26th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

Author: Mr. Andreas Freimann
University of Würzburg, Germany, freimann@informatik.uni-wuerzburg.de

Mr. Alexander Kleinschrodt
University Würzburg, Germany, kleinschrodt@informatik.uni-wuerzburg.de
Mr. Florian Kempf
University of Würzburg, Germany, florian.kempf@uni-wuerzburg.de
Mr. Tim Horst
University of Würzburg, Germany, tim.j.horst@stud-mail.uni-wuerzburg.de
Mr. Roland Haber
Zentrum für Telematik, Germany, rolandh@telematik-zentrum.de
Prof. Klaus Schilling
University Wuerzburg, Germany, schi@informatik.uni-wuerzburg.de

ADAPTIVE CODING AND MODULATION SCHEME FOR SATELLITE UP- AND DOWNLINKS

Abstract

The need for high performance communication has long reached the small satellite sector. Advances in storage technology, on-board computers and sensor systems enable more data to be generated, that require fast and efficient downlink. However most small satellite missions today still rely on fixed modulation and coding schemes for satellite up- and downlinks, limiting the achievable data rate and the mission's robustness. Analysis of typical mission data (e.g. UWE-3) shows that the data rate could be increased by more than a factor of ten in situations with good link quality by using an adaptive coding and modulation scheme. Next generation space-based communication systems aim for a more flexible and efficient operation and adapt to changing environments, including orbital dynamics or atmospheric changes. In this paper we propose a novel radio resource allocation algorithm that takes advantage of reconfigurable transceiver systems to adjust communication parameters such as modulation parameters, code rate and transmit power during a satellite fly-by to use the communication as optimal as possible despite changing channel characteristics, caused by changing system states such as relative node distances and atmospheric effects. The dynamic behaviour of the channel together with the thousands of possible radio parameter combinations and their uncertain combined performance generates a multidimensional state-action space, that requires universal approximators like neuronal networks instead of traditional discrete mapping approaches. The recurring of similar situations and tasks, due to repeating orbital situations is as well suited for learning procedures. For parameter adjustment the system takes advantage of a backchannel that is used to inform the transmitting node in space about necessary adjustments to provide a stable communication channel despite the constantly dynamically environment. In this paper a detailed presentation of the adaptive approach is given along with first simulation results and evaluations of the link characteristics. Simulations are based on mission data from the UWE-3 and UWE-4 missions in order to achieve realistic results.