The Future of Telecommunications

Comparing ECO Systems

With the emergence of the Smart Infrastructure evolution the connectivity challenge is not only becoming more complex but also more desired both across the world as well as in the air with 4 billion passengers commuting on an annual basis. On the ground the 5G infrastructure acceleration will be primarily limited to urban areas. LEO (Low Earth Orbit) based systems are argued and perceived to be the best solution to solve the aerial connectivity challenges with our current knowledge.

However, one piece of the puzzle is missing. A complementary "middle layer" airborne system to the existing infrastructures, which is easily upgradeable with higher speeds in the aerial domain.

Free Space Secure Network Inc. (FSSN) is working on this missing and complementary link by merging FSO technology with a software platform to lay the foundation for a Free Space Optics Mesh network to be carried by the existing fleets in the air today. The system interfaces seamlessly with the existing infrastructures both ground and in space.

To understand specifically how LEO based systems compare to the FSSN platform this paper shows a comparison of the features categorized under advantages and disadvantages. The complementary nature of the approaches is highlighted to unlock higher internet speeds to remote areas around the world, on the ocean and in the air.

Key considerations in that sense focus on upgradeability, cost, transmission speeds, limited spectrum, space debris, and compatibility with existing ground infrastructure to name a few. With a broader understanding of the FSSN technology players such as aircraft manufactures Telcom's and others have engaged with FSSN to bring this platform to reality as a total eco system solution.

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LEO Satellite Technology and benefit highlights

- The Low Earth Orbiting satellite constellation, which was known as the "Iridium" communications service was launched on November 1, 1998 by what was then Iridium SSC. The first Iridium call was made by Vice President of the United States Al Gore to Gilbert Grosvenor, the great-grandson of Alexander Graham Bell and chairman of the National Geographic Society. Motorola provided the technology and major financial backing. Iridium covered a major part of the globe and allowed people with "satellite phones" to call from remote locations.
- With modern technology, LEO (Low Earth Orbit) satellites could play a significant short-term role in solving some of the world's connectivity needs.
- Over the past few years, the cost to produce and launch LEO satellites has been reduced significantly as a result of new technology availability, "economy of scale" production, and more efficient launch vehicles.
- With a large enough quantity of satellites, a limited number of target customers can be provided with excellent performance expectations.
- Due to their high orbit speeds of around 17,000 miles per hour, and their typically 800-1200-mile altitudes, these are circling the globe in a mere 90 minutes. Hence, LEOs perform best when these have large, overlapping footprints, as the next satellite will need to take over seamlessly when their predecessor has passed.
- Persons living within the trajectory of these LEOs can expect reasonable Internet speeds.
- Investors feel comfortable in investing in LEO technology, as these are being developed by large, well-known companies, primarily SpaceX, LeoSat, and OneWeb. These companies have large advertising budgets, aimed at making potential investors feel more comfortable with the prospect s of a reasonable return on investment.
- Most high-tech investors realize that they would likely see an ROI before any rollout problems become evident, making their investments "low risk".

FSSN's Free Space Optics and benefit highlights

- Ultra "low earth orbit" high speed data tech operating in the flight levels.
- FSSN's proposed global meshed network, consisting of Free Space Optics (FSO) terminals and Radio Frequency (RF) signaling, configured as a hybrid system, offers the best of both technologies. FSSN's proprietary technology is based on a field proven FSO design, which has been tested extensively by the US DOD; FSSN's unique dynamic algorithms and ability to mass-produce its hybrid FSO terminals. FSSN's staff has a proven track record of creating disruptive new technologies, ranging from the world's first wireless consumer telephone in 1977, the wireless in-cabin AIRFONE (1982), to numerous global satellite, mobile, aeronautical and microwave systems. The world's first airborne RF mesh network (2017).
- On 14 August 2019, FSSN and, its strategic manufacturer/ vendor, successfully demonstrated a full-motion, 10 Gigabit Per Second, Error Free Bidirectional Free Space Optic link for a major aircraft manufacturer. This demonstration was the first phase of a Joint R&D agreement. Other participating companies are major global Telco's.
- In contrast to LEO technology, FSSN's global meshed network operates at the speed of light (FSSN's signals are carried on beams of light), allowing for data-rates of many gigabits per second. The demonstration for was at 10 Gb/sec. However, the system being developed is expected to have a data-rate of 40 Gb/sec, and upon global rollout, speeds of 100 to 400 Gb/sec are expected, as FSSN's engineers are developing new modulation techniques.
- The total number of flying nodes "Satellites" FSSN intends to "launch" (install on aircraft) over a 5 to 7-year period is up to 500,000. There are typically four hybrid terminals per passenger jet, cargo aircraft, or supporting ship (relay); fewer on smaller aircraft.
- FSSN's "satellites" can be updated or repaired at any time, LEOs cannot be repaired or upgraded.
- As a telephone company, FSSN intends to augment the global telecom network, including "landing signals for the anticipated global 5G networks.
- FSSN's smaller footprints over LEOs mean better reuse of spectrum and targeted efficient deliveries.

