A

Seminar report

On

Satellite Communications

Submitted in partial fulfillment of the requirement for the award of degree of Electronics

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Preface

I have made this report file on the topic **Satellite Communications**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Introduction

The outer space has always fascinated people on the earth and communication through space evolved as an offshoot of ideas for space travel. The earliest idea of using artificial satellites for communications is found in a science fiction **Brick Moon** by Edward Evert Hale, published in 1869-70.

While the early fictional accounts of satellite and space communications bear little resemblance to the technology as it exists today, they are of significance since they represent the origins of the idea from which the technology eventually evolved.

In the area of satellite communications, the technology has been responsive to the imaginative dreams. Hence it is also expected that technological innovations will lead the evolution of satellite communications towards the visions of today.

History

The Merriam-Webster dictionary defines a satellite as a celestial body orbiting another of larger size or a manufactured object or vehicle intended to orbit the earth, the moon, or another celestial body.

Today's satellite communications can trace their origins all the way back to February 1945 and Arthur C.Clarke's letter to the editor of Wireless World magazine, Clarke further fleshed-out this theory in a paper titled *Extra-Terrestrial Relays – Can Rocket Stations Give Worldwide Radio Coverage?*, published in Wireless World in October 1945.

Decades later a project named Communication Moon Relay was a telecommunication project carried out by the United States Navy. Its objective was to develop a secure and reliable method of wireless communication by using the Moon as a natural communications satellite.

The first artificial satellite used solely to further advances in global communications was a balloon named Echo 1. Echo 1 was the world's first artificial communications satellite capable of relaying signals to other points on Earth. It soared 1,000 miles (1,609 km) above the planet after its Aug. 12, 1960 launch, yet relied on humanity's oldest flight technology — ballooning.

Launched by NASA, Echo 1 was a giant metallic balloon 100 feet (30 meters) across. The world's first inflatable satellite — or "satelloon", as they were informally known — helped lay the foundation of today's satellite communications.

The idea behind a communications satellite is simple: Send data up into space and beam it back down to another spot on the globe. Echo 1 accomplished this by essentially serving as an enormous mirror, 10 stories tall, that could be used to reflect communications signals.

The first American satellite to relay communications was Project SCORE in 1958, which used a tape recorder to store and forward voice messages. It was used to send a Christmas greeting to the world from U.S. President Dwight D. Eisenhower.

NASA launched the Echo satellite in 1960; the 100-foot (30 m) aluminised PET film balloon served as a passive reflector for radio communications. Courier 1B, built by Philco, also launched in 1960, was the world's first active repeater satellite.

The first communications satellite was Sputnik 1. Put into orbit by the Soviet Union on October 4, 1957, it was equipped with an onboard radio-transmitter that worked on two frequencies: 20.005 and 40.002 MHz.

Sputnik 1 was launched as a step in the exploration of space and rocket development. While incredibly important it was not placed in orbit for the purpose of sending data from one point on earth to another. And it was the first artificial satellite in the steps leading to today's satellite communications.

Telstar was the second active, direct relay communications satellite. Belonging to AT&T as part of a multi-national agreement between AT&T, Bell Telephone Laboratories, NASA, the British General Post Office, and the French National PTT (Post Office) to develop satellite communications, it was launched by NASA from Cape Canaveral on July 10, 1962, the first privately sponsored space launch.

Relay 1 was launched on December 13, 1962, and became the first satellite to broadcast across the Pacific on November 22, 1963.

An immediate antecedent of the geostationary satellites was Hughes' Syncom 2, launched on July 26, 1963. Syncom 2 revolved around the earth once per day at constant speed, but because it still had north-south motion, special equipment was needed to track it

Evolution of Communication Satellites

During early 1950s, both passive and active satellites were considered for the purpose of communications over a large distance. Passive satellites though successfully used in the early years of satellite communications, with the advancement in technology active satellites have completely replaced the passive satellites.

