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TESTING AND IMPLEMENTATION OF A RECONFIGURABLE DATA-RATE COMMUNICATION SUBSYSTEM IN SMALL SATELLITE USING SDR

Abstract

One of the main challenges of small satellites in low Earth orbits (LEO) is the utilization of the limited communication window with limited bandwidth and power consumption communication systems. Small satellites typically use AX.25 protocol over UHF link. In Radio Packet Communication each frame contains the information intended to be sent with extra headers and footers to ensure the reliability of the communication. The bandwidth, the modulation scheme and the link budget are the most important factors to determine the usable data rate for the transmission. In the paper we investigate AFSK and GMSK modulation and their abilities to carry Ax.25 packets and their data rates. Amateur radio communication typical data rates are 1200bps and 9600bps. The advancing technologies in satellites need to deliver more information. For this purpose this paper presents the reconfigurable data rate approach to get the maximum use of the available communication link within the available technology by altering the data rate corresponding to the channel. The easy way to step up in this direction is by using Software-Defined radios (SDRs). SDR gives an important feature which is the ability to change the signal characteristics only by software. Reconfigurability advantages come from the fact that near to Acquisition of Signal (AOS) and Loss of Signal (LOS), the link budget margin is so small. This margin increases when the line of sight elevation goes near to 90 degrees. Thus, the link budget is not fixed during the communication window. To get maximum benefit, this paper studies how to increase the data rate within the part where the link budget is more reliable. The paper is doing the design in simulation software "gnu radio companion" and implements it using raspberry pi and an SDR as the space board, and a PC and SDR as the ground station. Transmitters and receivers are built, the channel link budget is simulated to mimic typical CubeSats condition, the satellite position impact on the channel is simulated by adding more attenuation to the link. The ground station is the controller of the link, it determines when the satellite should try higher data rate and whether it should continue or return back to lower data rate based on the Bit Error Rate (BER). For testing, different scenarios are considered to simulate the real case paths of satellites over ground stations.