Long-term potential problems and issues with LEOs

- Because of their high orbiting speeds, LEOs must use limited Radio Frequency (RF) bandwidth to carry their uplinks, as well as the downlink-footprint, making it virtually impossible to provide the service levels which they promise.
- Alternative connection methods, such as the much faster Free Space Optics (FSO), could see a practical application between satellites in the same orbit, as the difference in speed between satellites is minimal, but FSO up and down-links at these speeds are, in the foreseeable future, not feasible.
- If all envisaged customers were online at one time, the system would bog down; it would not be able to exceed "dial-up speed", which was the norm in the early days of the Internet, if it performed at all.
- Furthermore, it is not just the short-term development and deployment costs that should be considered. A LEO's orbit decays rapidly and after only approximately 5 years these will "fall out of orbit" and burn up; some of the remaining parts will fall down to earth, but the rest becomes space junk, which can damage other LEOs and hamper human space travel.
- Although the LEOs' concept to commissioning costs are significantly lower than a few years ago, the long-term costs associated with these are expected to far exceed those of other viable methods of providing global services.
- The LEOs are primarily supported by independent ISPs (Internet Service Providers), while the telecommunication industry in general favors more permanent solutions.
- One Web's Aircraft manufacturer/part-owner, is exploring alternate systems despite investing heavily in One Web.
- Single points of failure; when one satellite is damaged or destroyed by a collision or by space junk, there will be a data-interruption until the next satellite wizzes by. (Assuming a link can be established to the next satellite in the same orbit.)
- Heavy rain may impede service or cause complete outages.
- LEO constellations may need the support of FSSN and vice versa to fully cover the globe.

Disadvantages of FSSN's tech and possible solutions

- When an aircraft encounters heavy clouds, it can no longer support the global mesh. As FSSN is a hybrid system, the affected aircraft is isolated, dropped from the mesh, and supplied with basic link data only to service its "onboard needs" and to use its location data for managing its anticipated return to the telco mesh.
- Severe weather and/or volcanic ash could ground or force rerouting of aircraft, creating local voids in the global coverage. The first "line of defense" is routing signals to unaffected ground stations, in some cases this will mitigate the issues. As this is a rare but possible scenario, FSSN, as a telephone company, would rely on its associated global telecom partners to cover most of these outages. Although the cost per minute may be greater, it is a viable solution for minimizing interruptions. Once the weather has moved out, full service can be restored. As a side-note, because of their operating frequencies, LEO satellites are also affected, especially by heavy rain.
- FSSN's planned global mesh requires participation by dedicated fleets, airlines, and air cargo carriers for its primary infrastructure. FSSN's solution is to rollout in strategic areas. In addition to the targeted commercial aircraft, FSSN plans to use dedicated aircraft to fill these initial gaps; as the system is rolled out, commercial aircraft would take over and "filling gaps" would be limited to certain circumstances only. The aircraft designed to fill these gaps would also be used to offer services to disaster areas, as these could operate as part of the global mesh, or independently.
- FSSN is currently actively engaged in miniaturizing and optimizing its proven hardware for commercial deployment