Passive Satellites

The principle of communication by passive satellite is based on the properties of scattering of electromagnetic waves from different surface areas. Thus an electromagnetic wave incident on a passive satellite is scattered back towards the earth and a receiving station can receive the scattered wave. The passive satellites used in the early years of satellite communications were both artificial as well as natural.

In 1954, the US Naval Research Laboratory successfully transmitted the first voice message through space by using the Moon to scatter radio signal.

These experiments resulted in the development of **Moon-Relay System**, which became operational in 1959 for communications between Washington, DC and Hawaii and remained operational till 1963.

The first artificial passive satellite **Echo-I** of NASA was launched in August 1960. Echo-I was 100-ft. diameter inflatable plastic balloon with aluminum coating that reflected radio signals transmitted from huge earth station antennas. Echo-I had an orbital height of 1000 miles. Earth Stations across US and Europe picked up the signal and contributed a lot in motivating research in communication satellite.

Echo-I was followed by **Echo-II** in 1964. With Echo-II, Scientists of US and Soviet Russia collaborated for the first time on international space experiments. Signals were transmitted between University of Manchester for NASA and Gorki State University in Russia. The orbit of Echo-II was 600 to 800 miles.

In 1963, US Air Force under **Project West Ford** launched an orbital belt of small needles at 2000 miles height to act as a passive radio reflector. Speech in digitized form was transmitted intelligently via this belt of needles. However, further work in this area was discontinued due to strong protests from the astronomers.

Although passive satellites were simple, the communications between two distant places were successfully demonstrated only after overcoming many technical problems. The large attenuation of the signal while traveling the large distance between the transmitter and the receiver via the

satellite was one of the most serious problems. The disadvantages of passive satellites for communications are:

- Earth Stations required high power (10 kW) to transmit signals strong enough to produce an adequate return echo.
- Large Earth Stations with tracking facilities were expensive.
- Communications via the Moon is limited by simultaneous visibility of the Moon by both the transmit and the receive stations along with the larger distance required to be covered compared to that of closer to earth satellite.
- A global system would have required a large number of passive satellites accessed randomly by different users.
- Control of satellites not possible from ground.

Active Satellites

In active satellites, which amplify and retransmit the signal from the earth have several advantages over the passive satellites.

The advantages of active satellites are:

- Require lower power earth station
- Less costly
- Not open to random use
- Directly controlled by operators from ground.

Disadvantages of active satellites are:

- Disruption of service due to failure of electronics components on-board the satellites
- Requirement of on-board power supply
- Requirement of larger and powerful rockets to launch heavier satellites in orbit

World's first active satellite **SCORE** (Satellite Communication by Orbiting Relay Equipment) was launched by US Airforce in 1958 at orbital height of 110 to 900 miles. It transmitted a pre-recorded message of Christmas Greetings from US President Eisenhower. However, the satellite did not function as a true repeater.

The first fully active satellite was **Courier** launched into an orbit of 600 - 700 mile, by Department of Defense in 1960. It accepted and stored upto 360,000 Teletype words as it passed overhead and rebroadcast them to ground station farther along its orbit. It operated with 3 watts of on-board output power and it was also the first satellite to use solar cells for generating electrical power.

In July 1962 AT&T's active satellite **Telstar** was developed and launched. Telstar was placed in an elliptical orbit with orbital height of 682 to 4030 miles circling the earth in 2 hours and 40 min.

Through Telstar, the first live transatlantic television was transmitted. Voice, television, fax and data were transmitted between various sites in UK, France, Brazil Italy and US at 6/4 GHz frequency range.

Types of satellite orbits

There are at least three special types of orbits employed by modern satellites. These are the :

- Geostationary Orbit (GEO)
- Low Earth Orbit (LEO)
- Medium Earth Orbit (MEO)
- Molniya Orbit

Geostationary Orbit (GEO)

To an observer on the earth, a satellite in a geostationary orbit appears motionless, in a fixed position in the sky. This is because it revolves around the earth at the earth's own angular velocity (360 degrees every 24 hours, in an equatorial orbit).

