

Overview of a Satellite System

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Abstract— Now a day it is a fact to use a satellite for communication purpose. Almost many homes are equipped with antennas or dishes which are used for receiving the television signals. Also according to the data from GSMA, two-thirds of the world's population are using mobile phone for communication. For these purposes, satellites play a very important role. These satellites, revolving around earth, are making earth observation, global communication, navigation and science application possible. This paper presents overview of major narrowband GEO, MEO and LEO satellite systems. It presents commercial examples of satellite systems, their features and their applications.

Keywords— GEO, MEO, LEO, narrowband satellite system.

I. INTRODUCTION

The main purpose of satellite is for telecommunication. These satellites are used for mobile applications such as communication to ships, planes, vehicles and other hand held terminals. Also they are used for TV and radio broadcasting. Satellite provides their services to an assigned region on the earth. The power and bandwidth of these satellites depend upon the preferred size of the footprint, complexity of the traffic control protocol schemes and the cost of ground stations. The antenna pattern of the satellite is very important. It is designed such that it will cover the approximate geographical area of the earth. Satellites should be designed by keeping in mind its usability for short and long term effects throughout its life time. Historically, commercial operational satellite communication systems were developed. Initially the purpose of this communication system was to fulfil the needs of international transoceanic communication. In early days the earth stations were large due to low transit power available from the satellite. Now a day with the advancement of technology, higher transmitted power is available from the satellites. Because of this the size and cost of earth station is reduced. In rest of the paper, types of satellite depending on their orbit and major satellite systems are discussed.

II. TYPES OF SATELLITE DEPENDING ON THEIR ORBIT

The satellite revolves around the earth in a particular orbit called as earth orbit. These satellites are the Earth Orbit Satellite. Basically there are two earth orbits, lower earth orbit and higher earth orbit. The satellite is properly placed in these orbits according to the requirement. In lower orbit time required to travel around the earth for the satellite is less. And in higher orbit time required to travel around the earth is more and it covers more geographical area of the earth. So depending on the orbits, satellites have three important types.

- Geosynchronous Earth Orbit Satellite
- Low Earth Orbit Satellite
- Medium Earth orbit Satellite

2.1 Geosynchronous Earth Orbit Satellite

Geo-synchronous earth orbit (GEO) is one which is placed at an altitude of 22300 miles above the earth. This orbit is synchronized with a side real day (i.e. 23 hours 56 minutes). It is tilted at the poles of the earth. This satellite appears as stationary when observed from the earth. This satellite is also referred as geostationary satellite. These satellites are used for broadcasting of TV and radio as well as for weather forecast. These satellites are operating as backbones for the telephone networks.

These satellites have low elevation above latitude of 60 degree, so larger antennas are needed for the reception of signals. Because of this, Northern and southern regions of the earth (poles) have more problems receiving these satellites

2.2 Low Earth Orbit Satellite

The distance of these satellite from earth surface is 500-1500 kms. As LEO's circulate on a lower orbit, hence they exhibit a much shorter period that is 95 to 120 minutes. LEO systems try to ensure a high elevation for every spot on earth to provide a high quality communication link. Each LEO satellite will only be visible from the earth for around ten minutes. Low Earth orbit (LEO) satellites mainly classified into three categories. Those are little LEOs, big LEOs, and Mega -LEOs. These satellites are used for satellite phones and GPS. Little LEOs will operate in the 800MHz (0.8GHz) range. Big LEOs will operate in the 2 GHz or above range, and Mega -LEOs operates in the 20-30GHz range.

If a global coverage is to be reached then it requires many satellites and this is the biggest problem of the LEO concept. The general problem LEO has that is the short lifetime of about five to eight years. This is because of atmospheric drag and radiation from the inner Van Allen Belt 1. So if there are 48 satellites having lifetime of eight years, then a new satellite would be needed every two months.

2.3 Medium Earth Orbit Satellites

Considering their orbit and advantages and disadvantage, MEOs can be positioned somewhere between LEOs and GEOs. Using orbits around 10,000km, the system only requires a dozen satellites which is more than a GEO System, but much less than a LEO system . These satellites move more slowly relative to the earth's rotation allowing a simpler system design (satellite periods are about six hours). Because of larger population coverage (depending on the inclination), MEO's require fewer handovers. These satellites are used for High Speed telephone signals. In order to cover entire earth, ten or more MEO satellites are required

Again due to the larger distance to the earth, delay increases to about 70-80ms. The satellites need higher transmit power and special antennas for smaller footprints.

III. THE MAJOR SATELLITE SYSTEM

This section elaborate on Iridium [6], Globalstar[7], Thuraya[8], ACeS [9] and Inmarsat [10] satellite systems.

3.1 Iridium

The Iridium satellite network works on three principal components that are the ground stations and the satellite phones and data units. A large group of satellites is called satellite constellation. They provide voice and data coverage to satellite phones, pages and integrated transceivers over earth's entire surface. In this constellation there are 66 active satellites in orbit, and additional spare satellites to serve in case of failure. These satellites are in low Earth orbit at a height of approximately 485 mi (781 km) inclination of 86.4 degree. Orbital velocity of the satellite is approximately 17000 mph (27000 km/h). The communication of Satellites with neighboring satellite is through k band inert-satellite links.



