Paper ID: 39229
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SPACE OPERATIONS SYMPOSIUM (B6)
Interactive Presentations (IP)

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UNIFORM, MULTI-LEVEL COMPASS PROTOCOL FOR THE NETSAT FORMATION FLYING MISSION

Abstract

The main aim of the NetSat formation flying mission is the in-orbit demonstration of an autonomously controlled formation of four pico-satellites. The outcome of the NetSat mission is a broad range of scientific contributions: relative navigation, distributed computing, orbit and formation control, miniaturized propulsion system and communication protocols.

Based on the experience from the UWE pico-satellite missions at the University of Würzburg, we are now working on the next step: NetSat autonomous formation flying mission. Already a single satellite mission involves numerous components on different hardware and software layers that need to communicate with each other, such as multiple operator's workstations, ground station server, ground stations from mission partners and radio amateurs as well as the satellite subsystems. In a satellite formation the additional inter-satellite communication must be taken in account. Usually, as in CCSDS-compliant missions, different protocols are used for particular communication types. With NetSat we introduce a new uniform Compass protocol, which is used on different model layers enabling straightforward communication between arbitrary hardware and software nodes. Compass contains multiple functions to effectively respond to typical challenges during the communication: DTN, real-time capability, dynamic and manual routing.

After the introduction of the NetSat mission objectives, the entire communication chain from the operator to a specific satellite subsystem will be presented. We will show the incurred challenges and address different protocols which are usually used on specific layers, including CCSDS protocols, CSP, AX.25 or TCP/IP. We then explain why we decided to develop Compass. Next, basic concepts of the protocol will be shown: hierarchical addressing, dynamic-header, forward-and-forget and service-based communication; currently implemented services will be briefly described. Thereafter, we show scenarios and use-cases which were rendered possible, e.g. the ability to exchange any hardware node (e.g. ADCS subsystem) with a software node (e.g. from MATLAB, OMNeT, Orekit) to enable software-in-the-loop (SIL) and vice-versa for hardware-in-the-loop (HIL) testing. During the development process, the interaction between the satellite and the testing hardware (e.g. satellite turn tables) can be realized without additional soft- or hardware - provided that there is a communication route. We introduce yet another use case where we show how Compass can be used together with CCSDS protocols. In particular, we show how we run CCSDS/MO Services on top of Compass, and the advantages it brings when compared with existing CCSDS standards. Finally we show the results of the ongoing in-orbit performance test on board of the UWE-3 satellite.