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APPLYING THE SYSTEM ENGINEERING APPROACH TO DEVISE AND VERIFY BUAA-SAT VHF/UHF COMMUNICATIONS SEGMENT

Abstract

BUAA-SAT is a student micro-satellite project of Beihang University (BUAA) designing to utilize VHF/UHF radio amateur band as one of its telecommunication way in low earth orbit in late of 2014. The purpose of this paper is to illustrate design, analysis and verification of BUAA-SAT VHF/UHF telecommunications segment (UV segment) in a systematic approach. Aiming to transfer data, picture and voice; UV segment contains two transceivers along with RF front-end and antennas onboard of BUAASAT, one ground station (G.S.) capable of connecting to G.S. networks.

First of all, the paper presents the segment's objectives, ConOps and requirements containing interfaces and V-model as design process in the design part. Then, the trades off associated with selection of solutions extracted from database are enlightened. For instance, combined AFSK and BPSK modulation scheme and AX.25 protocol are selected for compliance with radio amateurs and RF spectrum efficiency. The solutions are employed for onboard unit development and ground station improvement.

In the analysis part, fit, form and function of the solutions are analyzed in the following steps to enhance performance and compatibility of the segment in system-level. The First step is the modeling of the segment and its operation environment. Proofing the feasibility of the selected operation scenario, the second step deals with data budget analysis by checking operational criteria e.g. onboard power consumption, access time and downlink capacity. The third step is link budget analysis considering 3D slant range in the path loss, the coupled behavior of satellite attitude and the antennas' pattern in the pointing loss and the human made noise. The last step is dynamic combined data-link analysis to perform sensitivity analysis and to increase communication link throughput through implementing adaptive data rate and the G.S. networks such as GENSO.

In the verification part, the verification procedure and devises are discussed to evaluate the requirements fulfillment and to assess the analysis results and the affiliated uncertainties. In addition, the validation of the modified G.S. is mentioned following with the results of the tests particularly integrated segment tests. The integrated tests include In-lab signal to noise demonstration and Outdoor tethered balloon test to check system performance parameters such as SNR, BER and antennas' radiation patterns.

The paper finally concludes the finalized segment configuration, lessons learned and next steps. These architecture, experiences and roadmap could benefit the future communications system development of university satellite projects specially in emerging space nations.