SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Near-Earth and Interplanetary Communications (3)

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COMMUNICATIONS EXPERIMENTS USING THE RECONFIGURABLE PAYLOAD OF OPS-SAT

Abstract

OPS-SAT is an ESA nanosatellite mission led by the European Space Operations Centre ESOC. The goals are to demonstrate novel operations concepts as well as new satellite and ground software under real flight conditions. OPS-SAT will carry a re-configurable payload consisting of powerful processors and field-programmable arrays (FPGAs). Software can be uploaded to this processor core, tested and modified during flight. Results of the experiments can be made available in near real-time using the CCSDS-compatible telemetry. A Phase A/B1 design study led by TU Graz was recently completed. In addition to this processor core so-called payloads of opportunity are envisaged for OPS-SAT. An optical uplink and a radio signal monitoring experiment were proposed. The optical communications experiment allows an optical uplink for the first time on a CubeSat with a transmission rate of several kbps using a miniaturised optical receiver. A prototype of the receiver was tested on ground and it was demonstrated that transmissions with the specified data rate can be carried out. For the uplink the Satellite Laser Ranging (SLR) in Graz shall be used. Using this system secure encryption key distribution can be demonstrated on the uplink, since the narrow Laser beam is impossible to intercept. By passing this secure key to other experiments on-board of OPS-SAT the broadcast downlink data (S- or X- band) can be encrypted providing a very secure downlink. In each path over the SLR station another key can be uplinked. Using the one-time pad philosophy unbreakable encryption can be implemented. This was never done in satellite communications. An RF front-end consisting of a tuner, down-converter and A/D converter is foreseen as another payload which interfaces directly with the processing core. Complex signal samples are delivered to the processor core, where signal processing (e.g. demodulation and decoding) can be performed. This allows the monitoring and demodulation of radio signals over a wide frequency range. This payload provides a "spectrum analyser" in the sky allowing to detect and locate radio interference sources on ground, to analyse the type of signal and its properties which helps in the identification of an interferer. The paper describes the OPS-SAT concept and the re-configurable processor core. The optical receiver and the software defined radio front-end are introduced in detail. Both experiments and the expected results are discussed.