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THE MERITS OF MEDIUM EARTH ORBIT FOR SATELLITE COMMUNICATIONS SYSTEMS

Abstract

Until recently, geostationary satellites have been the holy grail for satellite communication (SATCOM) systems. With a rotational period that mirrors Earth's, satellites in geosynchronous orbit (GEO, approx. 35,500 km from Earth) are able to provide consistent coverage to a given region with high reliability, favorable economics, and relatively simple ground infrastructure. At the same time, reliance on exquisite GEO satellite systems can also lead to national security and/or business continuity challenges.

A growing emphasis on resilience and lower latency has led some commercial providers and government agencies to shift their space architecture to low Earth orbit (LEO - less than 2,000 km from Earth), providing space-based connectivity with a much higher number of proliferated assets. LEO architectures require sophisticated ground and user terminal infrastructure, but offer "self-healing" redundancy by virtue of having hundreds of operational satellites.

Medium Earth orbit (MEO, between 2,000 km and 35,500 km from Earth) has been far less utilized in SATCOM architecture, but offers a unique set of merits worth discussion.

Boeing recently delivered to network provider SES the first two O3b mPOWER satellites, allowing the operator to provide global coverage while needing fewer satellites – in O3b mPOWER's case, just 6 spacecraft in equatorial MEO.

This approach introduces economic benefits while offering similar latency to SATCOM systems in LEO. It also creates less space debris - which is more sustainable - and far less light pollution, helping preserve the commons of space and ensuring continued ability for astronomers to survey the night sky. MEO satellites also tend to be more efficient in terms of cost-per-bit, a key measure of viability for commercial SATCOM providers.

MEO architectures do not come without challenges, however. The radiation environment of the Van Allen belt is the harshest in MEO. Satellites traveling to and operating in MEO have to be resilient to energetic charged particles that can threaten spacecraft electronics and solar arrays. In addition to hardening the platform, Boeing tapped subsidiary Spectrolab to custom-design solar arrays that withstand MEO radiation to power the satellites for more than a decade.

As a result of these technological advancements, this paper and proposed special session explores how MEO can be the proverbial "sweet spot" of low-latency, high-performance, and flexibility. MEO systems can offer comparable resilience to LEO architectures while also averting the challenges associated with GEO systems.