ROCKET, SATELLITE, AND LAUNCHING OF SATELLITE

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ABSTRACT: *This paper reviews and discusses rocket, satellite, and launching of satellites into the space, and satellite communication systems. Rocket science involves an advanced mathematics and meticulous physics calculations. A brief introduction and history of rocket, satellite and its applications are also presented in this article. A Satellite is an artificial object placed into a particular orbit with the help of rockets in order to meet the needs of technological developments and for the advancement of a country in the global scenario. Satellites used for various purposes like communication, weather details, identifying the resources, defense, and purposes etc. But launching of satellite by rockets from the ground is considered to be a very costly, tedious and risky process. Rocket launching is high risk process and always fears of failure in the initial stage it and while launching. Satellite carrying rockets are heavy, and it requires cautious design procedures.*

Keywords: Rockets, Satellite, Satellite communications; Satellite vehicles, satellite launching, etc.

I. INTRODUCTION

A satellite is a smaller object that revolves around a larger object in space. As moon is a natural satellite of earth. The exchange (sharing) of information between two or more entities, through any medium or channel is called **communication**. In other words, it is nothing but sending, receiving and processing of information. The communication takes place between any two earth stations through a satellite, and then it is called as **satellite communication**. In this communication, electromagnetic waves are used as carrier signals. These signals carry the information such as voice, audio, video or any other data between ground and space and vice-versa. Soviet Union had launched the world's first artificial satellite named, **Sputnik 1** in 1957. Nearly after 18 years, India also launched the artificial satellite named, **Aryabhata** in 1975. Aryabhata, the first Indian space satellite, was launched for India on April 19, 1975. Later, Bhaskara-I, an Earth observation satellite, launched for India on June 7, 1979. India launched its own satellite for the first time on July 18, 1980. It was the Rohini-1 satellite carried aloft on a Satellite Launch Vehicle (SLV) rocket from the Sriharikota Island launch site. **Geostationary Satellite** or a **Geo-Synchronous Earth Orbit** (GEO) Satellite is one, which is placed at an altitude of 22,300 miles 35,900kms above the Earth. This orbit is synchronized with a side real day (i.e., 23 hours 56 minutes). This orbit can have inclination and eccentricity. It may not be circular. This orbit can be tilted at the poles of the earth. But, it appears stationary when observed from the Earth. These satellites are used for satellite Television. The same geo-synchronous orbit, if it is circular and in the plane of equator, then it is called as geostationary orbit. These Satellites are placed at 35,900 kms (same as Geosynchronous) above the Earth's Equator and they keep on rotating with respect to earth's direction (west to east). The satellites present in these orbits have the angular velocity same as that of earth. Hence, these satellites are considered as stationary with respect to earth since, these are in synchronous with the Earth's rotation. The satellites were placed in low earth orbit. as a result the satellite at a such high speed that it visible to the ground only for a short time at each day , the satellite appeared below the horizon and dies appear below the opposite horizon , the ground station was cut off for long time in day , to maintain the communication link another station had to be activated , this problem was solved by placing the satellite in circular orbit of approximately 22,300 miles or 35, 900 km radius, as the satellite height increases from the earth surface , the speed of satellite decreases by the same manner, at that height the angular velocity of satellite will be proportional to the angular velocity of earth , the satellite rotates with the same speed as that of the earth due to which the satellite will

always be at the same place where it has been fixed , this type of satellite is called geo stationary satellite. There are 3 satellites are placed at angle 120° in geostationary orbit, they provide 100% coverage from one earth station to anywhere on the earth.

II. PURPOSE OF SATELLITE COMMUNICATION

The following two kinds of propagation are used earlier for communication up to some distance:

[1] Ground wave propagation: Ground wave propagation is suitable for frequencies up to 30MHz. This method of communication makes use of the troposphere conditions of the earth.

[2] Sky wave propagation: The suitable bandwidth for this type of communication is broadly between 30–40 MHz and it makes use of the ionosphere properties of the earth.

The maximum hop or the station distance is limited to 1500KM only in both ground wave propagation and sky wave propagation. Satellite communication overcomes this limitation. In this method, satellites provide communication for long distances, which is well beyond the line of sight. Since the satellites locate at certain height above earth, the communication takes place between any two earth stations easily via satellite. So, it overcomes the limitation of communication between two earth stations due to earth's curvature.

