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NETSAT - FIRST IN-ORBIT RESULTS OF THE FOUR CUBESAT MISSION

Abstract

NetSat (Networked Satellite Distributed System Control) is a recently launched small satellite mission consisting of four 3-unit CubeSats. It has been launched on September 28, 2020 on a Soyuz rocket from Plesetsk Cosmodrome into a circular Low Earth Orbit (LEO) with an altitude of 560 km. The aim of the mission is to validate and demonstrate different technologies required for satellite formation flying with a special focus on small satellites and the use of Commercial Off-The-Shelf (COTS) components. The satellites have been launched successfully and the commissioning of most of the subsystems has been completed (as of now). This paper will summarize the in-orbit results of the mission. The current state is presented in this abstract, however further results may be included in the final paper.

One of the crucial technologies for satellite formation flying is the Attitude Determination and Control System (ADCS) because it enables precise thruster and payload pointing. In NetSat a distributed ADCS aiming at high accuracy (pointing below 1) within very limited volume using highly miniaturized reaction wheels (20x20x20 mm volume) and camera-based sun-sensing (sensor size ¡ 2x2x1 mm) was tested. In addition, a COTS single-board computer (Raspberry Pi Zero) has been implemented as payload computer to connect and control the on-board camera system as well as to compute complex formation control algorithms (e.g. Model Predictive Control (MPC)). To allow for reliable usage of such COTS components several Fault-Detection, Fault-Isolation and Recovery Techniques (FDIR) approaches like automated Linux file system repair routines have been implemented. Further, a camera system which acts as the basis for future CubeSat formation missions like the Telematics Earth Observation Mission (TOM) is part of NetSat and has been tested in-orbit. Besides, an operations software framework that spans over multiple operators, multiple ground stations and multiple satellites and that allows for automated operations of several satellites has been deployed and extensively tested. It also lays out the software-sided foundation for the Inter Satellite Link (ISL), which is based on UHF radio modules. The ISL has been tested and showed connectivity for several hundreds of kilometers in LEO. Further in-orbit tests with the electric propulsion systems are planned to demonstrate orbit and formation control.

Besides the technical results of the NetSat mission, lessons learned during the implementation of a multi-satellite CubeSat mission are presented, e.g. the benefits of using robotic automation during manufacturing.