Paper ID: 75912
oral

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Engineering - Methods, Processes and Tools (1) (4A)

Author: Ms. Marlin Kanzow
Institute of Space Systems, University of Stuttgart, Germany

Mr. Thorben Löffler
IRS, University of Stuttgart, Germany
Prof. Sabine Klinkner
Institute of Space Systems, University of Stuttgart, Germany

A SIMULATION AND ANALYSIS TOOL FOR ITERATIVELY DESIGNING AND SIZING SOLAR ARRAYS AND BATTERIES FOR SMALL SATELLITE MISSIONS

Abstract

The Electrical Power System (EPS) provides all subsystems of a satellite with the required power. Thus, iterations in mission or satellite design have a high impact on the design of the power system. Due to the criticality of the system, an iteration step also includes the analytical verification of the functionality of the adapted system in every mission phase and mission design. The EPS design iteration process is time consuming. Especially in the feasibility and preliminary definition phases of a space project the iterations can be extremely tedious and contain errors as well as unnecessary margin. This work process is not feasible for the NewSpace economy, since it does not allow for an efficient and streamlined approach to satellite design. At the University of Stuttgart an "EPS Design Tool" has been developed in python utilizing the open-source Skyfield API. By defining the satellites modes with their expected power values, orbital constraints and operational constraints, an operational schedule is deducted for a synthetic satellite with the help of a list of priorities for the satellites operational profile. Additionally, through the orbit propagation and pointing parameters of the satellite, the power generation capabilities are analyzed for every time step. From this information, the battery capacity can be calculated in each time step. This allows for refinement of the operational schedule by adding a minimum limit in battery State of Charge (SOC) that is analyzed for each time step for the full duration of a mode. Not only does this tool verify the EPS functionality, but also provides a first estimation of satellite operations. This tool can be applied to quickly optimize the satellite power system when objectives, requirements, constraints or subsystem parameters have changed. At the time of this writing, the University of Stuttgart's Institute for Space Systems (IRS) is developing the ROMEO (Research and Observation in the Medium Earth Orbit) mission. The small satellite with 70 kg wet mass is constrained in solar array volume and is also required to operate in different orbits throughout the mission, ranging from a 600 km Solar-Synchronous Orbit (SSO) with a not yet defined Local Time of Ascending Node (LTAN) to an elliptical final orbit of 330 x 2500 km. This paper describes the "EPS Design Tool" and its application in the design of the ROMEO satellite EPS, showings its benefits.