III. WORKING OF SATELLITE COMMUNICATION

A satellite is a body that moves around another body in a particular path. A communication satellite is nothing but a microwave repeater station in space. It is helpful in telecommunications, radio and television along with internet applications. A repeater is a circuit, which increases the strength of the received signal and then transmits it. But, this repeater works as a transponder. That means, it changes the frequency band of the transmitted signal from the received one. The frequency with which, the signal is sent into the space is called as Uplink frequency. Similarly, the frequency with which, the signal is sent by the transponder is called as Downlink frequency. Fig.1, illustrates working of satellite communication

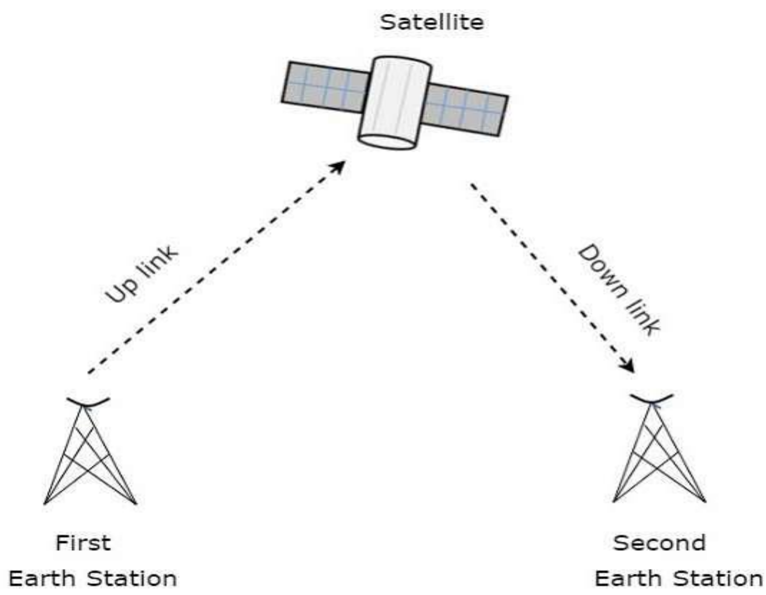

Figure 1: illustrates the working of satellite

The transmission of signal from first earth station to satellite through a channel is called as uplink. Similarly, the transmission of signal from satellite to second earth station through a channel is called as downlink. Uplink frequency is the frequency at which, the first earth station is communicating with satellite. The satellite transponder converts this signal into another frequency and sends it down to the second earth station. This frequency is called as Downlink frequency. In similar way, second earth station can also communicate with the first one. The process of satellite communication begins at an

earth station. Here, an installation is designed to transmit and receive signals from a satellite in an orbit around the earth. Earth stations send the information to satellites in the form of high powered, high frequency (GHz range) signals. The satellites receive and retransmit the signals back to earth where they are received by other earth stations in the coverage area of the satellite. Satellite's footprint is the area which receives a signal of useful strength from the satellite.

IV. HISTORY OF ROCKET

The name "Rocket" comes from the Italian *rocchetta*, meaning "bobbin" or "little spindle", given due to the similarity in shape to the bobbin or spool used to hold the thread to be fed to a spinning wheel. A rocket is a missile, spacecraft, aircraft or other vehicle that obtains thrust from a rocket engine. Rocket engines employ the principle of jet propulsion. Rocket engine exhaust is formed entirely from propellant carried within the rocket before use. Rocket engines work by action and reaction and push rockets forward simply by expelling their exhaust in the opposite direction at high speed, and can therefore work in the vacuum of space. In fact, rockets work more efficiently in space than in an atmosphere. Multistage rockets are capable of attaining escape velocity from Earth and therefore can achieve unlimited maximum altitude. Compared with air breathing engines, rockets are lightweight and powerful and capable of generating large accelerations. To control their flight, rockets rely on momentum, airfoils, auxiliary reaction engines, gim balled thrust, momentum wheels, deflection of the exhaust stream, propellant flow, spin, and or gravity. The first gunpowder-powered rockets were developed in the medieval Chinese Song dynasty by the 13th century. The Chinese rocket technology was adopted by the Mongols and the invention was spread via the Mongol invasions to the Middle East and Europe in the mid 13th century.