A geostationary orbit is useful for communications because ground antennas can be aimed at the satellite without their having to track the satellite's motion. This is relatively inexpensive. In applications that require a large number of ground antennas, such as DirectTV distribution, the savings in ground equipment can more than outweigh the cost and complexity of placing a satellite into orbit.

The concept of the geostationary communications satellite was first proposed by Arthur C. Clarke, building on work by Konstantin Tsiolkovsky and on the 1929 work by Herman Potočnik (writing as Herman Noordung) *Das Problem der Befahrung des Weltraums — der Raketen-motor*. In October 1945 Clarke published an article titled "Extra-terrestrial Relays" in the British magazine *Wireless World*.The article described the fundamentals behind the deployment of artificial satellites in geostationary orbits for the purpose of relaying radio signals. Thus, Arthur C. Clarke is often quoted as being the inventor of the communications satellite and the term 'Clarke Belt' employed as a description of the orbit.

The first geostationary satellite was Syncom 3, launched on August 19, 1964, and used for communication across the Pacific starting with television coverage of the 1964 Summer Olympics. Shortly after Syncom 3, Intelsat I, aka *Early Bird*, was launched on April 6, 1965 and placed in orbit at 28° west longitude. It was the first geostationary satellite for telecommunications over the Atlantic Ocean.

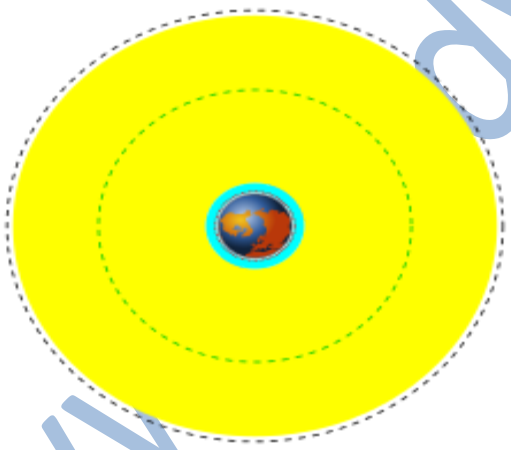
On November 9, 1972, Canada's first geostationary satellite serving the continent, Anik A1, was launched by Telesat Canada, with the United States following suit with the launch of Westar 1 by Western Union on April 13, 1974.

On May 30, 1974, the first geostationary communications satellite in the world to be three-axis stabilized was launched: the experimental satellite ATS-6 built for NASA

After the launches of the Telstar through Westar 1 satellites, RCA Americom (later GE Americom, now SES[disambiguation needed]) launched Satcom 1 in 1975. It was Satcom 1 that was instrumental in helping early cable TV channels such as WTBS (now TBS Superstation), HBO, CBN (now ABC Family) and The Weather Channel become successful, because these channels distributed their programming to all of the local cable TV headends using the satellite. Additionally, it was the first satellite used by broadcast television networks in the United States, like ABC, NBC, and CBS, to distribute programming to their local affiliate stations. Satcom 1 was widely used because it had twice the communications capacity of the competing Westar 1 in America (24 transponders as opposed to the 12 of Westar 1), resulting in lower transponder-usage costs. Satellites in later decades tended to have even higher transponder numbers.

By 2000, Hughes Space and Communications (now Boeing Satellite Development Center) had built nearly 40 percent of the more than one hundred satellites in service worldwide. Other major satellite manufacturers include Space Systems/Loral, Orbital Sciences Corporation with the STAR Bus series, Indian Space Research Organization, Lockheed Martin (owns the former RCA Astro Electronics/GE Astro Space business), Northrop Grumman, Alcatel Space, now Thales Alenia Space, with the Spacebus series, and Astrium.

