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The Era of Space Communication

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Abstract:- This paper discusses the evolution of space communications with special focus on Low Earth Orbits (LEOs) and how they are shaping the human daily life as well as the industrial day-to-day business.

I. INTRODUCTION

Communication is an important aspect of human daily life. People uses communication, for example, to build strong rapport, share experiences, pass on knowledge, express feelings, etc. Storytelling is considered among the oldest types of communication where people gather to share thoughts and lessons learned. Physical gathering was the only method, at the early ages, to perform this sort of communication and knowledge exchange. However, the form of communication has evolved substantially with the huge advancement in technology. For example, we have witnessed the use of copper connectivity to provide telephone services to homes and industrial facilities. In a very short period of time, the technology has switched into Fiber to the Home (FTTH) instead of copper. Lately, the revolution in space communications made it the unprecedented trend and it has changed the way we connect and explore beyond Earth's atmosphere. Through the use of satellites and advanced technology, we can now communicate across vast distances in space. Satellites act as relays, receiving signals from Earth and transmitting them to their intended destinations. They enable crucial functions such as weather forecasting, global positioning systems (GPS), and even television broadcasts. The recent advents in Low Earth Orbits (LEOs) technologies play big roles and they are considered game changers in today's communication.

II. LOW EARTH ORBITS (LEOS)

As illustrated in Figure 1 and as the name suggests, LEO is a non-geostationary satellite that rotates around the earth at a distance of around 2,000km. Being closer to the earth provides a latency benefit resulting in a drop in the delay time, this is the time it takes for the data to complete a round trip (RTT), going from earth to satellite and back again. LEO offers a latency of 40 milliseconds. However, one LEO satellite is not enough to provide the intended coverage. Therefore, it is required to create a network of satellites that make an orbiting communication mesh covering the entire globe. This is called LEO Satellite Constellation, as shown in Figure 2. The new LEO satellite "constellations" will allow noticeably faster speed and lower latency that are important factor for various applications such as Internet of Things (IoT), remote sensing, real-time monitoring, etc. Irrespective of your current location, the beauty of LEO is that it will always get you connected automatically provided you are within the mesh coverage of LEO Constellation, as reflected in Figure 3. Compared to GEO and MEO, LEO constellation provide several advantages including but not limited to:

- High Throughput
- Low Latency 30-50 ms
- Lower Costs
- Complete Global Coverage
- Less Interference
- Flexible and Focused Capacity

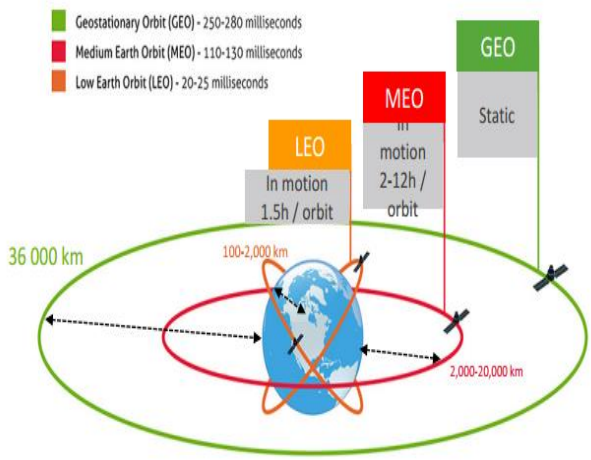

Fig 1: The different types and characteristics of communication satellites

Fig 2: The LEO satellite constellation

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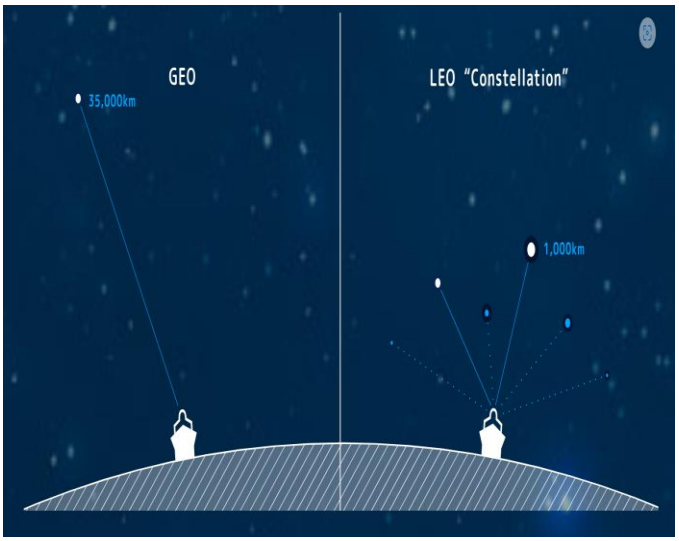

Fig 3: LEO Constellation vs GEO

III. APPLICATIONS OF LEO

LEO technology is widely used for mobile communication. Commercial users or enterprises who travel abroad or operate in places that are far from cellular coverage make use of the LEO satellite applications. Below are some of the applications related to this technology.

- Remote Industrial Business: LEO devices have the capability to provide services to remote areas that are far from terrestrial coverage, including onshore and offshore areas. Therefore, individuals, operating in the fields such as oil and gas, mining, and forestry, usually use LEO satellite services. Some of the services include connectivity to the Internet, voice communication, and even tracking and monitoring hardware and equipment.
- Emergency Response: natural disasters like earthquakes and hurricanes can severely compromise the availability of the on-ground communication infrastructure and thus may lead to total communication blackout. Due to LEO's ubiquitous nature, the disaster and recovery teams often use them to coordinate recovery and rescue efforts.
- Universe Imaging: due to close proximity, the imaging satellites will also be able to capture better and more detailed pictures of the earth.

IV. CONCLUSION

The low altitude of the LEO technology makes it a perfect technology for imaging and communication, especially at remote locations. Due to this low altitude, communication signals do not require a lot of power and time. In other words, LEO provides higher speed, wider coverage, and lower latency. The question that may arise by now: Is there any opportunity that LEO will soon replace the conventional cellular GSM? In our humble opinion, there will a hybrid transition where advanced phones will be operating in both terrestrial and non-terrestrial networks until the LEO takes over the full control. Nonetheless, LEO satellites come with some disadvantages. Due to the ease of launch and the growing popularity of these satellites, there is an increasing space debris issue. As a matter of fact, space agencies often must use layers of shields to protect from the debris. Additionally, these devices also have to deal with atmospheric drag. Moreover, a typical LEO satellite has a much lower lifespan than GEO machines.

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