Rockets consist of a propellant, a place to put propellant (such as a propellant tank), and a nozzle. They may also have one or more rocket engines, directional stabilization device(s) (such as fins, vernier engines or engine gimbals for thrust vectoring, gyroscopes) and a structure (typically monologue) to hold these components together. Rockets intended for high speed atmospheric use also have an aerodynamic fairing such as a nose cone, which usually holds the payload. As well as these components, rockets can have any number of other components, such as wings (rocket planes), parachutes, wheels (rocket cars), even, in a sense, a person (rocket belt). Vehicles frequently possess navigation systems and guidance systems that typically use satellite navigation and inertial navigation systems.

V. PROCESS OF LAUNCHING OF SATELLITES

The process of placing the satellite in a proper orbit is known as launching process. During this process, from earth stations we can control the operation of satellite. Launching of satellites require rockets, which comes with a high risk. Rockets run on fuels that are very fragile to handle and use. Also, the cost of constructing a rocket is not very effective. Mainly, there are four stages in launching a satellite.

[1] FIRST STAGE- The first stage of launch vehicle contains rockets and fuel for lifting the satellite along with launch vehicle from ground.

[2] SECOND STAGE- The second stage of launch vehicle contains smaller rockets. These are ignited after completion of first stage. They have their own fuel tanks in order to send the satellite into space.

[3] THIRD STAGE- The third (upper) stage of the launch vehicle is connected to the satellite fairing. This fairing is a metal shield, which contains the satellite and it protects the satellite.

[4] FOURTH STAGE- Satellite gets separated from the upper stage of launch vehicle, when it has been reached to out of Earth's atmosphere. Then, the satellite will go to a "transfer orbit". This orbit sends the satellite higher into space. When the satellite reached to the desired height of the orbit, its subsystems like solar panels and communication antennas gets unfurled. Then the satellite takes its position in the orbit with other satellites. Now, the satellite is ready to provide services to the public.

VI. TYPES OF SATELLITE LAUNCH VEHICLES

Satellite launch vehicles launch the satellites into a particular orbit based on the requirement. Satellite launch vehicles are nothing but multi stage rockets. Following are the two types of satellite launch vehicles.

[1] Expendable Launch Vehicles (ELV)
[2] Reusable Launch Vehicles (RLV)

[1] Expendable Launch Vehicles: Expendable launch vehicles (ELV) get destroyed after leaving the satellites in space. Expendable launchers are consumed during the launch process and fall into the sea or burn up in the atmosphere. It is shown below in Fig. 1.

Fig. 1: Expendable Launch Vehicles (ELV)

The ELV contains three stages. First and second stages of ELV raise the satellite to an about 50 miles and 100 miles. Third stage of ELV places the satellite in transfer orbit. The task of ELV will be completed and its spare parts will be fallen to earth, when the satellite reached to transfer orbit.

Fig. 2: Reusable Launch Vehicles (RLV)

[2] REUSABLE LAUNCH VEHICLES

Reusable launch vehicles (RLV) can be used multiple times for launching satellites. Reusable launchers make a soft landing on earth or at sea and can be refurbished for use on a future mission.

Generally, this type of launch vehicles will return back to earth after leaving the satellite n space. The llowing image shows a reusable launch vehicle. It is also known as space shuttle. The functions of space shuttle are similar to the functions of first and second stages of ELV. Satellites along with the third stage of space shuttle are mounted in the cargo bay. It is ejected from the cargo bay when the space shuttle reaches to an elevation of 150 to 200 miles. Then, the third stage of space shuttle gets fired and places the satellite into a transfer orbit. After this, the space shuttle will return back to earth for rescues. It is shown above in Fig. 2.