Low-Earth-orbiting satellites (LEO)



Low Earth orbit in Cyan

A low Earth orbit (LEO) typically is a circular orbit about 200 kilometres (120 mi) above the earth's surface and, correspondingly, a period (time to revolve around the earth) of about 90 minutes. Because of their low altitude, these satellites are only visible from within a radius of roughly 1000 kilometers from the sub-satellite point. In addition, satellites in low earth orbit change their position relative to the ground position quickly. So even for local applications, a large number of satellites are needed if the mission requires uninterrupted connectivity.

Low-Earth-orbiting satellites are less expensive to launch into orbit than geostationary satellites and, due to proximity to the ground, do not require as high signal strength (Recall that signal strength falls off as the square of the distance from the source, so the effect is dramatic). Thus there is a trade off between the number of satellites and their cost. In addition, there are important differences in the onboard and ground equipment needed to support the two types of missions.

A group of satellites working in concert is known as a satellite constellation. Two such constellations, intended to provide satellite phone services, primarily to remote areas, are the Iridium and Globalstar systems. The Iridium system has 66 satellites.

It is also possible to offer discontinuous coverage using a low-Earth-orbit satellite capable of storing data received while passing over one part of Earth and transmitting it later while passing over another part. This will be the case with the CASCADE system of Canada's CASSIOPE communications satellite. Another system using this store and forward method is Orbcomm. The Low-Eirth-Orbiting satellite are cover very small area of the earth and the distance between two satellite is small than MEO satellite.

Molniya satellites

Geostationary satellites must operate above the equator and therefore appear lower on the horizon as the receiver gets the farther from the equator. This will cause problems for extreme northerly latitudes, affecting connectivity and causing multipath (interference caused by signals reflecting off the ground and into the ground antenna). For areas close to the North (and South) Pole, a geostationary satellite may appear below the horizon. Therefore Molniya orbit satellite have been launched, mainly in Russia, to alleviate this problem. The first satellite of the Molniya series was launched on April 23, 1965 and was used for experimental transmission of TV signal from a Moscow uplink station to downlink stations located in Siberia and the Russian Far East, in Norilsk, Khabarovsk, Maga an and Vladivostok. In November 1967 Soviet engineers created a unique system of national TV network of satellite television, called Orbita, that was based on Molniya satellites.

Molniya orbits can be an appealing alternative in such cases. The Molniya orbit is highly inclined, guaranteeing good elevation over selected positions during the northern portion of the orbit. (Elevation is the extent of the satellite's position above the horizon. Thus, a satellite at the horizon has zero elevation and a satellite directly overhead has elevation of 90 degrees.)

The Molniya orbit is designed so that the satellite spends the great majority of its time over the far northern latitudes, during which its ground footprint moves only slightly. Its period is one half day, so that the satellite is available for operation over the targeted region for six to nine hours every second revolution. In this way a constellation of three Molniya satellites (plus in-orbit spares) can provide uninterrupted coverage.

Medium Earth Orbit (MEO)

A MEO satellite is in orbit somewhere between 8,000 km and 18,000 km above the earth's surface. MEO satellites are similar to LEO satellites in functionality. MEO satellites are visible for much longer periods of time than LEO satellites, usually between 2 to 8 hours. MEO satellites have a larger coverage area than LEO satellites.A MEO satellite's longer duration of visibility and wider footprint means fewer satellites are needed in a MEO network than a LEO network.One disadvantage is that a MEO satellite's distance gives it a longer time delay and weaker signal than a LEO satellite, though not as bad as a GEO satellite.

A medium earth orbit satellite (MEO) is a satellite that orbits the earth in between Low Earth Orbit Satellites (LEO), which orbit the earth at a distance from the earth of about 200-930 miles (321.87-1496.69 km) and those satellites which orbit the earth at geostationary orbit, about 22,300 miles (35,888.71 km) above earth. Each type of satellite can provide a different type of coverage for communications and wireless devices. Like LEOs, these satellites don't maintain a stationary distance from the earth. This is in contrast to the geostationary orbit, where satellites are always approximately 22,300 miles from the earth.

