27th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

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A CHIPSAT-CUBESAT COMMUNICATION FRAMEWORK TO SUPPORT UPCOMING LUNAR MISSIONS

Abstract

The continuous miniaturization in electronic and mechanical components over recent decades has led to the advent of ChipSats - an inexpensive easily fabricated sub-10-gram satellite - symbolizing a shift in the conventional paradigms where high development expenditure and engineering are traded against mission redundancies and risk. Major space agencies worldwide have begun redirecting their efforts and resources toward establishing a permanent human presence on the Moon. The development of an effective communications framework between the lunar surface and orbiting platforms will be paramount to ensuring mission success. It is plausible that lunar teams will experience communication difficulties due to lapses in coverage during crater exploration and when venturing toward inaccessible lunar regions. A ChipSat-CubeSat communication framework has considerable potential in mitigating against these outcomes. Historically, CubeSats have demonstrated the successful deployment of ChipSats in Low-Earth orbit. Given the clear intent commercial entities have expressed to sending CubeSats to the Moon, the conceptual translation across to a lunar mission is not inconceivable.

The design of the ChipSat subsystems across a lunar mission profile will be critical. Overcoming the existing component readiness levels and legislative hurdles for lunar ChipSat deployment remains challenging. A proposed ChipSat constellation is of concern and may contribute to the "littering" of a celestial body towards the end of an operational lifetime. Article 7.1 of the Moon Treaty prohibits the disturbance of the Moon's environment from extra-environmental material. A clear mitigation policy encompassing both the financial commitments and clean-up plans must be taken into account during mission planning. Elevating the technology readiness levels of ChipSat subsystem components, radiation hardening, and developing the appropriate end-of-life strategies should be focal points in future mission discussions.

Ultimately, the benefits of solving the existing technical hurdles of ChipSats to support lunar missions far outweighs overcoming the anticipated mission difficulties due to communication inadequacies. A failure to develop a far-reaching communication framework risks compromising mission objectives and may, indeed, jeopardize the safety of lunar crews. Lunar missions are expected to commence in a few short years. Space agencies have an opportunity now to architect an innovative communications profile for forthcoming missions by leveraging ChipSats.

This paper proposes an implementation strategy for a temporary communications network incorporating both ChipSats and CubeSats in low lunar orbit to support lunar operations. This should be of interest to mission orchestrators and illicit action toward reinforcing future Moon activities.