VII. TYPES OF SATELLITE ORBITS

There are three main types of orbits used for satellite telecommunications. LEO, or Low Earth Orbit, is one type of orbit commonly used on satellites today. According to Boriboon and Pongpadpinit, it is a satellite trajectory in which a satellite platform moves very rapidly in a low orbit. A constellation of these satellites will be used because they are so close to the earth that they cannot provide full disk coverage. This closeness is why they move faster than geostationary satellites. But this has an advantage; frequencies can be reused due to the rapid orbits, and thus the capacity of telecommunication use is higher. Pontani points out other advantages of low earth orbit satellites. They are cheaper to build and operate compared to geostationary satellites. They are also cheaper to launch and have lower operating power requirements. Furthermore, they provide much higher resolution images due to being much closer to the earth's surface. Time delays are obviously smaller as well, which has advantages in telecommunications. For this reason, constellations of LEO satellites are being used more than geostationary satellites these days for telecommunications purposes. Another type of orbit is the geostationary orbit. According to Poole, this is where the satellite orbits at the same angular speed of the earth's rotation, so it stays over the same spot on the equator. This orbital altitude is 35,900 km above the earth's surface. This has advantages of more ground coverage (nearly the entire half of the earth facing the satellite) and continuous dwell time (since the satellite does not move). The drawbacks to this are higher operating costs, lower resolution, and more power needed for transmission due to it being further away.

Table 1: Types of Satellite Orbits and Altitudes

SATELLITE ORBIT DEFINITIONS			
ORBIT NAME	ORBIT INITIALS	ORBIT ALTITUDE (KM ABOVE EARTH'S SURFACE)	DETAILS/COMMENTS
Low Earth Orbit	LEO	200-1200	
Medium Earth Orbit	MEO	1200-35790	
Geosynchronous Orbit	GSO	35790	Orbits once a day, but not necessarily in the same direction as the rotation of the Earth – not necessarily stationary
Geostationary Orbit	GEO	35790	Orbits once a day and moves in the same direction as the earth and therefore appears above the same point on the Earth's surface. Can only be above the Equator.
High Earth Orbit	HEO	Above 35790	

VIII. ADVANTAGES OF SATELLITE COMMUNICATION

- **Area of coverage is more than that of terrestrial systems**
- **Each and every corner of the earth can be covered**
- **Transmission cost is independent of coverage area**
- **More bandwidth and broadcasting possibilities**

IX. DISADVANTAGES OF SATELLITE COMMUNICATION

- **Launching of satellites into orbits is a costly process.**
- **Propagation delay of satellite systems is more than that of conventional terrestrial systems.**
- **Difficult to provide repairing activities if any problem occurs in a satellite system.**
- **Free space loss is more.**
- **There can be congestion of frequencies.**

X. APPLICATIONS OF SATELLITE COMMUNICATION

Satellite communication plays a vital role in our daily life. Following are the applications of satellite communication:

- **Radio broadcasting and voice communications**
- **TV broadcasting such as Direct To Home (DTH)**
- **Internet applications such as providing Internet connection for data transfer, GPS applications, Internet surfing, etc.**
- **Military applications and navigations**
- **Remote sensing applications**
- **Weather condition monitoring & Forecasting**

XI. MERITS OF SATELLITE COMMUNICATION SYSTEM

1. **No tracking is required by Geostationary Satellites.**
2. **Multiple access points are available in Satellite communication**
3. **24 hour communication can be achieved with the help of satellite.**
4. **The signal quality of Satellite communication is higher.**
5. **To put more information on the carrier a broad band can be used.**
6. **Satellite Communication is used for long distance communication or across oceans.**
7. **low transmitting Power and low receiver sensitivity is required by the Satellite in close elliptical orbits.**

XII. DEMERITS OF SATELLITE COMMUNICATION SYSTEM

1. **The transmitter and receiver used in satellite communication requires high power, most sensitive transmitters and large diameter antenna's.**
2. **Satellite communication is disturbed by solar activities and cyclones in the space.**
3. **Due to ageing effect the efficiency of Satellite components decreases.**
4. **The longer propagation times (APPOX,300 ms) is one of a disadvantage of satellite communication.**
5. **The cost for Initial design and launching of the satellite in the orbit results in extremely high**

XIII. CONCLUSIONS

The rocket is a reaction device which works in accordance with Sir Isaac Newton's Third Law of Motion. A rocket can be compared to a continuously firing machine gun mounted on the rear of a rowboat. It is clear to see that satellites have a whole host of applications, many of which are in the telecommunications field. It is not as simple as launching a platform containing antennas into space and sending transmissions through it. The huge amount of data and voice transmitted today demands that constant improvements be made in security and data throughput. Furthermore, it is essential that cheaper operating and construction costs are realized because these satellites are going to wear out from the huge demands placed on them. Any efficiency that can be gained in data throughput, power generation, and launch cost will have positive implications for the future.

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