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

Author: Mr. Tim Horst
University of Würzburg, Germany

Mr. Alexander Kleinschrodt
Zentrum für Telematik, Germany
Prof. Markus Gardill
University Wuerzburg, Germany
Prof. Klaus Schilling
University Wuerzburg, Germany

SOFTWARE-DEFINED GROUND STATION ARCHITECTURE OF A FOUR-SATELLITE 3D FORMATION FLYING MISSION

Abstract

Reliable ground stations are the backbone of every satellite mission, from amateur and academic satellites to commercial or large-scale earth observation and communications missions. With a long heritage of successful nano-satellite missions from UWE 1 to UWE 4, the ground station at the University of Wuerzburg has a long history of reliable operations and incremental improvements. However, new missions especially in the area of formation-flying satellites require more than gradual performance improvements. To meet the advanced requirements on operations of satellite formations, flexibility with respect to communication protocols, multi-satellite reception, and frequency agility are key criteria to be provided. Furthermore, improved reliability and diagnostic capabilities are necessary. All those features go beyond the capabilities of traditional amateur radio-based ground station architecture. In this paper we describe how Software Defined Radio (SDR) can be utilized to fulfill those requirements. We focus on operations of the formation-flying mission NetSat launched by the Center for Telematics (German: Zentrum fuer Telematik, ZfT) in mid-2020, which require novel approaches to meet the increased communication demand of simultaneously operating four satellites flying in 3D formation. We explain how the traditional ground station architecture operating in the UHF amateur frequency bands is migrated towards and SDR architecture. Specifically, we focus on the SDR transmission chain as this is not nearly as often described in the literature as the SDR receiving chain of satellite communication. The RF signal has to be amplified by a significant amount to close the link budget while also having the right timing to prevent damage to the RF frontend. Here we will present our method to accurately time the different events in the transmission chain while also having failsafes in mind. Through the SDR architecture we are able to change transmit and receive frequency of the radio instantly in Software and receive and transmit to and from multiple satellites at the same time while staying in the bandwidth of the SDR radio. The paper concludes with examples for some advanced diagnostics such as a real-time SNR analysis of the downlink data packets from the Netsat Satellites during overpass.