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CUBESAT ENERGY MODELLING FOR IMPROVED MISSION PLANNING AND OPERATIONS

Abstract

The recent increase in small satellite and multi-satellite systems is accompanied by a demand for novel software concepts that not only enable the implementation of innovative satellite systems and multi-satellite missions but also increase mission outcome by optimization of the system performance and reduction of resource consumption. Especially for CubeSats the management of the limited energy available for operation of the satellite is an important topic. Single subsystems such as transceivers or thrusters often consume more power than the satellites produce. Since CubeSats are usually operated in low Earth orbits the system also needs to cope with eclipse periods. Since the energy generation is predictable by means of orbit propagation and the consumption of subsystems is known as well to a certain extent, this predictability can be utilized for the optimization of satellite operations. If a detailed numeric model of the power consumption of subsystems and a prediction for the power generation based on sun incident angles and eclipse intervals would be available, the operation of subsystems could be coordinated to prevent over- and undersupply. Especially in formations, satellites with fully charged batteries can execute tasks of satellites, that run out of energy. As an example, routing in a satellite network could be optimized based on the predicted energy profiles of satellites. Therefore, energy models as well as simulations of the dynamic power generation and consumption of satellites are presented in this paper, along with resulting energy profiles. The defined models have been implemented in the OMNeT++ discrete event simulator, integrating power generation based on orbit and attitude propagation, multiple satellite subsystem models and mission scenario-based power consumption. Models for 1U and 3U CubeSats will be presented and evaluated in typical CubeSat mission scenarios. Possibilities for improving the operation of satellites are identified and recommendations are given.