IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advanced Technologies for Space Communications (1)

Author: Mr. Andreas Freimann
University of Würzburg, Germany

Mr. Roland Haber
Zentrum für Telematik, Germany
Prof. Klaus Schilling
Zentrum für Telematik, Germany

RF COMMUNICATION SYSTEM CONCEPTS FOR SMALL SATELLITE FORMATION FLYING MISSIONS

Abstract

The trend in the satellite industry towards multi-satellite systems and CubeSats leads to an increased demand for innovative inter-satellite communication systems and space communication protocols. Inter-satellite communication is a crucial aspect with respect to the implementation of cooperative satellite systems. It enables data exchange between satellites for cooperative tasks as well as payload data forwarding for satellite-based communication services. The implementation of such a communication system is a challenging task for engineers. Depending on the actual mission the communication system must be adapted to fulfill multiple requirements, e.g. regarding energy consumption, data rate and latency. The implementation of inter-satellite communication also yields further requirements on the satellites, such as pointing accuracies in the case of directed antennas, and formation keeping abilities for drift compensation. The radiation pattern of an antenna system yields specific requirements for the Attitude Determination and Control System of the satellites. Slew maneuvers are required if directional antennas are used, imposing additional latencies into the system, which can be an issue for control loops used for formation keeping and may cause conflicts with pointing requirements of other subsystems such as optical sensors, star trackers, or solar panels. Since there are multiple communication devices for CubeSats available on the market the satellite developer has to select the most suitable combination of radio, antenna, and communication protocols. A variety of system concepts is possible, ranging from a single transceiver and an omnidirectional antenna up to complex systems with multiple transceivers and antennas. In this paper we present promising communication system concepts for future CubeSat formations. Simulations on implementations of selected concepts in an event-based satellite communication simulation software framework based on OMNeT++ will be presented and used for evaluation. Concepts will be analyzed with regard to parameters such as energy demand, throughput, latencies, and pointing requirements.