Communication Link for a Cubesat

An SDR approach

This report is compiled in LaTeX, originally developed by Leslie Lamport, based on Donald Knuth's TeX. The main text is written in *Computer Modern* pt 11, designed by Donald Knuth. Flowcharts and diagrams are made using Microsoft Visio, Inkscape and Tikz, a TeXpackage for generating graphics.

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AALBORG UNIVERSITY
STUDENT REPORT

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Abstract:

In this project, a communication link between a cubesat and a ground station is designed. This includes an investigation of available frequencies as well as performance characteristics of different antenna- and modulation types. From the investigation, it is chosen to use a 10.5 GHz link with a patch antenna and to use both OQPSK as well as 8-PSK modulation. A link budget is constructed, showing an SNR of 2.8 dB at the receiver, yielding a feasible bitrate of 1.3 Mbps in LEO (1000 km) and 900 bps in lunar orbit (384000 km). This link is simulated in MATLAB showing a plausible bit-error rate (BER) of $0.0251 \pm 0.5 \cdot 10^{-4}$ for the lunar link, and $0.0235 \pm 0.5 \cdot 10^{-4}$ for the LEO link, without forward error coding (FEC). Based on this, an Software Defined Radio (SDR) prototype is implemented on two USRP's using LabVIEW. The prototype has various reconfigurable parameters including modulation type, bitrate and carrier frequency. Synchronization issues are seen at low SNRs, and the BER is up to 18.5 times bigger than what the simulation shows. The end result is a reconfigurable SDR that can transmit and decode data using OQPSK and 8-PSK with a bitrate of up to 500 kbps, with a BER of 0.0239 (without FEC) at an SNR of 5 to 6 dB.

Contents

Preface

This bachelor project in Communication Systems has been carried out during the spring of 2016, by a group of three students from Electronics and IT at Aalborg University.

The project regards the development of a communication link between a satellite in space and a ground station, as well as the development of a prototype implementation of a software defined radio to be used in the link.

A general knowledge of electronic engineering and more specifically communication systems is needed to read the report.

References to sources are of the APA-style, i.e. of the type [*source name/author's surname, year, optional page number*]. Sources are listed in a bibliography at the end of the report, and PDFs, datasheets etc. can be found in the attached ZIP-file. Figures without a source are made by the project group.

This report is organized in three parts. The first part is a technical analysis that goes in depth with antennas, a link budget of the communication link between a satellite and a ground station at AAU, different suitable modulation types and, finally, a requirements for a prototype of the radio to be used in the communication link is established.
In part two, the theory, simulation and implementation of the prototype is described.
Part three contains the test of the prototype related to the requirements set up for it in part 1.

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Appendix