GROUND SEGMENT

MCC (Aalborg, Denmark)
The Mission Control Computer (MCC) is the interface between the human Operations team and the two ground stations. It is capable of controlling the uplink of detailed flight plans to the spacecraft and has a database in which all downlinked telemetry is stored. The MCC can be remote controlled.

OPER (Warsaw, Poland)
The Operations (OPER) team is responsible for defining the flight plans and commanding the spacecraft via the MCC and ground stations. All contingencies have been considered and responses defined in advance, so that analysis of real-time telemetry always leads to a clear and concise course of action to further the mission objectives.

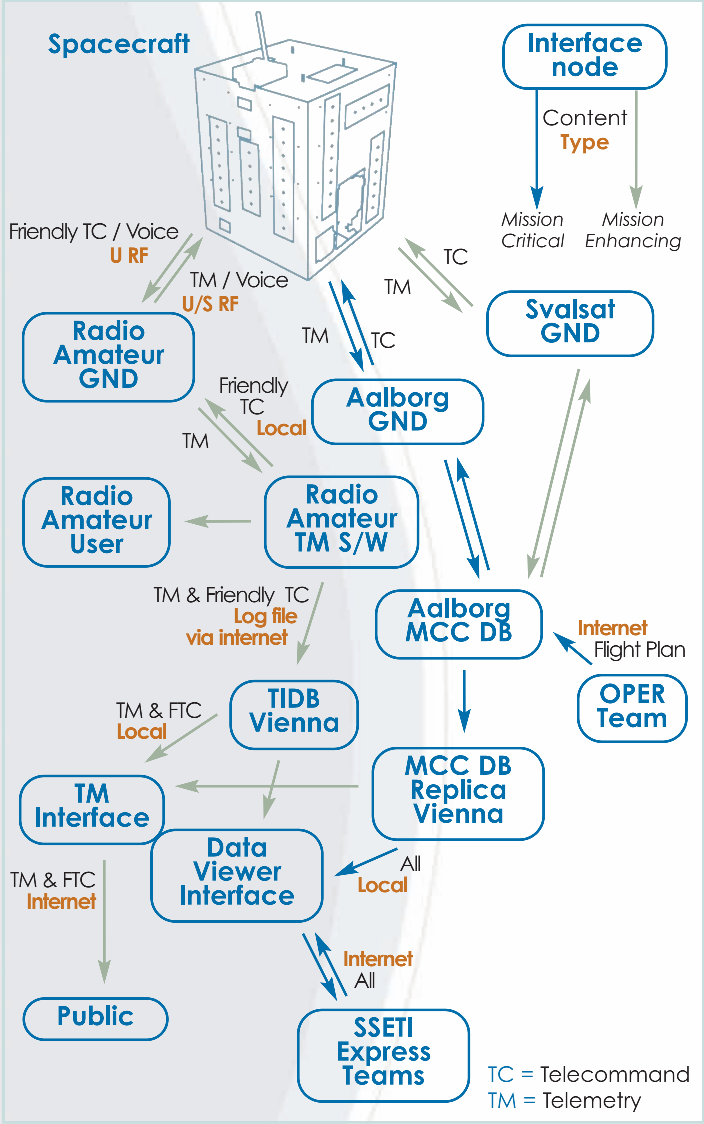
Primary Ground Station (Aalborg, Denmark)
The main mission ground station consists of tracking antennas, an Ultra-High Frequency (UHF) radio, an S-Band to Very-High-Frequency (VHF) down-converter, a VHF radio, a Terminal Node Controller (TNC) and a controlling computer. It is the primary command station for controlling the spacecraft and for downlink of mission telemetry on both radio frequency channels.

Secondary Ground Station (Svalbard, Norway)
The secondary ground station provides a redundant UHF uplink and downlink support for telecommand uplink and mission telemetry downlink. Its extreme latitude ensures fourteen passes of the satellite per day, therefore allowing for a high data return during the mission. This station is entirely remote-controlled from the primary ground station in Aalborg.