Any satellite that orbits the earth between about 1000-22,000 miles (1609.34- 35,405.57 km) above earth is an MEO. Typically the orbit of a medium earth orbit satellite is about 10,000 miles (16,093.44 km) above earth. In various patterns, these satellites make the trip around earth in anywhere from 2-12 hours, which provides better coverage to wider areas than that provided by LEOs.

In 1962, the first communications satellite, Telstar, was launched. It was a medium earth orbit satellite designed to help facilitate high-speed telephone signals, but scientists soon learned what some of the problematic aspects were of a single MEO in space.

It only provided transatlantic telephone signals for 20 minutes of each approximately 2.5 hours orbit. It was apparent that multiple MEOs needed to be used in order to provide continuous coverage.

Services provided by Satellite:

Satellite Communication has a wide range of services. Applications are in numerous and broadly classified as follows:

- In communication such as T.V. telephony, data transfer such as mail and internet etc. are mostly done through different communication satellites these days.
- Remote sensing and Earth observation can be done with the help of lower Earth Orbits (LEO) Satellite.
- Metro logical applications such as whether survey to study different layers and amount of ozone's content in the atmosphere.
- Military applications like short distance local communication from any camp to another, to study the location of the enemy etc,

Other services provided by Satellite Communication is:

- Fixed satellite service
- Broadcast satellite service
- Navigational satellite service
- Meteorological satellite service
- Mobile satellite service.

The number of operational and planned satellite communication system is growing rapidly.

Advantages and Disadvantages of Satellite Communication:

Satellite Communication is one of the most impressive spin-off from space programs, and made a major contribution to the international communication. Satellite plays a very important role in telephone communication, TV and radio program distribution and other certain communications.

This the major field of study and has intensive literature. These communication systems are now become an integral part of major area telecommunication networks through the world.

The purpose of this post is to discuss various advantages of Satellite Communication and Services provided by the Satellite.

Advantages

Because of its unique geometry and it's inherently a broadcast medium with an ability to transmit simultaneously from one point to an arbitrary number of other points with in its coverage area. Thus satellite Communication possesses several advantages which are as follows:

- Point to multipoint communication is possible whereas terrestrial relay are point to point, this is why satellite relay are wide area broadcast.
- Circuits for the satellite can be installed rapidly. Once the satellite is in position, Earth Station can be installed and communication may be established within some days or even hours.
- During critical condition each Earth Station may be removed relatively quickly from a location and reinstalled somewhere else.
- Mobile communication cab be easily achieved by satellite communication because of its flexibility in interconnecting mobile vehicles.
- As compared to fibre cable, the satellite communication has the advantage of the quality of transmitted signals and the location of Earth Stations. The sending and receiving information independent of distance.

Disadvantages

Apart form advantages Satellite Communication also posses some disadvantages that are as follows:

- With the Satellite in position the communication path between the terrestrial transmitter and receiver is approximately 75000 km long.

- There is a delay of ¼ sec between the transmission and reception of a signal because the velocity of electromagnetic wave is 3* 10^5 Km/second.

- The time delay reduces the efficiency of satellite in data transmission and long file transfer, which carried out over the satellites.

- Over-crowding of available bandwidth due to low antenna gains is occurred.

- High atmosphere losses above 30 GHz limit the carrier frequency.

The Future

The modern day satellites we use today are more efficient and could accommodate larger data inputs.

Add to that the versatility in which some can even take photos, transmit signals for GPS devices and even monitor weather conditions.

Truly, the humble beginnings of satellite launching have come a long way to serve mankind.

Soon, we can expect to acquire transmission services which are tailored to each and every need of individual users.

Conclusion

- Limited satellite transmitter power
- Significant path losses
- High gain antennas needed
- Antenna patterns can be shaped as desired
- Location and tracking necessary
- Atmospheric effects can be significant

References

- www.studymafia.org
- www.google.com
- www.wikipedia.com