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SYSTEM DESIGN STUDY OF A CONSTELLATION OF SMALL SPACECRAFT TO DELIVER SEAMLESS 5G CONNECTIVITY TO UNMODIFIED CELL PHONES THROUGH AN END-TO-END NON-TERRESTRIAL NETWORK

Abstract

The increasing demand for high-speed mobile data services has led to the development of 5G and 6G technology, which promises to revolutionize the way people access and use the internet. However, the full exploitation of 5G network potential is often limited by the challenges related to the deployment of the physical infrastructure required to support these networks. In order to address these limitations, a new approach is needed to bring 5G services to areas that are currently underserved. This paper presents the results of a system design study that explores the use of a constellation of small spacecraft to deliver seamless 5G connectivity to unmodified cell phones, through an end-to-end non-terrestrial network. Within the study, several use cases have been taken into account including offering enhanced service to cities and connecting areas not served by traditional mobile services such as remote regions, ships and offshore

platforms, regions hit by natural disasters and contested battlefields. A trade space exploration approach was undertaken to identify the optimal solution for meeting stakeholders' requirements associated with the different use cases. The analysis explores the effects of key architectural decisions on overall system performance and lifecycle cost, benchmarking them against foreseen customers' needs and market demand. A variety of alternatives were evaluated including the number of satellites, types of orbits, number of orbital planes, satellite size, weight and power, antenna technologies, inter-satellite links technologies and routing schemes among others. As a result, it was proposed the use of a constellation of about 3000 satellites in a sun-synchronous LEO orbit, with a satellite lifetime of 5 years. Each satellite is equipped with a phased array antenna in 5G non-terrestrial band frequency n256 for direct connectivity to unmodified user cell phones and free space optical telecommunication terminals for on-orbit backhauling. COTS components for spacecraft subsystems and sensors were considered when available. With more than 95% of Earth coverage and high system scalability, the mission represents a promising solution for providing global 5G connectivity paving the way for a more connected world.