TIDB (Jouy En Josas, France)
The Telemetry Interface Database (TIDB) is a web-based application facilitating the dissemination of all mission telemetry from the MCC to the distributed SSETI Express teams, radio amateurs and the general public. Radio amateurs may also submit downlinked mission data to the TIDB.

GROUND STATIONS

European Ground Stations Map



SSETI Express Ground Segment Layout

SCHEDULE

Mission Timeline	Nominal Date
Project kick-off	27th January 2004
Major Sub-systems delivery	End August 2004
Integration start	Mid September 2004
Integration ended	End March 2005
System Tests	11th April 2005
Promotional campaign	May-July 2005
Launch	25th August 2005
Main objectives achieved	End October 2005
Extended operations	Until end-of-life

LAUNCH

SSETI Express will be launched from Plesetsk, Russia, on the DMC-3 flight of Surrey Satellite Technology Limited.

Launcher	COSMOS 3M
Orbit type	Low-Earth sun-synchronous
Altitude	686km
Inclination	98deg
Eccentricity	0
Local Time of Ascending Node (LTAN)	10:30
Date	25th August 2005

PARTNERS

Aalborg University, Denmark
www.auc.dk/english

AMSAT-UK, United Kingdom
www.uk.amsat.org

Andøya Rocket Range, Norway
www.rocketrange.no

Dutch Space, Netherlands
www.dutchspace.nl

EADS Space
www.space.eads.net

Holger Eckardt, Germany
www.df2fq.de

Industrieanlagen-Betriebsgesellschaft (IABG), Germany
www.iabg.de

Institut für Spanende Fertigung (ISF), Germany
www-isf.maschinenbau.uni-dortmund.de

Konsberg Satellite Services (KSAT), Norway
www.ksat.no

Map, France
www.map-coatings.com

Royal Netherlands Marine Korps, Netherlands
dutchmarines.homestead.com

Saft
www.saftbatteries.com

Snecma (SAFRAN Group)
www.snecma-moteurs.com

Surrey Satellite Technologies Limited (SSTL), United Kingdom
www.sstl.co.uk

University of Tokyo Intelligent Space Systems Laboratory
www.space.t.u-tokyo.ac.jp/cubesat/main-e.html

University of Toronto Institute for Aerospace Studies – Spaceflight Laboratory (UTIAS-SFL), Canada
www.utias-sfl.net