Fig. 1 Iridium satellites

3.2 Globalstar

The Globalstar system is designed to provide affordable satellite-based digital voice services to a broad range of subscribers and users. Globalstar should meet the needs of cellular users and global travellers who roam outside cellular coverage areas as well as residents of under-served markets who will use Globalstar's fixed site phones to satisfy their needs for basic telephony. Each Globalstar satellite consists of an antenna, a trapezoidal body, two solar arrays and a magnetometer and operates at an altitude of 1414 km. The satellite are placed in eight orbital planes of six satellite each, inclined at 52 degree to provide service on Earth from 70 degree North latitude to 70 degree South latitude. The Globalstar constellation consists of 48 LEO satellites, with an additional four satellites in orbit as spares. The Globalstar system's software resides on the ground, not on the satellites, which means fast and easy system maintenance and upgrades. The satellites use 'bent-pipe' architecture (a signal relay scheme in which a terrestrial-based signal is sent to a satellite, which then relays the signal back to earth with minimal processing by the satellite).

3.3 Thuraya

Thuraya is a regional mobile satellite phone provider. Thuraya is an advanced geo-synchronous mobile satellite system providing access to Satellite and GSM services from the same Handset. It offers the facility for high quality voice, voice mail and SMS as standard, together with an in built GPS. Data/fax facilities are available through the optional data kit with speeds obtainable up to 9.6Kb/s(similar to Globalstar and faster than Iridium). Thuraya's robust satellite network provides coverage in the most remote locations, ensuring congestion-free satellite communications to keep you connected at all times. From innovative satellite design to the reliability of each Thuraya device and accessory, we provide a truly superior satellite communication solution beyond the boundaries of terrestrial systems and cellular networks. Thuraya has 2 satellites in geosynchronous orbit (Thuraya 2 and Thuraya 3). The Thuraya 1 satellite originally launched for testing purposes, has now reached the end of its life and remains in junk orbit above Korea.



Fig. 2 The Thuraya coverage area

3.4 ACeS

Asia Cellular Satellite System(ACeS) is a combined cellular telephone and satellite wireless system from Ericsson that provides digital communication service to mobile phone and computer users in the Asia Pacific Region. Adding satellite communication to the terrestrial Global System for Mobile (GSM) communication system, ACeS is billed as the first integrated satellite-GSM system in the world. Users with Ericsson dual-mode terminals will be able to roam within the region switching as necessary between cellular (local) service and satellite service. The Asian Cellular System (AceS) is a GEO regional system quite similar in philosophy and market orientation with Thuraya that covers South East Asia, India, China & Australia

3.5 Inmarsat

The GEO satellite systems operated by the International Maritime Satellite Organisation (Inmarsat) cover entire ocean surface from latitudes of approximately 70oN to 70o S (see Figure 2). The operational generations of Inmarsat satellites include Inmarsat A, B, C and E. Inmarsat-A is an analogue mobile satellite communication system approaching the end of its service life. It accommodates voice and 9.6 kbit/s data communications in its standard configuration. A High Speed Data (HSD) option offered by some MES (Mobile Earth Station) manufacturers permits data communications up to 64 kbit/s. Inmarsat-B constitutes the digital replacement for Inmarsat-A. It supports voice, data, fax and telex. Standard data rate is 9.6kbit/s, while the supported rate

for the HSD option is 64kbit/s. Inmarsat-C is a data store-and-forward messaging system and does not support voice. The data rate is 600bits/s and the maximum message length is 32kB. The system can connect to telex and data networks. It provides a facility for Enhanced Group Calls (EGC), which permits groups of vessels in a geographic area to be simultaneously addressed. Inmarsat-E includes geostationary satellites and a built-in GPS receiver used mainly for rescuing activities. It offers high positional accuracy and minimal delay between activation and information forwarding to search & rescue authorities.

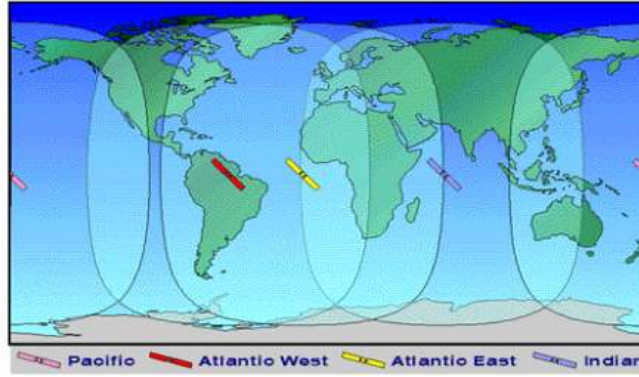


Fig. 3 Inmarsat satellite

IV. CONCLUSION

Taking into account the emerging communication role of satellite systems, the paper discusses narrowband LEO, MEO and GEO satellite systems. This paper also discusses the major satellite system like Iridium, Globalstar, Thuraya, ACeS and Inmarsat and their features and applications.

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