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CONCEPTUAL DESIGN OF A SUSTAINABLE SMALLSAT CONSTELLATION TO ENABLE RELIABLE LUNAR COMMUNICATION NETWORK

Abstract

National Aeronautics and Space Administration's (NASA) Artemis program aims to establish a permanent Human presence on the lunar South Pole by the end of the decade. Providing complete and continuous coverage around the Moon using a reliable and sustainable communication infrastructure will be vital for future robotic and human exploration. Such efforts involve high-cost and long lead time solutions, which are often inaccessible to smaller companies and governments.

This paper explores the use of a constellation of small satellites, which will enable cost-effective communication infrastructure around the Moon and enhance future communication between lunar missions and Earth. With a focus on SmallSat technologies, such as small form factor CubeSats, the feasibility and practicality of developing a low-cost and sustainable lunar constellation is assessed in this conceptual design study. The proposed work addresses a set of system trade-offs and places a focus on Optical Communication Technology (OCT), an indispensable technology with substantial applications in space communication. OCTs have the potential to enable high data rates and minimize crowd spectrum usage, making them a promising solution for lunar communication networks. The most promising satellite architecture solution that meets the defined requirements is presented. Furthermore, the paper discusses the rarely addressed problem of disposal strategies for debris mitigation on cislunar orbits, as part of the sustainable development goals defined by United Nations (UN).

The present work tackles the conceptual design and the architecture of a sustainable OCT constellation of SmallSats in a frozen orbit around the Moon to enable a reliable communication network and to contribute to create the building blocks for future space exploration infrastructure.