUSION

The satellite must be designed to operate correctly for the entire life of their mission. The Telemetry system is used to transmit the data over the communication channel obtained from multiple sensors on the satellite, the purpose is to monitor the satellite via a telemetry link to the earth station. The TTC&M satellite system very well the satellite should contain a number of subsystems to handle its communications mission.

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