APPLICATIONS OF TRANSPONDERS IN SATELLITE COMMUNICATION SYSTEM

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ABSTRACT: ***In this paper we presents a bit about satellite telecommunications. We study a brief introduction and history of satellite telecommunications will be presented. An object which are sometimes called artificial satellites to distinguish them from natural satellites such as the Moon. Satellites are useful for a number of purposes. They are used for communications, navigation, map-making, astronomical observations, scientific experimentation, and monitoring of the Earth's environment and weather conditions. Some satellites with military missions may conduct espionage or carry weapons to destroy enemy warheads and satellites. Transponder performs the functions of both transmitter and receiver-Responder in a satellite. Hence, the word 'Transponder' is obtained by the combining few letters of two words, Transmitter -Trans and Responder -ponder.***

Keyword: **'Transponder', Moon, artificial, satellites, satellite orbit types, DTH, GPS.**

I. INTRODUCTION

Russia (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. The first satellite that was used for communication purpose in India was Aryabhatta and it was launched in 19th April.1975. It was made and assembled by an organization called Indian Space Research Organization (ISRO). In the year 1981, a satellite named APPLE was launched in space which was the first Indian Experimental communication satellite. The unique feature of it was that it was a three axis stabilization geosynchronous satellite and weighed around 645 kg. The term APPLE is an abbreviation for Ariane Passenger Payload Experiment. It consisted of (6/4 GHz) processing equipment called Transponder. Various experiments were carried out with APPLE, SITE, STEP (Other satellite telecommunication experiment projects)] and the results obtained from these experiments provided an impetus for Government of India to have its own multipurpose Geosynchronous Earth Orbit satellite under INSAT (Indian National Satellite) program. The first satellite INSAT-1A was launched in the year 1982 which was under this INSAT program, but this effort went in vain as the power house of this satellite consisting of solar cells did not operate properly(failed to open) and this satellite was unused latter on. The average electrical power required by INSAT-1 was approximately 1000W and was provided by the power house subsystem of the satellite. The payload was one C-band transponder and two S-band transponders. Later succession of INSAT-1 series was launched like INSAT-1B, INSAT-C, and INSAT-D. After this due to the success of the first generation satellites, INSAT-2 series was launched viz. INSAT-2A, INSAT-2B, INSAT-2C, INSAT-3D and INSAT-2E which provided variety of services. In general terms, a satellite

is a smaller object that revolves around a larger object in space. For example, moon is a natural satellite of earth. The Communication refers to the exchange of information between two or more entities, through any medium or channel. In other words, it is nothing but sending, receiving and processing of information. If the communication takes place between any two earth stations through a satellite, 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.

II. SATELLITE COMMUNICATION – TRANSPONDERS

The subsystem, which provides the connecting link between transmitting and receiving antennas of a satellite, is known as Transponder. It is one of the most important subsystems of space segment subsystems. Transponder performs the functions of both transmitter and receiver (Responder) in a satellite. Hence, the word 'Transponder' is obtained by the combining few letters of two words, Transmitter (Trans) and Responder (ponder).

III. BLOCK DIAGRAM OF TRANSPONDER

Transponder performs mainly two functions. Those are amplifying the received input signal and translate the frequency of it. In general, different frequency values are chosen for both uplink and down link in order to avoid the interference between the transmitted and received signals. The block diagram of transponder is shown in below figure.

