28th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

Author: Mr. Slavi Dombrovski
Zentrum für Telematik, Germany, veaceslavd@telematik-zentrum.de

Prof. Klaus Schilling
University Wuerzburg, Germany, schi@informatik.uni-wuerzburg.de
Mr. Julian Scharnagl
Zentrum für Telematik, Germany, julian.scharnagl@telematik-zentrum.de

EXPERIENCE WITH COMPASS-BASED IOT APPROACH USED IN NETSAT FORMATION MISSION

Abstract

NetSat is a satellite formation composed of four 3U-CubeSats. It was launched on 28.9.2020 to demonstrate in orbit IoT approaches for realizing the interconnection functionality and the accessibility of all distributed ground and space system components.

The Compass middleware, which offers inherent IoT capabilities, was used to create a dynamic decentralized virtual mission network, which was active during all mission stages: satellite development, in-house and external satellite tests, and in-orbit operations. The middleware is an implementation of the Compass network protocol and standardized Compass services, and is used as a software and protocol basis for all NetSat satellite subsystems and all ground systems, which are involved in the mission: ground stations, mission control, formation control simulators and high precision test equipment. The Compass network does not follow the classic server-client approach – instead, all systems are uniformly accessible as autonomous nodes and offer their entire functionality via standardized services. The design of Compass services was inspired by several existing protocols and standards, such as CCSDS PUS and MO services, CCSDS File Delivery Protocol, and MQTT.

We will show that this approach improved the realization process, the testability and controllability of space and ground systems in the NetSat mission. An overview of prominent standardized services will be given along with the associated improvement of particular systems: commanding, file exchange, unit-tests, dynamic code execution and model service. Thereafter, it will be explained how model service was used to uniformly represent the system's model: states, parameters, sensor and control values – and how it enabled model-based M2M communication between Compass network nodes, which became the major contingent of the entire mission traffic. We will show that the entirety of distributed system models forms a top-level digital twin of the entire mission and how the distributed model approach can be utilized for future research and developments, such as AI based anomaly detection and cooperation between satellites from different missions.

Related in-orbit tests and in-orbit evaluations of the performance of this Compass based IoT approach will be addressed.