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# PRELIMINARY MISSION ANALYSIS FOR THE 16U4SBSP MISSION CONCEPT

**Abstract**

The 16U4SBSP mission aims to demonstrate Space-Based Solar Power (SBSP) using a CubeSat swarm from Earth orbit. This demonstration employs seven 16U CubeSats to deliver 1 kW-scale wireless energy via Radio-Frequency (RF) beaming, adaptable for both space-to-ground and space-to-space applications. The primary goal is to validate SBSP provision using a satellite swarm and explore miniaturized technologies for future large-scale missions that could benefit remote or emergency areas. A pre-Phase 0 study of the mission, funded by the European Space Agency (ESA) through the Sysnova campaign "Innovative Missions Concepts enabled by Swarms of CubeSats", has led to encouraging results on the feasibility of this mission concept.

This paper presents a study on the formation flying and orbital dynamics of the mission. The dynamical model used accounts for perturbations from Earth's gravitational field up to the fourth degree, solar radiation pressure, atmospheric drag, lunar and solar gravity. The swarm configuration includes seven CubeSats in a circular formation, with one CubeSat positioned at the center and six CubeSats distributed in a hexagonal shape around it. The Concept of Operations (CONOPS) is divided into three phases: formation deployment and acquisition, formation maintenance, and formation disposal. In the first phase, the CubeSats are assumed to be deployed separately at 30-second intervals at the target altitude. One day of the Launch and Early Orbit Phase (LEOP) is allocated for attitude acquisition, solar array deployment, and subsystem checks. Subsequent maneuvers are conducted to establish the formation, allowing sufficient time for observation campaigns. Then, a formation with a radius of 1000 meters is established, and two days are reserved for verifying formation control, assessing orbit/attitude

perturbations, antenna pointing, and time synchronization. The formation is then adjusted to decrease the radius to 100 meters and is maintained for the first half of the mission's duration. For the second half, the radius is further reduced to 10 meters. The relative positioning is maintained with a bang-bang limit-cycle controller. Finally, depending on the altitude, a disposal strategy is outlined, considering the ESA's Space Debris Mitigation Requirements. This analysis, conducted at various altitudes, characterizes propellant consumption for each phase of the CONOPS and proposes the optimal initial conditions and launch dates. A trade-off analysis among the selected altitudes is performed, leading to a complete characterization of the mission.

The work presented in the paper proves the feasibility of the 16U4SBSP mission, which would supply clean energy from space through wireless power transfer.