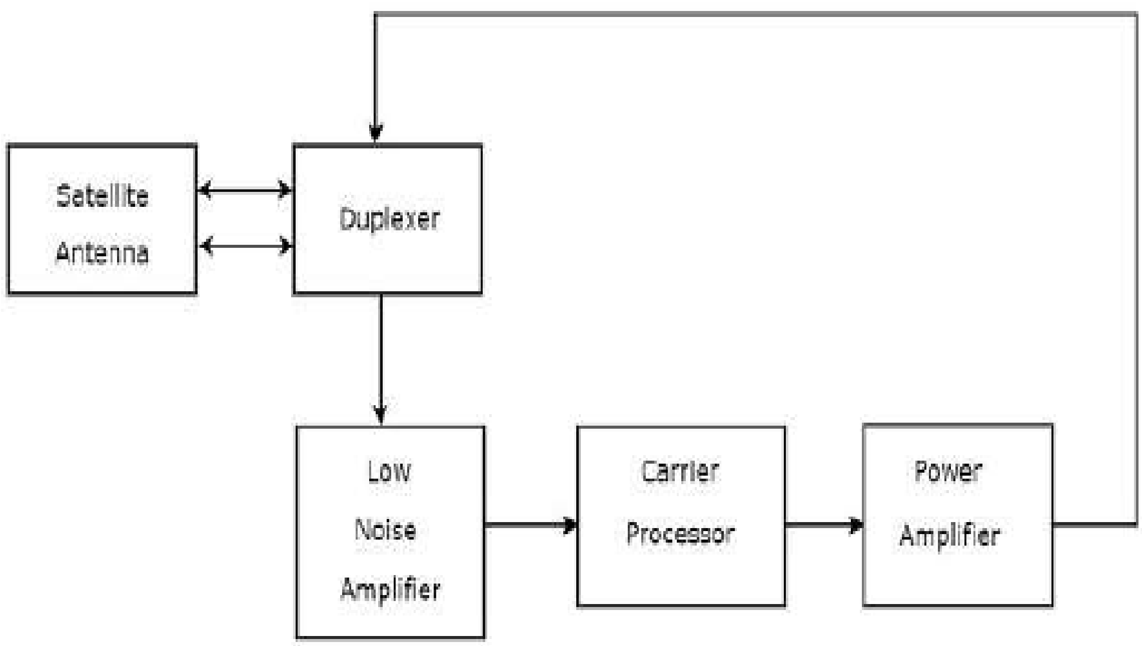


Fig. [1]: The block diagram of transponder

We can easily understand the operation of Transponder from the block diagram itself. The function of each block is mentioned below.

[1] Duplexer is a two-way microwave gate. It receives uplink signal from the satellite antenna and transmits downlink signal to the satellite antenna.

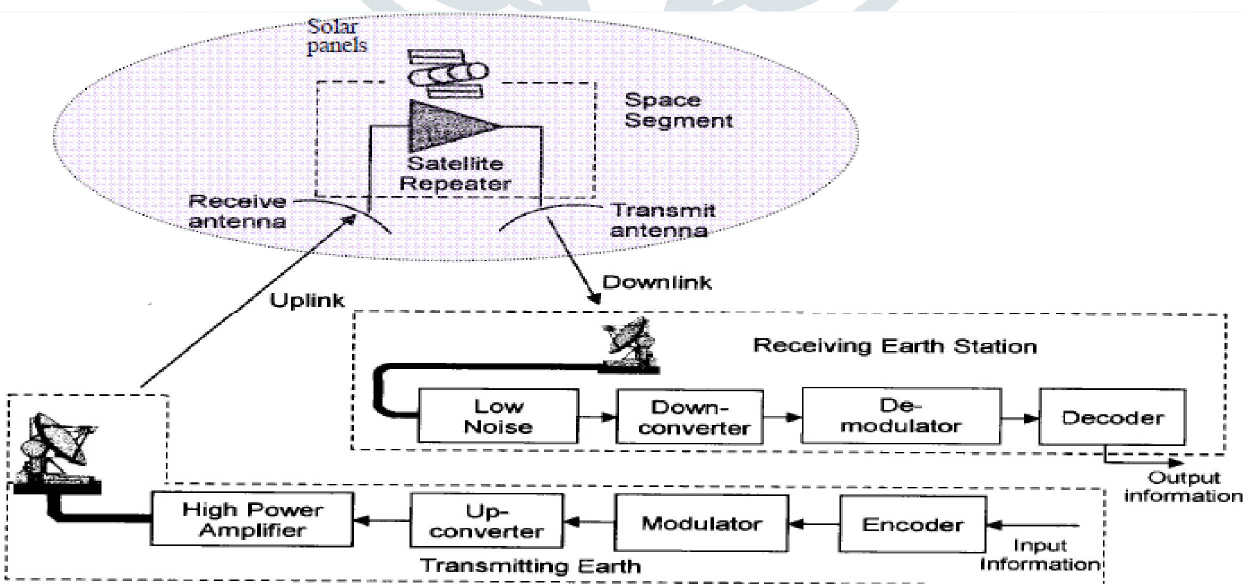
[2] Low Noise Amplifier (LNA) amplifies the weak received signal.
[3] Carrier Processor performs the frequency down conversion of received signal (uplink). This block determines the type of transponder.
[4] Power Amplifier amplifies the power of frequency down converted signal (down link) to the required level.

IV. NEED OF SATELLITE COMMUNICATION

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

V. HOW A SATELLITE WORKS

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. The following Fig [1]: illustrates this concept clearly of basic communications satellite components system.



