

SATELLITE COMMUNICATION

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Abstract— A panoramic view on the study and design of digital satellite communication links is the focus of this paper. Starting from the characterization of satellite propagation channel in different application environments. Satellite moves in their own orbit. There are the term called satellite segment which differentiate the parts of the satellite. This paper examines the propagation needs of the Satellite communication services, and presents research topics for the in addition to service-oriented problems, propagation community. Slant path propagation research contributes to new developments in the satellite communications' market share is satellite communications [1]. We address the types of satellite that we're using right now i.e GEO and LEO etc. and the applications of the satellite communications.

Index Terms- digital satellite communications, GEO, LEO, satellite segment, needs, orbit, applications.

I. INTRODUCTION

Satellites are man-made systems that operate in space (the broadest definition of "satellite" includes celestial bodies (such as the moon) orbiting around planets. In this chapter, the definition of "satellite" is limited to man-made spacecrafts only). Since the launch of the first satellite in 1957, people have found diverse applications for these systems and have made significant technical advances and innovations to improve their efficiency. Currently, millions of people around the world rely on satellites for telecommunication, navigation, weather forecast, military intelligence, space exploration, and scientific studies of the atmosphere and beyond [2]. About 6,600 satellites have been launched. The latest estimates are that 3,600 remain in the orbit. Of those about 1,000 are operational. Approximately 500 operational satellites are in the low-earth-orbit, 50 are in medium-earth orbit (at 20,000 km) and the rest are in geostationary orbit (at 36,000 km)[3]

Of the operational satellites, more than half are dedicated to telecommunication purposes. These satellites are used around the globe for telephone calls, fax, e-mail, internet, financial transactions, television (TV), radio broadcasts, and much more. Compared to terrestrial communication systems, satellites have the unique advantage of being able to provide coverage to large geographical areas. A single satellite can connect users on different continents across the Atlantic or Pacific Ocean. Moreover, satellites can provide communication services to mobile users anywhere in the

coverage region, including land, ocean, and air. Figure 1 depicts a satellite system providing communication services to a diverse range of users using electronic devices on Earth [4].



Fig. 1. Showing the setup between satellite and electrical devices

II. SATELLITE COMMUNICATION SEGMENTS

Satellite communication mainly has two components.

- 1) Ground Segment
- 2) Space segment

A. Ground Segment

The **ground segment** provides the means and resources to manage and control the mission, to receive and process the data produced by the instruments, and to disseminate and archive the generated products. Furthermore, it provides a single interface to the users to allow optimum utilization of the system resources in line with the user needs. Example Meteosat-7 ground station. The ground segment can be split into two major elements:

- The flight operation segment (FOS), which is responsible for the command and control of the satellite

- The payload data segment (PDS), which is responsible for the exploitation of the instrument data [6].



Fig 2. Primary ground station

B. Space segment

The **space segment** of an artificial satellite system is one of its three operational components (the others being the user and control segments). It comprises the satellite or satellite constellation and the uplink and downlink satellite links [7].

Geostationary earth orbit (GEO) supports major businesses in satellite video and radio broadcasting as well as data and mobile communications. The medium earth orbit (MEO) and low earth orbit (LEO) configurations can also be used for various applications. ATSI is very familiar with all of the elements and subsystems that comprise modern satellites used to develop and operate them [8]. Any communications satellite is composed of a communications payload (repeater and antenna system) and its supporting spacecraft bus (solar array and batteries, attitude and orbit control system, structure and thermal control system), and is placed in orbit by a launch vehicle. The Space Segment also includes the tracking, telemetry and command (TT&C) station or stations, and a satellite control centre. There are numerous types of space systems providing a wide variety of capabilities and services. In spite of this diversity, there are similarities among all satellites because they all must operate in the environment of space. All satellites have two principal subsystems [9]:

- The platform
- The payload

The platform is the basic frame of the satellite and the components which allow it to function in space, regardless of the satellite's mission. The control segment on the ground monitors and controls these components.

The platform consists of the following components [10]:

- Structure of the satellite
- Power
- Propulsion
- Stabilization and Attitude Control
- Thermal Control
- Environmental Control
- Telemetry, Tracking and Command



Fig 3. GAGAN satellite for Indian navy navigation

III. ORBIT

An orbit is a regular, repeating path that one object in space takes around another one. An object in an orbit is called a satellite. A satellite can be natural, like Earth or the moon. Many planets have moons that orbit them. A satellite can also be man-made, like the International Space Station [11].

Distance:

- Low-earth orbit (LEO): 500...1700 km
- Medium-earth orbit (MEO): 10.000...20.000 km
- Geostationary orbit (GEO): 35.786 km

Inclination:

- Equatorial: $i = 0^\circ$
- Polar: $i = 90^\circ$
- Inclined: $0 < i < 90^\circ$

Eccentricity:

- Circular
- Elliptical [12]

IV. ORBIT AND SATELLITE

According to the satellite altitude, H, circular orbits can be classified as: LOW-ALTITUDE EARTH ORBITS, having $500 < H < 2000$ km, MEDIUM-ALTITUDE EARTH ORBITS, having $5000 < H < 20,000$ km, the geostationary orbit (GEO)

having $H=35,800$ km. the choice of H is a fundamental driver of the constellation size, N_s [13].

