Technology Development for a Cost-Effective SCOM on the Move System for LEO Satellite Constellations

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Low earth orbit (LEO) constellations offer lower latency, greater resilience to space phenomena, and increased affordability compared to geosynchronous earth orbit (GEO) and medium earth orbit (MEO) satellites. Consequently, LEO satellite communication (SCOM) on the move terminals is becoming attractive, particularly for enhancing 5G and upcoming 6G services in rural areas, where deploying classic terrestrial networks are both technically challenging and expensive [1]. SCOM terminals are crucial for tracking LEO satellites and range from fully mechanical to electronically scanned systems. Towards scanning speed and efficiency, choice of phased array antennas offers a compact solution with excellent scanning performance, high gain, superior radiation patterns, and multibeam capability [2]. However, these advantages come at a relatively higher cost of RF electronic components, like phase shifters, power amplifiers, low noise amplifiers, and similar. Therefore, hybrid integrated capabilities can be a balanced solution for maintaining performance and reducing RF components costs. In this study we propose an integrated and cost-effective SCOM on the move system Fig. 1, featuring electronic scanning in the elevation plane, facilitated by a flat panel leaky wave antenna (LWA) array adapted to an optimised version from folded substrate integrated waveguide (FSIW) antenna array, previously proposed in [3], with a mechanical scanning functionality in the azimuth plane. Link budget calculation [4] and block diagram of this architecture is depicted in Fig. 2.

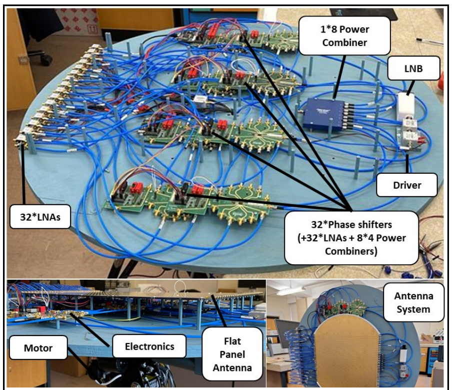

Fig. 1. Prototype with antenna system.

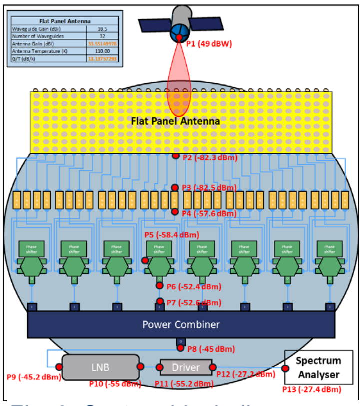

Fig. 2. System block diagram and link budget.

Starting with a 49 dBW transmission from the GEO satellite Eutelsat 16A at 12 GHz, to ensure sufficient tolerances to track LEO satellites with stronger signal to noise ratio (SNR), thank GEOs. The signal undergoes free-space path loss, atmospheric attenuation, and polarization mismatch, reducing received power to -82.3 dBm at the flat panel antenna. Additional RF cable losses further attenuate the signal to -82.5 dBm before low-noise amplification (LNA) increases it to -57.6 dBm. Subsequent cable losses and gain contributions from phase shifters and combiners result in -52.4 dBm after a 4-channel combiner and -45 dBm after an 8-channel combiner. Further LNB and cable losses lower the signal to -55 dBm, before driver amplification restores it to -27.2 dBm, ensuring operational viability. Far-field pattern measurements were conducted using an NSI™ nearfield measurement system, yielding accurate results from 10.5 GHz (Fig. 3) to 12.5 GHz. Future efforts include integrating subsystems at component level in contrast to current approach based on off the shelf devices, to further reduce insertion losses and enhance system compactness. These advancements will significantly improve performance, demonstrating strong potential for future satellite communication applications.

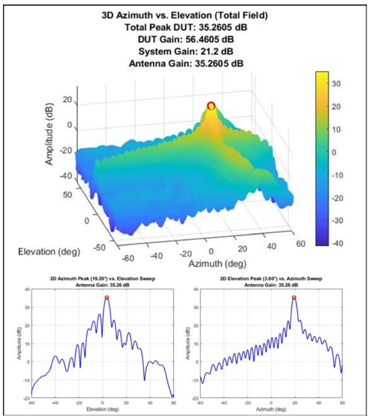

Fig. 3. RX Gain measurement at an arbitrary direction.

References

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