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Author: Mrs. Susann Pätschke
Institute of Space Systems, University of Stuttgart, Germany

Prof. Sabine Klinkner
IRS, University of Stuttgart, Germany

TOWARDS A HIGHLY ADAPTIVE SOFTWARE-DEFINED RADIO TRANSMITTER FOR SMALL SATELLITE PLATFORMS

Abstract

The Institute of Space Systems (IRS) of the University of Stuttgart is currently analysing a mission to explore the inner van Allen radiation belt using a small satellite of approximately 60 kg. The satellite shall be launched to an orbit of approximately 600 km and shall then use its orbital control system to reach an elliptical orbit of 350 km x 2500 km. In addition to scientific analysis, the mission shall demonstrate new components harsh radiation environment; these include a water-based orbital control system, a core avionic system and a ham radio X-Band data downlink system. The data downlink system for this mission is a new development at the IRS. Due to the elliptical orbit, the need for an adaptive data downlink transmitter platform arises, that is capable of adapting its transmission to the current transmission state. Moreover, this transmitter shall be fully compliant with the Consultative Committee for Space Data System (CCSDS) recommendations for RF, Modulation and Coding while implementing the adaptive coding and modulation of the Digital Video Broadcast – Second Generation DVB-S2 standard. Furthermore, this development focusses on low-power consumption, use of commercial-off-the-shelf components, re-configurability and miniaturisation. The transmitter platform is based on a System-on-Chip which implements the CCSDS as well as the DVB-S2 protocol stacks. The analogue components are chosen to provide possible scaling of the platform to commercial X-Band and Ka-Band. The transmitter is able to support data rates up to 200 Mbps and delivers up to 2 Watts RF. The use of the DVB-S2 standard allows increasing the downlink capacity by 66This adaptive platform is crucial for the mission success in order to transmit the high data budget, which could not be downlinked with a state-of-the-art transmitter platform. The increase in downlink capacity by adapting to the link conditions can also be useful for other missions, e.g. were ground terminals are located in regions with high rain loss or for satellite constellations where each satellite has limited ground station contact. The development of this transmitter platform that can be adapted in nearly-real time to the existing link conditions is presented in this paper.