# READ FIRST !
# Project Overview

This document is included to give an overview of what have been made in the project period from February 2$^{nd}$ 2005 to May 30$^{th}$ 2005, by group 05GR834. All work during this period has been concerning space technology for which reason the group participated in the STEC 2005 conference at Aalborg University, 6$^{th}$ - 8$^{th}$ of April 2005. A great deal of the work has also been to participate in the coordination of the AAUSAT-II project.

The documentation of this project consists of two separate documents:

- **A report concerning the development of the AAUSAT-II attitude control system.**
- **Documentation of the development of the AAUSAT-II communication system.**

## AAUSAT-II Overview

The AAUSAT-II satellite is a pico satellite which is designed primarily by students from Aalborg University and from IHK in Copenhagen. The project was initiated in September 2003 and the satellite is expected to be launched in December 2005. The AAUSAT-II follows the CubeSat concept developed by California Polytechnic State University, and the Space Systems Development Laboratory at Stanford University [1]. This concept allows the satellite to have a mass of maximum 1 [kg] and the dimensions of 10 [cm] × 10 [cm] × 10 [cm], hence the designation CubeSat. The size constrains the amount of power and space available which entails that low power consumption, small volume and low mass are important factors in the design process.

Several subsystems have been designed and built for the AAUSAT-II. Each of these subsystems have an important role in making the satellite function as a complete system. Generally all subsystems on-board the AAUSAT-II satellite have been designed as parts of a distributed network system, connected internally via a Controller Area Network (CAN).

The subsystems in the AAUSAT-II project are depicted in Figure 1 and described below. The description is excerpted from the ACS report.

**MCC** (Mission Control Center) is responsible for handling and storing all transmission data from the satellite and sending flight plans etc. to the satellite. The MCC provides a user interface

[1] http://cubesat.calpoly.edu/_new/index.html

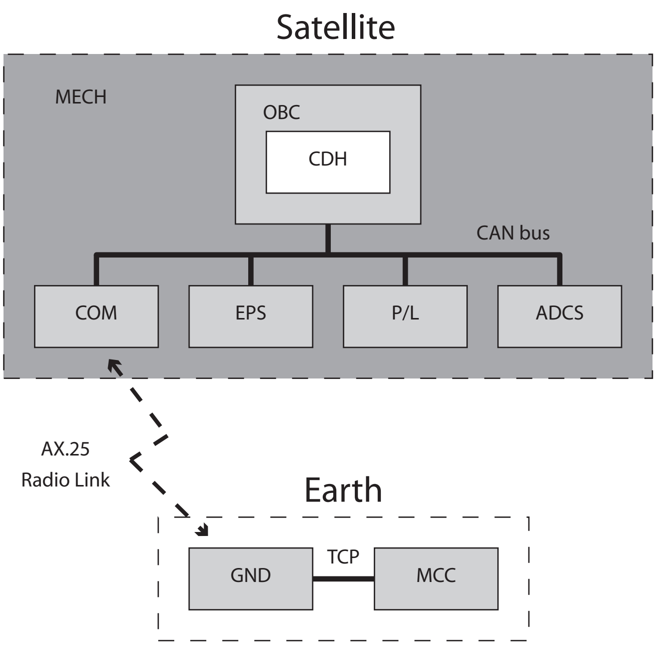


**Figure 1:** The subsystems in the AAUSAT-II project.

and a database to store housekeeping data from the satellite. The mission control center is furthermore able to control multiple ground stations, both the ground station located in Aalborg and a ground station placed at Svalbard in Norway which is currently in the final stages of developement.

**GND** (Ground Station) is responsible for the communication between the MCC and the satellite. The task of the ground station is to track the satellite throughout each pass and adjust the radio frequency, so data between the satellite and the MCC can be sent and received correctly. Furthermore, the ground station is designed to be autonomously controlled by the MCC, both for communicating with the AAUSAT-II satellite and the ESA SSETI Express satellite[2].

**COM** (Communication System) is designed to function as a pipeline for the communication between the ground station and the Command and Data Handling system (CDH). COM modulates and sends data from CDH to the ground station. Data received from the ground station is demodulated and sent via the CAN bus to the CDH subsystem.

**EPS** (Electrical Power Supply) is responsible for generating power from the solar cells and storing it in the batteries in order to be able to deliver continuous power during eclipse and peak demands. The EPS subsystem also conditions and distributes the power to other satellite subsystems.

**ADCS** (Attitude Determination and Control System) is responsible for determining and controlling the attitude of the satellite. This primarily implies detumbling and stabilization of the satellite.