University of Würzburg, Germany
www7.informatik.uni-wuerzburg.de/cubesat

Williamson Electronique, France
www.will-elec.com

more information: www.sseti.net

SSETI EXPRESS

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SSETI Express

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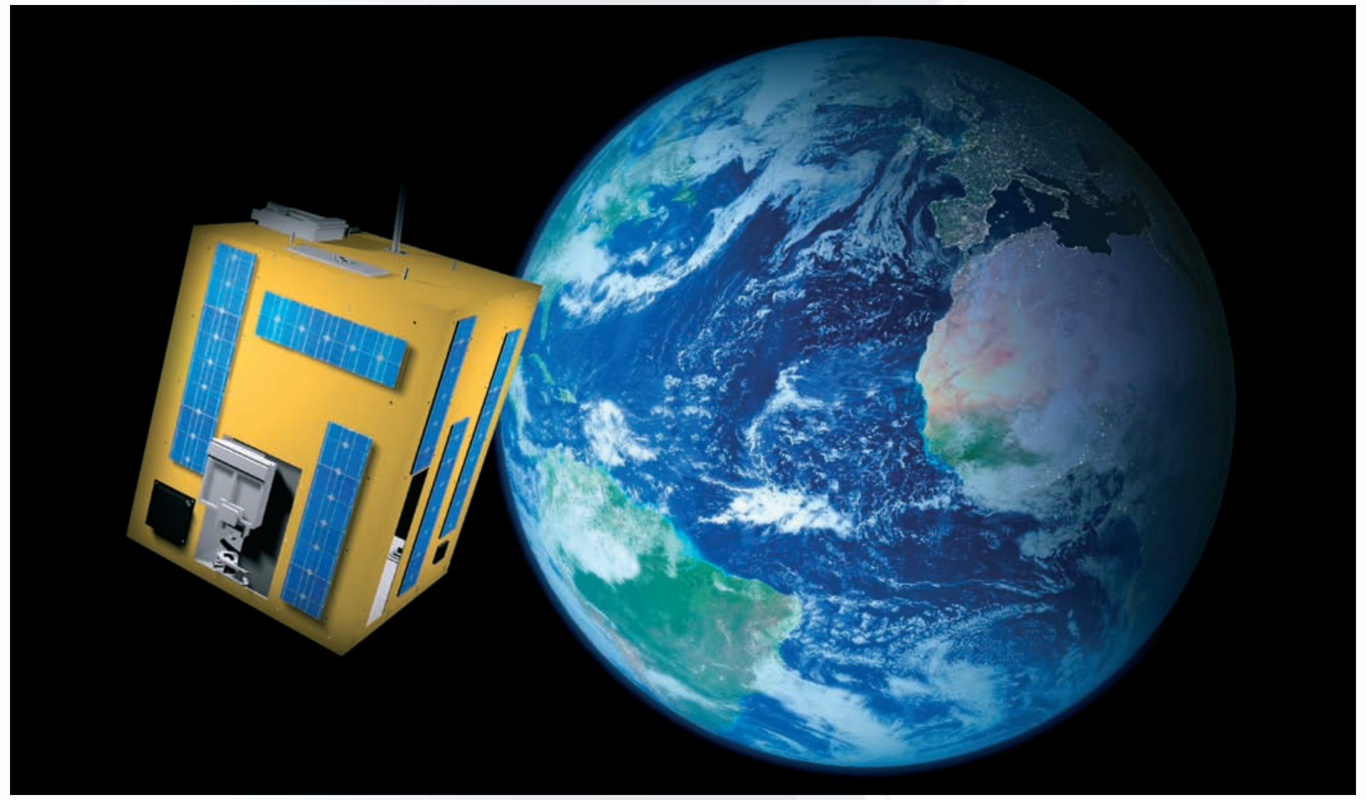


MISSION STATEMENT

SSETI Express is an educational mission that shall deploy CubeSat pico-satellites developed by universities, take pictures of Earth, act as a test-bed and technology demonstration for hardware of ESEO, the European Student Earth Orbiter, and function as a radio transponder for the global amateur radio community.

MISSION OBJECTIVES

- To demonstrate the successful implementation of ESA's pan-European educational initiative, SSETI, and therefore encourage, motivate and challenge students to improve their education and literacy in the field of space research and exploration.
- To carry as passengers, and subsequently deploy, three educational Cubesat pico-satellites.
  The primary payload of SSETI Express is therefore a set of three deployment tubes to eject the passengers once in orbit, after which they will embark on their autonomous missions.
- To demonstrate and test the hardware and technology being developed for the European Student Earth Orbiter (ESEO).
  The secondary payload of SSETI Express is the ESEO cold-gas attitude control system. Other hardware related to ESEO consists of the structure, the electrical power system and the patch antennas.
- To take pictures of the Earth.
  The tertiary payload of SSETI Express is a visible-light camera developed specifically for low- Earth orbit.
- To involve the amateur radio community in the downlink of housekeeping and payload data, and support this community by acting as a transponder once the main mission objectives are complete.
  The SSETI Express UHF and S-Band communications systems can be combined to form a voice transponder that will be freely available, along with the mission data downlink, to the global radio amateur radio community.

European Space Agency (ESA)
www.esa.int

ROLE OF SSETI EXPRESS

SSETI Express is the first ESA Student satellite and is:

- a **technical** pre-cursor to the SSETI ESEO micro-satellite, several essential ESEO subsystems being flown on-board
- a **logistical** pre-cursor to the future SSETI micro-satellite projects
- **hugely motivational** and has enhanced the enthusiasm and dedication of the students involved in the SSETI Programme
- a **pilot project** for the SSETI student community, a **demonstration** of how ESA experts can support student initatives and an **inspiration** for other educational satellite programmes developed by students in Europe
- **bringing together** several educational and related programmes, academic institutions and commercial industries, therefore expanding the SSETI Network for the mutual benefit of all