A. Geostationary orbit

A geostationary orbit, geostationary Earth orbit or geosynchronous equatorial orbit (GEO), is an orbit whose position in the sky remains the same for a stationary observer on earth. This effect is achieved with a circular orbit 35,786 kilometres (22,236 mi) above the Earth's equator and following the direction of the Earth's rotation. An object in such an orbit has an orbital period equal to the Earth's rotational period and thus appears motionless at a fixed position in the sky to ground observers. Communications satellites and weather satellites are often placed in geostationary orbits, so that the satellite antennas which communicate with them do not have to move to track them.

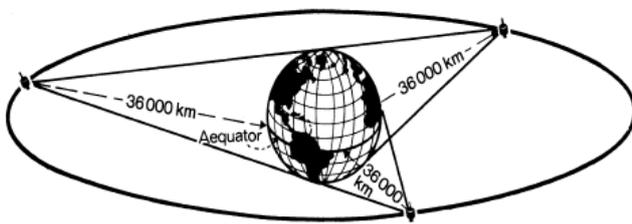


Fig 4. Three satellites cover globe with exceptions of polar region

i. PRACTICAL USE

- a) Most commercial communications satellites, broadcast satellites and SBAS satellites operate in geostationary orbits.
- b) A geostationary transfer orbit is used to move a satellite from low Earth orbit (LEO) into a geostationary orbit.
- c) A worldwide network of operational geostationary meteorological satellites is used to provide visible and infrared images of Earth's surface and atmosphere.

ii. COMMUNICATIONS

Satellites in geostationary orbits are far enough away from Earth that communication latency becomes significant — about a quarter of a second for a trip from one ground-based transmitter to the satellite and back to another ground-based transmitter; close to half a second for a round-trip communication from one Earth station to another and then back to the first.

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For example, for ground stations at latitudes of $\phi = \pm 45^\circ$ on the same meridian as the satellite, the time taken for a signal to pass from Earth to the satellite and back again can be computed using the cosine rule, given the geostationary orbital radius r the Earth's radius R and the speed of light c , as:

$$\Delta t = \frac{2}{c} \sqrt{R^2 + r^2 - 2Rr \cos \phi} \approx 253 \text{ ms}$$

(Note that r is the orbital radius, the distance from the centre of the Earth, not the height above the Equator.)[14]

B. LOW EARTH ORBIT

A low Earth orbit (LEO) is an orbit around Earth with an altitude between 160 kilometres (99 mi), (orbital period of about 88 minutes), and 2,000 kilometres (1,200 mi) (about 127 minutes). Objects below approximately 160 kilometres (99 mi) will experience very rapid orbital decay and altitude loss.

i. USES

- a) Earth observation satellites and spy satellites use LEO as they are able to see the surface of the Earth more clearly as they are not so far away. They are also able to traverse the surface of the Earth. A majority of artificial satellites are placed in LEO, making one complete revolution around the Earth in about 90 minutes.
- b) A low earth orbit is simplest and most cost effective for a satellite placement and provides high bandwidth and low communication time lag. [15]

V. APPLICATIONS

Satellite communications are still used in many applications today. Remote islands such as Ascension Island, Saint Helena, Diego Garcia, and Easter Island, where no submarine cables are in service need satellite telephones. There are also regions of some continents and countries where landline telecommunications are rare to nonexistent, for example large regions of South America, Africa, Canada, China, Russia, and Australia. Satellite communications also provide connection to the edges of Antarctica and Greenland. Some of the applications of satellite communications are:

1. TELEPHONE

The first and historically most important application for communication satellites was in intercontinental long distance telephony. The fixed Public Switched Telephone Network relays telephone calls from land line telephones to an earth station, where they are then transmitted to a geostationary

satellite. The downlink follows an analogous path. Satellite phones can be accomplished in many different ways. On larger scale often there will be local telephone system in the isolated area with a link to a telephone system in a main land area. There are services that will patch a radio signal to a telephone system in this example most any type of satellite can be used. Satellite phones connect directly to a constellation of either geostationary or low-earth-orbit satellites.

2. TELEVISION

As television became the main market, its demand for simultaneous delivery of relatively few signals of large bandwidth to many receivers being a more precise match for the capabilities of geosynchronous comsats. Two satellite types are used for North American television and radio: Direct broadcast satellite (DBS), and Fixed Service Satellite (FSS).

3. RADIO

Satellite radio offers audio services in some countries. A satellite radio or subscription radio (SR) is a digital radio signal that is broadcast by a communications satellite, which covers a much wider geographical range than terrestrial radio signals. Radio services are usually provided by commercial ventures and are subscription-based. The various services are proprietary signals, requiring specialized hardware for decoding and playback. Providers usually carry a variety of news, weather, sports, and music channels, with the music channels generally being commercial-free.

4. INTERNET

After the 1990s, satellite communication technology has been used as a means to connect to the Internet via broadband data connections. This can be very useful for users who are located in remote areas, and cannot access a broadband connection, or require high availability of services.

5. MILITRY

Communications satellites are used for military communications applications, such as Global Command and Control Systems. Examples of military systems that use communication satellites are the GSAT-7, India's first launched Military Communication satellite. [16]

VI. CONCLUSION

Future satellite communications cannot prescind from the evolution of terrestrial broadcast and broadband communication. In this perspective, development of new satellite systems tends to align with that of terrestrial communications. In this paper I have provided a brief sketch of parts of satellite communication and the segment of the satellite communication. We've also discussed about the types of satellite along with their respective functions. The applications of the satellite and the issues related to the

satellite have been discussed in the paper. Now-a-day the satellite communication become very beneficial and important. Different kinds of satellite have their own importance and usable field.

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