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OPERATIONAL EXPERIENCE OF THE TRANSITION FROM INITIAL TO NOMINAL OPERATIONS OF THE UNIVERSITY SMALL SATELLITE "FLYING LAPTOP"

Abstract

The small satellite "Flying Laptop", launched in July 2017, was developed and built by graduate and undergraduate students at the Institute of Space Systems of the University of Stuttgart with support by space industry and research institutions. The mission goals are technology demonstration, earth observation and serving as an educational satellite. At a mass of 110kg, it features three-axis stabilised attitude control, a completely redundant bus architecture, and 5 payloads requiring different pointing manoeuvres. Industry standards like CCSDS and ECSS, as well as professional software tools were applied and are introduced to the students trained in operating the satellite to improve the educational aspect. The satellite is operated entirely by a student team using the University's own ground station and mission control infrastructure.

Operating a complex satellite system is a challenge for a team doing this for the first time. An intensive planning for the critical Launch and Early Operations Phase (LEOP) was fundamental to prepare the operations team. This was achieved through simulation trainings applying validated flight procedures. During LEOP, a professional ground station network including two polar ground stations could be accessed, resulting in over 60 contacts within 4 days and a successful LEOP with the first reception of an image on the 5th day. The commissioning activities have now been completed with the successful verification of the redundant On-Board Computer.

Performing nominal operations with a reduced operations team, using only passes with uplink during normal working hours, also presented a significant challenge, as a higher degree of automation and prior mission planning became decisive. Missing automation at the beginning made basic tasks, like scheduling of transmitter (de-)activation or pointing manoeuvres for passes, a time-consuming work.

The development of software tools has led to a significant reduction in workload and optimized operations. The open source project management application "Redmine" is used for organising satellite operations. It was further adapted using Python scripts and plug-ins to access the flight dynamics database and Mission Information Base, as well as other external sources. That eases operations and combines mission planning, flight dynamics and automatic generation of command stack files for the Mission Control System SCOS-2000.

This paper presents the preparation activities before launch, the LEOP and Commissioning execution of the satellite, and some lessons learned. It then focusses on how the transition from LEOP to nominal operations was accomplished, while gaining more experience in operating the satellite with a student team.