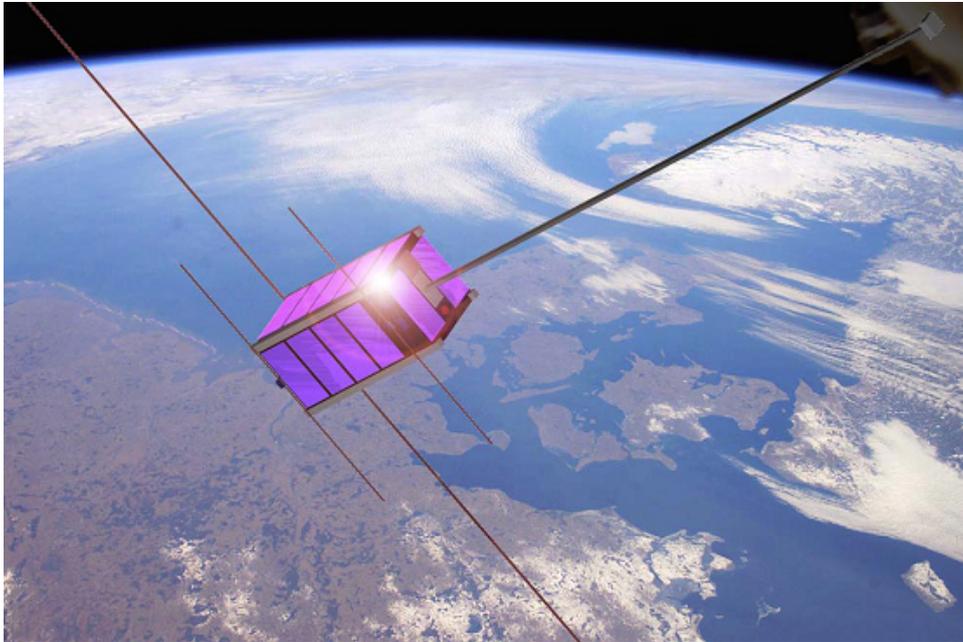


NUTS-1 Mission Statement

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1 Background

The NUTS (NTNU Test Satellite) project was started in September 2010. The project is part of the Norwegian student satellite program run by NAROM (Norwegian Centre for Space-related Education) [1]. The projects goal is to design, manufacture and launch a double CubeSat by 2014. The national student satellite program involves three educational establishments, namely the University of Oslo (UiO), Narvik University College (HiN) and NTNU.

1.1 Mission Statement

The NUTS project aims to design, develop, test, launch and operate a double CubeSat by 2014. Students from different curiums will do the largest part of the work, supported by project management and technical staff. The work will be performed as part of the students project- and master theses. We have chosen our design to be generic and modular, so the satellite-bus can support different pay loads. As payload for the first satellite, an IR-camera will be implemented, in addition to a wireless internal databus.

Recruitment and education of skillful students will be a main part of the projects goals. Through hands-on experience, the students will be able to master different skills needed in their jobs after graduation.

1.2 Mission Goals

- Deliver a tested satellite according to mission specifications
- Transmit a beacon signal receivable for radio amateurs
- Confirm successful de-tumbling
- Establish two-way communication and receive full telemetry
- Test IR camera
- Test RF intra-satellite bus
- Initiate camera pointing
- Initiate IR camera sequence
- Receive a valid series of images

The list above shows the tentative mission goals as of June 2010. As the project evolves, the mission goals may be changed and adapted. One other main goal, not mentioned above, is to educate students. This goal will be met even if none of the goals above are fulfilled.

2 About NUTS

Our satellite will be a double CubeSat, complying to the CubeSat Specification [3]. However, our satellites electronics will not be build around the "standard" PC-104 form factor. Instead, have chosen to use a design with a backplane. See Figure 1. This concept was first planned in 2006 [2]. Through this backplane, the different sub systems will access the main I²C communications bus as well as the power buses.



Figure 1: A 3D-model of NUTS-1

Use of other materials for the satellite structure will also be investigated.

2.1 Bus Concept

Our bus concept differs from many CubeSats since we do not use the PC-104 form factor for our electronics cards. There are several reasons for this: We want to try something new, we want to enhance the power and data buses and we feel that the backplane strategy provides us with an easier setup in the development and testing phase. The main draw back is that this leaves us quite "alone" since we now have heavily reduced our possibility to buy COTS modules for our satellite.

Our goal is that our bus concept can be used for a broad variety of payloads. For the first satellite, we have chosen to look into the use of a IR camera to observe the Earths atmosphere as well as an internal RF communication link. The on-board OBC is a powerful 32-bit AVR32 UC3

micro controller with a lot of computing capacity to support payloads in other missions as well.

To enhance the reliability of the satellite, we have decided to have to backplane masters in the satellite. This means that both the OBC and the communication system are able to remove other subsystems from the backplane power- and data buses. The communication system can be controlled directly from ground, but these capabilities should not be used unless the OBC has failed.

2.2 Payload

As main payload, the NUTS project will fly an IR-camera for atmospheric observations. In addition, a concept for a wireless short range data bus connecting different subsystems will be added. For communication, the satellite will use the common amateur radio bands and fly one transceiver for each frequency.

2.3 Ground station

In conjunction with our lab, we have set up a ground station for use with our satellite. Figure 2 shows pictures of our equipment.

Ground station equipment:

- 5 meter antenna mast
- Tonna 2x9 crossed Yagi-Uda for VHF
- Tonna 2x19 crossed Yagi-Uda for UHF
- Yaesu 5500 antennae rotor
- ICom IC-9100 radio
- ICom PCR-1500 radio for weather data download



Figure 2: Our ground station antenna mast to the left and our ground station radio and PC at the right

3 Education

The project is highly multidisciplinary. We need project members, both students and staff, from various departments. As examples, IET (Department of Electronics and Telecommunication), ITK (Department of Engineering Cybernetics), IPM (Department of Engineering Design and Materials), PHYS (Department of Physics), IDI (Department of Computer and Information Science) and ITEM (Department of Telematics) can be listed. The project is run and managed by IET, but students for the different departments must be supported and have a guidance teacher at their home department.

The satellite lab and ground station room serves as a common place for project members to study and work together. The use of this lab is vital for the project. However, each student should have access to a private and quiet work space also.

During the first half of 2011, ten students from different departments and curriculums were involved in the project.

Since we are developing our own bus concept, we cannot buy COTS subsystems, we are on our own in this matter. However, we believe that NTNU as a broad education provider should have enough resources and specialist environments to cover the whole spectrum of knowledge and skills needed.

3.1 PR and Outreach

The project will use Internet for public outreach, as well as other printed media. Our web page is <http://nuts.iet.ntnu.no>. In addition, we are on Twitter (@NUTS_Sat) and on Facebook. These pages and profiles will be frequently updated as the project moves forward.

3.2 Conferences

NUTS will be presented at SmallSat 2011, as a part of the University Exhibits. Two students will present their theses work at IAC in October this year also.

References

- [1] NAROM. Narom home page, 2011. URL <http://www.narom.no>. Online.
- [2] Erik Narverud Roger Birkeland, Elisabeth Karin Blom. Design of a small student satellite. Project work, NTNU, 2006.
- [3] Cal Poly SLO The CubeSat Program. Cube-sat design specification rev. 12, 2011. URL http://www.cubesat.org/images/developers/cds_rev12.pdf. Online.