Figure[2]: Basic communications satellite components

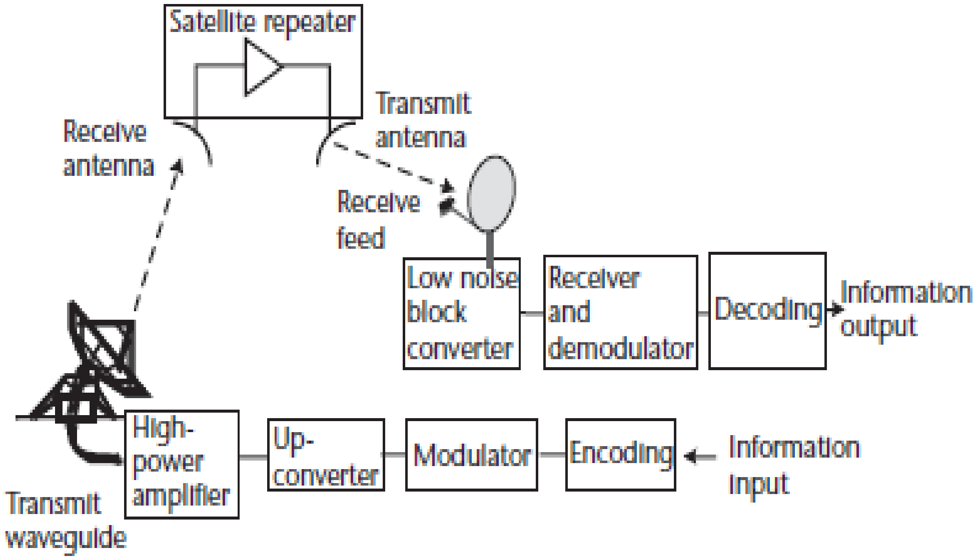


Figure [3]: Critical elements of the satellite link.

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 (GHz range) frequency 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. The following table [1], discusses various types of circular earth orbits and their altitudes.

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	

VI. PROS AND CONS OF SATELLITE COMMUNICATION

In this section, let us have a look at the advantages and disadvantages of satellite communication.

FOLLOWING ARE THE ADVANTAGES OF USING SATELLITE COMMUNICATION:

[i] Area of coverage is more than that of terrestrial systems.
[ii] Each and every corner of the earth can be covered.
[iii] Transmission cost is independent of coverage area.
[iv] More bandwidth and broadcasting possibilities
[v] No tracking is required by Geostationary Satellites.
[vi] Multiple access points are available in Satellite communication.
[vii] 24 hour communication can be achieved with the help of satellite.
[viii] The signal quality of Satellite communication is higher.
[ix] To put more information on the carrier a broad band can be used.
[x] Satellite Communication is used for long distance communication or across oceans.
[xi] low transmitting Power and low receiver sensitivity is required by the Satellite in close elliptical orbits.

FOLLOWING ARE THE DISADVANTAGES OF USING SATELLITE COMMUNICATION:

[i] Launching of satellites into orbits is a costly process.
[ii] Propagation delay of satellite systems is more than that of conventional terrestrial systems.
[iii] The transmitter and receiver used in satellite communication requires high power, most sensitive transmitters and large diameter antenna's.
[iv] Satellite communication is disturbed by solar activities and cyclones in the space.
[v] Due to ageing effect the efficiency of Satellite components decreases.
[vi] The longer propagation times (APPOX,300 ms) is one of a disadvantage of satellite communication.
[vii] The cost for Initial design and launching of the satellite in the orbit results in extremely high.

DIFFICULT TO PROVIDE REPAIRING ACTIVITIES IF ANY PROBLEM OCCURS IN A SATELLITE SYSTEM.

[i] Free space loss is more

[ii] There can be congestion of frequencies.

VII. APPLICATIONS OF SATELLITE COMMUNICATION

Satellite communication plays a vital role in our daily life. It goes without saying that satellites have broad and far reaching applications in many areas. Most of these applications relate to telecommunications, meteorology, military spying, navigation, scientific measurement and ground mapping. Following are the applications of satellite communication:

[i] Radio broadcasting and voice communications

[ii] TV broadcasting such as Direct To Home (DTH)

[iii] Internet applications such as providing Internet connection for data transfer, Global Positioning System (GPS) applications, Internet surfing, etc.

[iv] Military applications and navigations

[v] Remote sensing applications

[vi] Weather condition monitoring & Forecasting

VIII. CONCLUSION

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. One can never rest in this field; research must be constantly striving to improve cost of ownership, security, and data transmission rates, as well as developing newer and better protocols for how bandwidth is managed. Huge strides have already been made just since the Internet became mainstream.

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