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AN OVER VIEW OF SATELLITE COMMUNICATION

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ABSTRACT

With the introduction of satellites, communication throughout the whole world has been revolutionized. Satellite communication has benefited humanity in a variety of ways, including predicting weather, providing storm warnings, and providing a wide range of communication services in the fields of relaying television programs, digital data for a variety of business services, and, most recently, telephony and mobile communication. If satellite communication connections are utilized for voice and fax transmission to aircraft on international routes in the near future, it will not surprise the global community. Other uses of satellite communication include GPS navigation, global telephone, multimedia video and internet connection, Earth imaging through remote sensing satellites for resource monitoring, telemedicine, and tele-education services, among others. The satellite communication system is transitioning from high-cost, high-capacity trunk connectivity to low-cost multipoint-to-multipoint transmission. Satellite communication has progressed in various ways, including frequency reuse, linking numerous ground terminals across the globe, multiple spot beam communications, laser beam-based satellite communication, and the utilization of networks of tiny satellites in low earth orbit. Different application aspects, both current and future, are addressed in this article on satellite communication development. If we pool our efforts and come up with creative and low-cost solutions for the global community, satellite communication offers numerous applications and markets.

KEYWORDS: *Satellites, GPS Navigation, Remote Sensing, Telemedicine, Frequency Reuse.*

1. INTRODUCTION

The satellite communication service business has expanded at a faster rate than predicted in 1992. This expansion has been a worldwide phenomenon, as the world's economies have grown and developed to the point where more communication services are required for both corporate and consumer sectors. Consumer terrestrial mobile and internet communication services have created new possibilities for satellite communication as a result of increasing demand and recent big, fast growth of company[1].The need for new multi-state satellite constellations to service this industry on a national and worldwide scale has been sparked by the growth of the mobile and Internet transport access industries[2]. The current and projected rise is due to growth in the aforementioned sectors, as well as an increase in worldwide TV viewership and high data rate transit. There is also a growing need for integrated satellite and terrestrial communications that will allow information to be sent smoothly between both modes of transportation.

Many countries' governments and industries have become interested in these huge and quickly expanding satellite-based commercial possibilities, and these countries are investing substantial additional money to allow them to participate in this developing market. To guarantee their long-term presence in the commercial satellite sector, several nations have set aside money for satellite R&D initiatives. The increasing worldwide demand for satellite communications services, as well as the development of satellites into new applications, has piqued the interest of the investing community. As a consequence, new satellite service providers have emerged, as well as mergers and acquisitions, the establishment of new businesses, worldwide partnerships, and the privatization of formerly public satellite service organizations. The satellite communication business has expanded dramatically, as has the number of experts and activities available[3]. Commercial communication satellite manufacturers and service providers have historically been cautious and reluctant to incorporate new technologies into spacecraft [2]. This has evolved in response to the urgent need to provide consumers' growing demand for entertainment content on television, mobile communications, and high-speed Internet access. Industry is rapidly integrating new technologies into satellites. Onboard processing and switching, more efficient solar cells, higher power components, more effective heat dissipation methods, electric-based station maintaining thrusters, inter satellite connections, huge antennas, and phased arrays are only a few examples of recent developments. antennas, antennas with multiple spot beams, and TWTAs that are better. Satellite is increasingly being seen as more than just a "bent pipe," but as an essential component of a huge global communications networking system that necessitates interoperability between satellite and terrestrial communication components, as well as compatible protocols and standards. The satellite business will have to undertake massive software operations and create new end-user services in order to integrate satellites into the global network. a larger geographic area, so that it may be received by a variety of consumers using suitable equipment Another use of satellites is observation, in which the satellite is outfitted with cameras and other sensors and simply downlinks whatever data it gathers from its vantage position[4].

