IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Systems and Services, Part 1 (1)

Author: Mr. Shayan Majumder
Birla Institute of Technology and Science(BITS), India, f20190259@pilani.bits-pilani.ac.in

Mr. Hrishit Tambi
Birla Institute of Technology and Science(BITS), India, f20190807@pilani.bits-pilani.ac.in
Mr. Karan Mathur
Birla Institute of Technology and Science(BITS), India, f20180340@pilani.bits-pilani.ac.in
Mr. Pranay Putrevu
Birla Institute of Technology and Science(BITS), India, pranay.putrevu@gmail.com
Mr. Hariharan Venkat
Birla Institute of Technology and Science(BITS), India, f20190244@pilani.bits-pilani.ac.in

DESIGN AND DEVELOPMENT OF A HIGH-SPEED COMMUNICATION SYSTEM FOR A LEO NANO SATELLITE

Abstract

With an increasing number of CubeSats aiming for higher data rates, S-Band is an emerging standard. However, this goal faces strict design constraints as CubeSats offer a limited power budget and processing capabilities. This paper discusses the design, simulation, and system architecture for the Telemetry and Telecommand (TTC) subsystem of a 3U Nano Satellite equipped with a multispectral imager as its payload. The system implements a Full-Duplex S-Band/UHF architecture, additionally, a backup downlink system is also designed where in the event of a poor link or S-band failure, the system will switch to downlinking in UHF. The paper will present the onboard architecture for the S-band downlink and the UHF uplink/backup downlink system, where various Commercial off-the-shelf (COTS) components are selected according to power constraints and link budget requirements. The communications subsystem is also responsible to carry out packet structuring and Forward Error Correction (FEC) algorithms onboard. This involves implementing CCSDS (TM and TC) frames for the data link layer along with half-rate convolutional code with constraint length 7 concatenated with Reed Solomon (255,223) with an Interleaving Depth of 5. Though adding FEC increases data redundancy but provides essential coding gain which helps increase data reliability. Furthermore, a patch antenna for 2.4GHz is designed, simulations are performed on Ansys High-Frequency Structural Simulator (HFSS), and parametric simulations for desirable network matching, radiation pattern, directivity, and optimal placement are discussed. This paper also discusses the selection procedure of optimal code rate and modulation scheme depending upon the system requirements. Lastly, it will present the dynamic link budget calculation and simulations. The paper concludes by discussing the various challenges and limitations faced while implementing high data rates in amateur missions.