**P/L** (Payload) consists of a gamma ray burst detector. The gamma ray burst detector is a newly developed detector crystal supplied by Danish National Space Center.

[2] `http://sseti.gte.tuwien.ac.at/WSW4/express1.htm`

**OBC** (On-Board Computer) is the main computer on the satellite. The CDH subsystem software is executed on the OBC. The OBC subsystem also provides processing facilities for other satellite subsystems.

**CDH** (Command and Data Handling) is implemented as software running on the OBC. The CDH subsystem is responsible for maintaining the flight plan, accumulating housekeeping data, managing the subsystems and controlling the communication with the ground station.

**MECH** (Mechanical Structure) provides the physical satellite frame structure and casing in which the other satellite subsystems are mounted. Besides the satellite frame, also an additional solar cell array is designed to be mounted on the satellite frame.

The satellite is an intelligent autonomous system which interacts on tele commands sent from the MCC using the ground station. The communication path is illustrated in Figure 2. A tele command is transmitted through the ground station and received by the COM system. The communication system then passes the tele command on to the CDH system which decodes and executes the command. It is not possible to send a command directly through the communication system to a specific subsystem. All tele commands is directed through the CDH system.

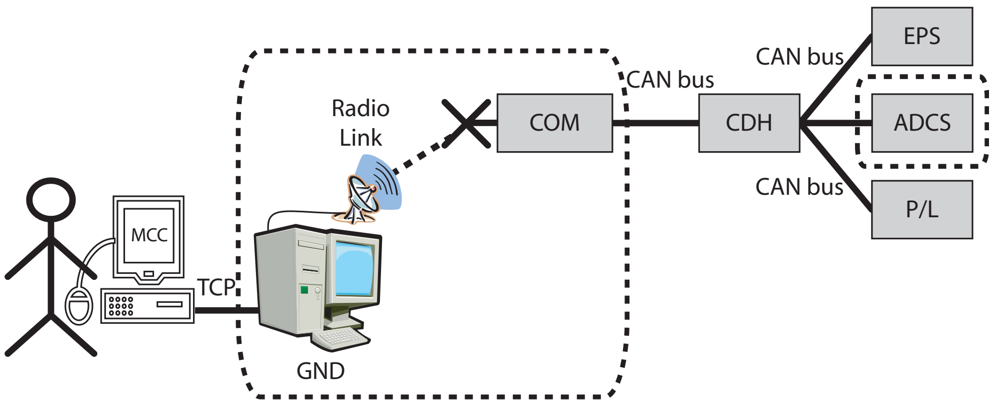


**Figure 2:** The communication path for the AAUSAT-II.

Blocks encircled with a dashed line are made by our group. The GND system was our main project on the last semester and work on the COM system started during last semester. On this semester we have worked on ACS, COM and GND.

The COM system is an important part of the distributed system, since all communication between a ground station and the satellite goes through the COM system. No students volunteered to design this system, and therefore, in order to complete the satellite for launch, our group has taken the responsibility of developing this system aside from the ACS project.

## Projects During the Semester

During the project period the primary project has concerned the design and implementation of an attitude control system for the AAUSAT-II. Parts of the project have been done in co-operation with group 05GR833, who has designed an attitude determination system for the AAUSAT-II. The co-operation between the groups has been made to ensure the attitude determination system and the attitude control system are designed with shared goals.

Together these systems will constitute the software for the attitude determination and control system to be used on AAUSAT-II. The hardware used has been designed and built by a group of previous $8^{th}$ semester students, group 04GR830a, who has continued with the final implementation of the hardware.

The AAUSAT-II ground station, located at Aalborg University, has been developed by us as well during the $7^{th}$ semester project. During this semester we have continued the work on expanding the ground station in order to enable S-band communication with the SSETI Express student satellite, designed and built by students all over Europe and coordinated by ESA. The ground station is designed in such a way that it can be controlled from the mission control center which includes the possibility of controlling multiple ground stations. Thus a ground station is being set up at Svalbard[3] in Norway, using a modified version of the ground station software. This software has been developed for the ground station at Aalborg University by us on the previous semester. During this semester it has been ported from Linux to Windows, and the drivers for the modem and the radio have been replaced since the Svalbard ground station makes use of another radio than the ground station at Aalborg University. Finally the software has been installed at the Svalbard ground station. In addition the communication system for the AAUSAT-II has been designed and is ready for implementation. The documentation for the communication system is included aside from the documentation of the attitude control system.

[3] http://www.space-technology.com/projects/svalbard/