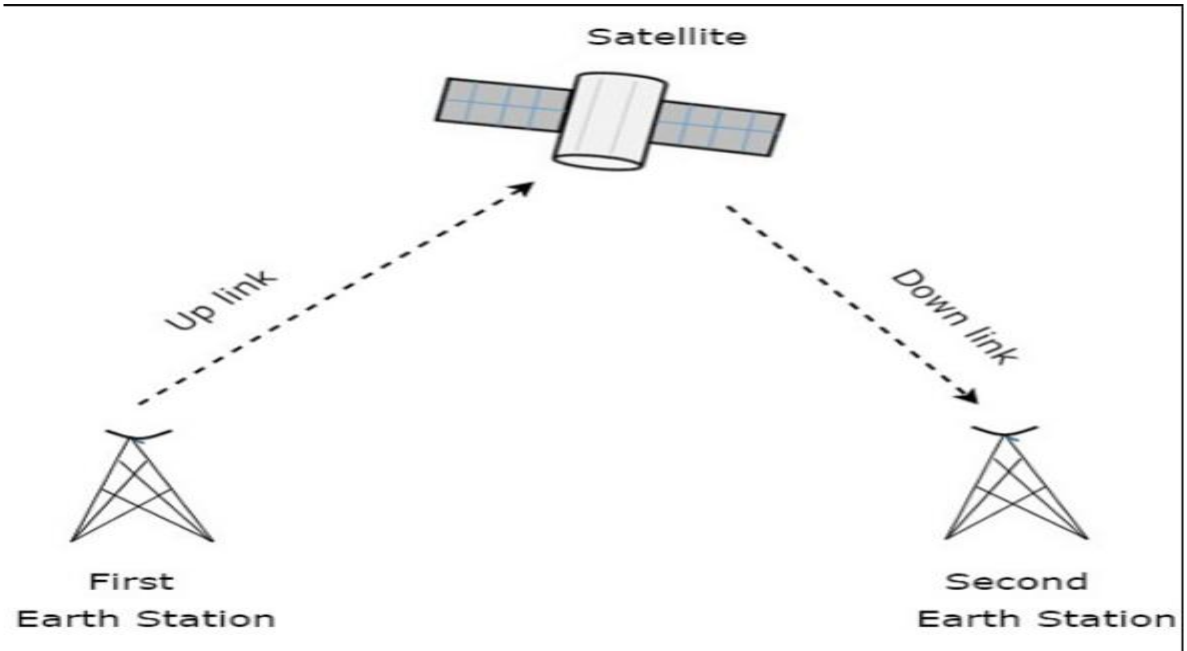

Figure 1: Diagrammatic Representation of Overview of Satellite Communication [ELECTRONIC HUB]

1.1 Advantages of Satellite Communication

- Satellite broadcasting provides extensive coverage across a wide geographic region, particularly in sparsely inhabited areas.
- The bandwidth is quite high.
- Satellite communication can quickly develop wireless and mobile communication applications regardless of location.
- It is used in a wide range of applications, including global mobile communication, private business networks, long-distance telephone transmission, weather forecasting, radio/TV signal broadcasting, military intelligence gathering, ship and aircraft navigation, connecting remote areas, and television distribution, among others.
- The coding and decoding technology in satellite transmissions generally offer security.
- It is simple to get service from a single supplier, and uniform service is accessible.It may be less expensive over large distances.
- Satellite communication is the ideal alternative since its installation and maintenance are simple and inexpensive.
- During a catastrophic situation, each Earth Station may be rapidly removed from its current position and placed somewhere.
- Ground station locations are simple to set up and maintain.

1.2 Disadvantages of Satellite Communication

- The expense of designing, developing, investing in, and insuring a satellite is greater.
- Time taken to reach the satellite from Earth may range from 270 milliseconds to 320 milliseconds. Over telephone lines, this propagation delay may produce an echo.
- Repairing and maintaining satellites is a difficult task.
- Some factors, such as weather or sunspots, may disrupt the satellite's signal, causing interference and making effective functioning difficult.
- It must be monitored and managed on a regular basis to ensure that it stays in orbit once launched.

