NCUBE: The first Norwegian Student Satellite
Participants

Initiative
Power Supply, Ground Segment:
- 6 students
  Narvik University College
Project funding

Norsk Romsenter
Norwegian Space Centre

Project management
Support & Test

Andøya Rocket Range
- the cost effective entrance to space

NAROM

Norwegian University of Science and Technology
Payload, Communications System
ADCS, OBDH:
- 8 students

University of Oslo
Mechanical structure, Solar Cells:
- 1 student

Payload application
Orbit calculations:
- 6 students

Norwegian Agricultural University

Narvik University College
Power Supply, Ground Segment:
- 6 students

22.05.2009
Demonstrate ship traffic monitoring (Automatic Identification System) using a LEO satellite

Demonstrate reindeer herd monitoring from a LEO satellite using the AIS system
Objectives

1. Receive radio signals and telemetry from the satellite

2. Receive AIS-messages from a ship or a reindeer and forward it to the ground station.

3. Perform attitude control of the satellite

4. Allow radio amateurs to use the satellite as a digital repeater for digital packet communications (Digipeater operation)
**Payload**

- AIS: Automatic Identification System
- Maritime information system for data exchange between ships
- Mandatory from 1 July 2002 for ships larger than 300 grt
- The ship broadcasts identity position, course, velocity at regular intervals

**Technical specifications:**
- 162 MHz maritime VHF band
- 9600 bps GMSK
- Messages transmitted in 27 milliseconds frames
• **AIS: Automatic Identification System**
System Overview

- AIS antenna
- VHF antenna
- UHF antenna
- S-band antenna

- AIS RX
- Uplink RX
- UHF TX
- S-band TX

- Terminal Node Controller (TNC)
- Beacon Generator
- Telecommand Decoder
- Data Selector

- Power Management Unit
- Power Switch Unit

- Solar cells
- Charger
- Battery

- 3-axis Magnetometer
- Magnetic torque actuators

- Telecommand bus (I²C)
- Data bus (I²C)

- 1²C to parallel

- Voltage monitors
- Current monitors
- Battery temperature
- Solar panel temperatures

- ADMS power
- AIS RX power
- UHF TX power
- S-band TX power

- Solar panel current monitors
Actuators:

**Passive:** Gravity gradient boom

**Active:** Magnetic torque coils

Regulation methods:

- Detumbling
- Stabilize Roll/Pitch within ±10°
Amateur radio equipment:

Uplink: 145.980 MHz
Downlink: 437.305 MHz
Downlink: 2407.250 MHz

AX.25 protocol: 9600 bps GMSK

Satellite transmitter power: ~0.8 Watt

Antennas: Monopoles (VHF/UHF)
Patch (S-band)
Transmitters:

- **UHF**: 435MHz amateur band
  - Homemade
  - Output power: ~800mW

- **S-band**: 2.4GHz amateur band
  - Modified telemetry transceiver from ARS
Receivers:

-AIS - 162MHz maritime VHF band

-VHF, 144MHz amateur band
  -Common design eases implementation
  -Double superheterodynes, 10.7MHz and 455kHz IF

-SA606, PLL and TXCO:
  -Excellent dynamic range
  -Ditto frequency stability
  -Cheap, standard filters.
Why AX.25?

- Large knowledge base worldwide.
- Cheap hardware (Ebay: TNC2, $7).
- Thousands of ground stations worldwide.
- Valuable asset to the amateur radio community.
How?

- Hardware built from scratch.
- Atmel microcontrollers used throughout the design.
- Useful advice and feedback from the amateur community.
AX.25 in a nutshell:

- Data link layer protocol, packet based.
- Flow control, error detection, automatic retransmission of corrupted frames.
- Suitable both for half and full duplex communications.
Ground Station

- LINUX based software
- Internet access via FGN (Federated Ground Station Network)

[J. Cutler, Stanford University]
Ground Stations

Svalbard (SvalSat)

Narvik University College

Trondheim, Akademisk Radioklubb (LA1K)
4 meter radome with antennas and rotator available

Owned and operated by Kongsberg Satellite Services AS, Norway
Supporting Partners

Kongsberg Defence and Aerospace

Kongsberg Seatex

Norwegian Defence Research Establishment

www.thor-satellites.no
Summary

- Project period 2001 - 2005
- Initial phase: 26 students from 4 universities
- Implementation: 16 students from 4 universities
- CubeSat ideally suited for university education
- Support and administration is important
- NCUBE-2 is in preliminary development phase