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SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Small Satellite Operations (3)

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MEASURING AND MODELING LINK QUALITY IN GROUND STATION NETWORKS FOR SMALL SATELLITE OPERATIONS

Abstract

The development of nano- and picosatellites for educational and scientific purposes becomes increasingly popular. As these satellites are very small, high-integrated devices with a very low power budget, data transmission between ground and satellite is vulnerable to several ascendancies. Another handicap is the lower earth orbit wherein the satellites are usually located because it keeps the communication time frame very short.

The concept of global ground station networks like GENSO (the Global Educational Network for Satellite Operations) counters these disadvantages. To optimize the communication between ground station and satellite, metrics and methods have to be identified to gain information about the communication link quality during a satellite pass. Such a global effort is hindered by utilization of very different hardware, protocols, frequencies and modulations.

We show a generic and widely applicable approach to passively measure and compare link quality that can be applied in a heterogeneous ground station and satellite configuration. Besides such a-posteriori measures of the link quality, we also develop methods to give an a-priori estimate of the expected link quality of a future pass. In combination with proper scheduling methods for ground station networks, such an a-priori link quality information has high impact on the efficient usage of ground station and satellite resources and could help to increase mission data return.

In a case study, we analyze signal strength measurements of over 550 passes of AAUSAT-II, a CubeSat which transmits in the ultra high frequency band. For this purpose, we extract a link quality measure based on the signal-to-noise ratio from the digital S-meter readings of the receiving ground station radio. We then investigate influences on the link quality among pass-related data as well as surface and space weather data from publicly available Internet resources. Furthermore, we formulate the prediction of the quality of a future pass as a machine learning task and create models to solve it. We show that the surface and space weather information can enhance the precision of such prediction models.

Experimental results are as follows: The precision of a conventional prediction model that only takes into account the distance between the satellite and the ground station is 3.22 dB. With additional surface and space weather information, we reach 2.80 dB using support vector machines, a popular machine learning paradigm. After binning the measured quality values in the two coarse classes 'low' and 'high', we reach a classification accuracy of 86.25