1.2 Issue in Satellite Communication

- A new approach to satellite design, prototype, and production:

The old pattern of highly specialized, customised, developed and produced a few at a time in satellite production is currently shifting. The usage of common buses and the use of CAD tools to tailor communications payloads are currently being emphasized more. In an assembly line setting, a mass-manufactured system is used, and numerous satellites are created at once. Integration and testing are both automated to a large extent. After prototype and early production are completed, the scope and character of testing is decreased[5].

- New High-Performance Platform:

The construction of big aperture GEO systems with extremely high power systems has been one of the major technological developments in response to the deployment of LEO and MEO satellites. Commercial satellite power production was formerly restricted to 7 to 12 KW[6]. New generation designers, on the other hand, have started to propose huge flexible floppy solar arrays capable of producing 50-60 KW. Intensive attempts are also being made to enhance solar cell performance by utilizing gallium arsenide/germanium multi-junction cells, which have the potential to achieve solar cell efficiencies of above 30%. In order to build higher and higher powered satellites, simultaneous efforts are being made to enhance battery (lithium ion) and fuel cell technologies[7].

- Importance of Future Technologies

Batteries, devices, and structures for Phased Array and Multiple Spot Beam Antennas on the Ground and in Space Fuels and combustion structures for launch vehicles High frequency (>20GHz) devices Materials for electronics devices Solar cell materials and structures Network technology for high data rate, integrative satellite communications Materials for thermal dissipation Furthermore, experimental satellites are required to test new technologies that cannot be readily tested on the ground. At the system level, high altitude, long endurance platforms such as airships and loitering aircraft that fly between 65,000 and 1,00,000 feet may have an effect on satellites' future. In regional applications, such systems may be used to replace satellite communication, or they could be used in combination with satellites as a system capacity multiplier over populous regions[5].

- Issues with policies and regulations

Landing rights agreements, annual terminal licensing fees, non-tariff barriers, frequency and orbital slot allocation, adequacy and effectiveness of intersystem coordination procedures, security and privacy of information relayed on satellite systems, and other issues must be resolved in international satellite trade[8]. The necessity to create protocols for seamless connectivity of satellite, wireless, and terrestrial fiber networks is the most essential of all. Interconnection of satellite systems, especially inter-satellite connections, will be a major issue in the twenty-first century. It's a real difficulty to connect them to a low-latency terrestrial network[9].

1.3 Application of Satellite Communication

Satellites are ideal for certain applications. Broadcasting, service to mobile users such as ships, airplanes, land mobility, and emergency services, and delivering near-instant infrastructure in underserved regions are all examples of these[10]. The Internet's development has been a major role in these plans, and it shows no signs of slowing down, despite the inadequate access that most users presently have. As a result, the deployment of certain of these Ka-band systems may solve the issue of "last mile connectivity" that plagues most industrialized nations. This would be a significant application that has hitherto been overlooked by satellite systems. Other uses include:

- Traditional Telecommunication:

Direct-to-home television (DTH) or direct broadcast satellite (DBS), the enormous growth in wireless hand-held phone usage (cellular, personal communication services, and paging), and the growth in the number of personal computers in the world, increasing numbers of which are multimedia ready and are being used to internationally.

- Satellite-based atmospheric, oceanic, and terrestrial observation

i) Atmospheric monitoring

Meteorological satellites from the region's main space-faring nations are utilized to gather atmospheric data for climate forecasting. The INSAT-3 series, MATSAT, China's Feng Yung-1C, and the European metrological satellite NOAA series, among others, are all active for this purpose.

ii) Observations from the sea

In order to predict maritime storms, wind speed and direction near the ocean's surface are crucial. The operating satellites for oceanic observation include India's Oceansat-1 and Oceansat-2, China's QuikSat, KOMPSAT for monitoring ocean color, and Envisat for measuring pigment concentrations, suspended sediments, and soluble organic matter.

iii) Observation on the ground

Crop management, fertility, pest and disease information to increase crop yields and profitability, flood forecast, forestry estimation, global change studies, land cover monitoring and assessment, large area mapping, cartography, search and rescue operations, emergency disaster communication and hazard mitigation are some of the terrestrial observations carried out by remote sensing satellites. India has a four-satellite Resourcesat constellation, as well as NASA's Landsat-7, ALOS, IKONOS-2, Quickbird1, Orbview-3&4, and other satellites that provide terrestrial observation.

