

TFE4850 - EiT - Student satellite

Bluebox

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Abstract

This project aimed to create and test a BlueBox, an USB-driven ground station, developed for AAUSAT3 by Aalborg University to send and receive signals from satellites. The NUTS project have a problem with low transfer rate between the single ground station at the university and the satellite, and by setting up a network of BlueBoxes at different ground stations around the globe, we can increase the time which the satellite is available for data transferring.

Since setting up the network proved too time consuming, we set as our goal to make a BlueBox, and test that it can receive signals from a satellite, and in this way make it easier for others to set up the network, in that they already have documentation on how to set up and configure each individual ground station.

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Chapter 1

Introduction

This chapter will contain a short introduction to our project. That means what we're doing and what people are working on the project. It will also be discussed some short background on why we're doing this project.

1.1 The Project group

The project group consisted of 6 people from 5 different directions, so we had a wide variety of competence to use in the project. The group members can be seen in ??.

Name	Background
Marius Ekerholt	Computer technology
Eirik Skjeggstad Dale	Computer technology
Hanne Thorshaug Andresen	Energy and Environmental technology
Leif-Einar H. Pettersen	Electronics and Telecommunications
Børge Irgens	Theoretical Physics
Hallstein Skjølsvik	Electronics and digital design

Table 1.1: Group members

Chapter 2

Theory

Before we started our project, we did quite a lot of pre-study, covering which technology was available, to determine which fit our project best. This chapter will contain a summary of the different technologies, and also some theory behind the reasoning for having multiple ground stations listen to our satellite.

2.1 Network technology for ground stations

When we decided to work on a network of ground stations, we first looked into four different ground station network technologies. We first hoped to work on a BlueBox, but this would require support from Aalborg that we couldn't get, as they were busy with a satellite launch of their own. Because of this, we decided to look into Carpcomm, that seemed more complete and doable than connecting to PYXIS with a BlueBox.

2.1.1 Pico

information about Pico

2.1.2 Genso

information about Genso

2.1.3 Carpcomm Space Network

Carpcomm is a private company that delivers a plug and play ground station [3] that costs \$700. The software for the ground station is open source and is provided pre-compiled for x86 and arm debian. It is compatible with the Carpcomm Space Network [4]. The advantage of using this solution is that the network is actually functioning, though there are few other operational ground stations.

2.1.4 PYXIS

The BlueBox is part of a distributed ground station network called PYXIS, developed primarily for the AAUSAT3 by Aalborg University (2013 [2]). The PYXIS goal is to offer a robust and effective ground station network for satellite developers, and one of the key factors is that everyone is free to setup a ground station using the open source BlueBox hardware.

The PYXIS concept includes a backend server, BlueBox hardware and a Ground Station Server (GSS). The backend server runs an individual instance for each satellite utilizing the BlueBox, and is operated by the persons responsible for the ground station.

The BlueBox itself is hardware to receive and transmit signals from the satellites.

Control of the BlueBox and ground station mechanics is handled by the GSS, and both the BlueBox and the GSS is operated by the responsible for the Ground station.

Both the backend server and the GSS is already in place at each ground station, and to join the PYXIS network we would only have to make a BlueBox, and test that it works.

2.2 Raspberry pi

Raspberry Pi is a small computer, with everything gathered in one board. In our project we will be using the B model, revision 2, which have a 700MHz ARM CPU, 512MB of RAM and a SD-card reader, in addition to the leads to connect to different devices, for the full overview, see figure 2.1. The recommended operating system is Raspbian, a linux distribution based on Debian.

The Raspberry pi was originally intended to help teach programming, but it can also perform many of the standard computer tasks, and it can be connected to a monitor or tv using an HDMI lead. In our project we hope to be able to use a Raspberry pi to run the software required to control the ground stations. The software provided by the carpcomm project has Raspbian as one of its supported platforms, so we hope this will work well.

2.3 SunPower

When a satellite communicates to its groundstation and operates its payload it is dependent on power supply. Without any electrical power a satellite will have no function other than to drift around in orbit unable to communicate. NUTS double CubeSat uses sunlight as an energy source through solar panels.

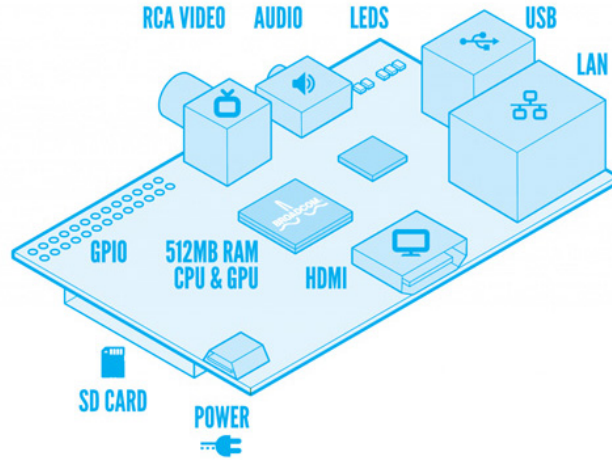


Figure 2.1: A highlevel schemantic of the Raspberry pi, model B rev 2

Solar panels base their operation on the ability to convert sunlight into electricity by exploiting the photovoltaic effect by using semiconductors. The conversion process where the sun's radiation is converted into an electrical current is achieved by creating mobile charged particles in the semiconductor. They are in turn separated by the device structure and produce the electrical current. (kilde) The use of photovoltaic solar generators is the best choice for providing electrical power to satellites in an orbit around the Earth (kilde: Solar Electricity, page 180, kilden skal skrives ordenligt!).

To get information on how long communication time the CubeSat can achieve through a ground station network the energy supply must be calculated.

Solar power calculations:

Solar constant: $S = 1367 \frac{W}{m^2}$

Area of the Earth presented to the Sun: A_S

Area of the Earth: A_E

Total energy flux on the Earth: $S_E \times A_E = S \times A_S$

$$S_E = \frac{S \times \pi \times R^2}{4 \times \pi \times R^2}$$

$$S_E = \frac{S}{4} = 342 \frac{W}{m^2}$$

Orbital period of the satellite: $T = 5700 \text{ sek}$ (from Atg simulation program)

Efficiency of the solar cells: $\eta = 0.16$

Average area exposed to the sun: $A_{Sat} = 0.016213185 m^2$

Input energy to the satellite from the sun: $E[J]$

Power from the sun to the satellite: $P[W]$

$$\mathbf{E} = \mathbf{A}_{sat} \times \mathbf{S} \times \mathbf{T} \times \boldsymbol{\eta}$$

$$E = 20213.04J$$

$$\mathbf{P} = \mathbf{A}_{sat} \times \mathbf{S} \times \boldsymbol{\eta}$$

$$P = 3.55W$$

Bibliography

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- [4] *Carpcomm Space Network*. Available at: <<http://carpcomm.com/howitworks.html>>
- [5] *Raspberry pi*. Available at: <<http://www.raspberrypi.org/>>