SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

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CONSTELLATION OF CUBESATS: 3-STAR IN THE HUMSAT/GEOID MISSION

Abstract

The 3-STAR program is the new cubesat educational project at the Politecnico di Torino. It has been thought in response to the GEOID call for proposals issued by the Education Office of the European Space Agency. The GEOID (GENSO Experimental Orbital Initial Demonstration) initiative wants to settle an orbiting constellation of Cubesats to be operated by the GENSO (Global Educational Network for Satellite Operations) ground-stations network. GEOID is expected to be the communication backbone of the initial version of the HUMSAT system. The main goal of HUMSAT is to use the constellation of satellites and the GENSO ground stations, to provide support for humanitarian initiatives, especially in developing areas or areas without infrastructure. The 3-STAR will be one of the nine cubesats in the GEOID constellation. It will be a 3U cubesat derived from the e-st@r spacecraft experience. In addition, it will carry two payloads: the HumSat payload, consisting of a simple but extremely reliable communication module compatible with the elements of the HUMSAT system, and the P-GRESSION (Payload for GNSS remote sensing and signal detection) payload. The P-GRESSION payload aims at performing measurements by means of radio-occultation technique and scattering theory, using GNSS signals. It may also work as a radar interference detector. In this paper the 3-STAR project and its main payloads are described together with a preliminary assessment on the performances of the GEOID/HUMSAT constellation. The main requirements of the GEOID/HUMSAT project have been used to drive an optimization process aimed at determining the best configurations of a swarm-like constellation of cubesats. The mission scenario is made of the nine GEOID cubesats, a number of GENSO ground nodes and several sensors distributed on the Earth surface. The objective is to maximize the time-in-view (thus minimizing the gap between subsequent accesses) of the entire constellation with the sensors and with the GENSO ground stations, while minimizing the overall constellation cost and providing acceptable link margins (used as constraints). The optimization process takes into account the orbital parameters of every cubesat of the constellation and the design parameters of the communication architecture between the cubesats and the sensors, and between the cubesats and ground stations, with the inherent power and dimensions limitations of a cubesat system. The result is a combined optimization of the constellation taking into account both mission and systems-design issues.