- Navigation and positioning using satellites

Advanced applications that need very accurate location and tracking, such as precision mapping and surveying or monitoring oil spills and dangerous icebergs, will be enabled by SPS satellites. The same satellites will also offer improved navigation services for airplanes and vessels, as well as moving-map displays for automobiles. The NAVSTAR and GLONASS constellations, as well as the GNSS-1 satellite, are all contributing to this goal.

- Space science and solar applications on the ground.

i) Application of space science

With the building of the International Space Station currently underway, a new door has opened to not just long-term studies of the space environment, but also research and industrial operations in microgravity. The International Space Station, known as Mir, will provide a more sophisticated platform for conducting space research and technological studies.

ii) Solar-terrestrial uses

Some nations are looking into the possibility of using solar electricity from space. The Solar Power System 2000 concept would use solar cells on board satellites in low equatorial orbits to generate electrical power, which would then be sent by microwave to specially built power receiving antennas in nations near the equator.

- Education and training through satellite

i) Teaching and learning at a distance

Open learning and distant education programs have been adopted by South-East Asian Ministries of Education in respective nations via satellite-based education and training in discipline open learning centers situated across the region. PEACESAT and other such satellites are utilized for education and training throughout Asia and the Pacific.

ii) Engineering

At least nine nations are undertaking small-scale experimental missions with human resource and industrial development as their goals. The Badr-B, FedSat, TMSat, and KITSAT series are among them.

- Military Relevance

In military operations, space is becoming more important. They're often employed to assist military or security-related operations like checking compliance with weapons control accords. Imagery, navigation, signal intelligence, telecommunications, early warning, and metrology are all examples of military applications. Over 270 military spacecraft, as well as 600 civil, commercial, and multifunctional satellites, are currently in orbit. These satellites are used for both military and civilian purposes.

2. DISCUSSION

Because satellite systems cover vast regions such as nations or continents, the available beam width must be shared by a large number of beams. To get around this, the frequency reuse [4] method is often used. This is based on spatially separated beams utilizing the same frequencies. As a result, the available bandwidth in the coverage region is split into a smaller number of beams. Cluster refers to a group of beams that share the entire available bandwidth. The cluster is then repeated throughout the coverage region, relying on the assumption that beams operating at the same bandwidth will be sufficiently distanced from one another to avoid interference. To allow a continuous coverage of hexagonal geometry, there is only a finite set of feasible cluster sizes. A communications satellite is a man-made spacecraft that uses a transponder to relay and amplify radio telecommunication signals, establishing a communication link between a source transmitter and a receiver at various places on Earth. Television, telephone, radio, internet, and military applications all utilize communications satellites. There are 2,224 communications satellites in Earth orbit as of January 1, 2021. Most communications satellites are in geostationary orbit, which is 22,236 miles (35,785 km) above the equator, and therefore look stationary in the sky; thus, ground station satellite dish antennas may be pointed at that location continuously and do not need to move to follow the satellite.

3. CONCLUSION

Satellite communication, its components, advancements in satellite communication, and current and prospective uses are briefly covered in this article. This is a one-time effort to provide a short overview of satellite communication applications. A thorough examination of the applications is still required. In our future research, we will look at the specifics of frequency reuse in satellite and mobile cellular systems. The high-frequency radio waves required for telecommunications connections move in a straight path and are therefore hindered by the Earth's curvature. The aim of communications satellites is to transmit signals around the Earth's curvature, enabling communication between geographically distant locations. A broad variety of radio and microwave frequencies are used by communications satellites. International organizations have rules governing the frequency ranges or "bands" particular organizations are permitted to utilize in order to prevent signal interference. This band assignment reduces the likelihood of signal interference.

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