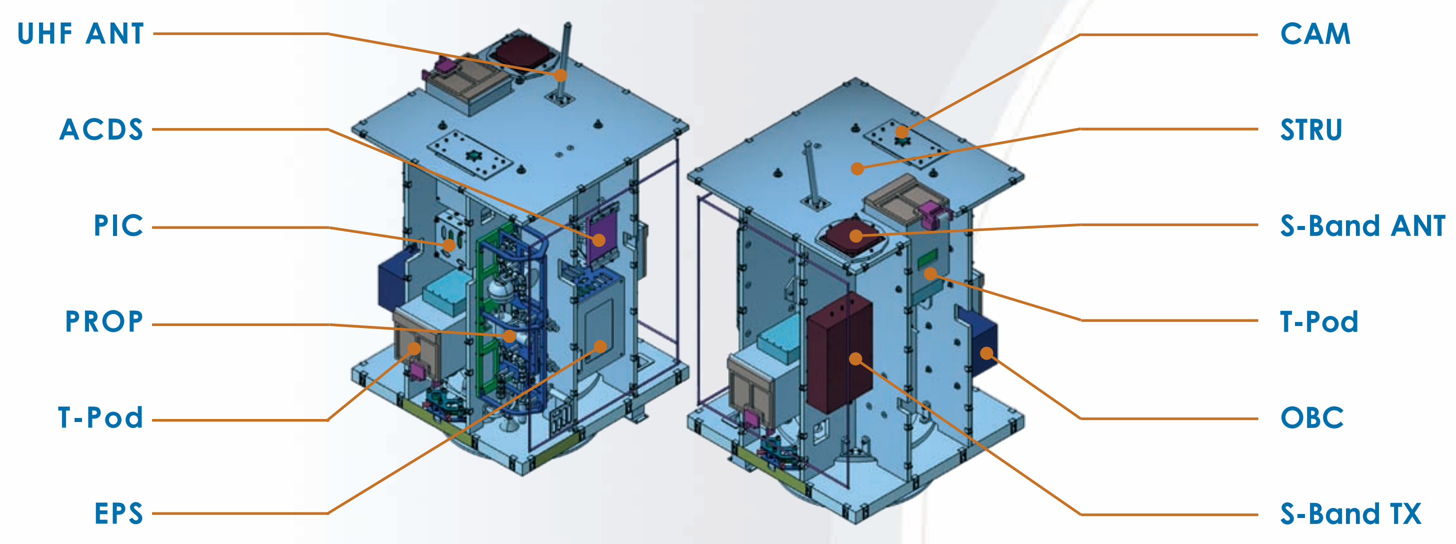
MAIN CHARACTERISTICS

- Designed, built and operated by students
- Telemetry freely available on the web for download
- “Radio Amateur Friendly” mission
- Launch platform for pico spacecraft

TECHNICAL FACTS

Dimensions	560 x 560 x 900 (maximum envelope)
Mass	62kg
Mass of payload	24kg
Expected lifetime	Minimum 2 months, extended mission until end-of-life
Attitude Determination System	Sun-sensors and magnetometer
Attitude Control system	Semi-passive magnetic stabilisation, plus a cold-gas payload
On-board Data Transfer	CAN, RS232
Telemetry - UHF - S-Band	 437.250 MHz, 9.6 kb/s, AX25 2401.84 MHz, 38.4 kb/s, AX25
Power - Average - Peak	Body mounted solar panels 12 W 20 W
Batteries	Li Ion, 90Wh
Propulsion	6l, 300bar, Nitrogen cold gas
Camera	~100m/pixel, 1280x1024 pixels, CMOS
Power Bus	28V regulated
Thermal Control	Passive

SUBSYSTEMS



ADCS (Aalborg, Denmark)
The Attitude Determination and Control System (ADCS) has two parts. The Attitude Control System uses semi-active magnetic stabilisation. A pair of magnetorquers provide detumbling functionality and actively damp any subsequent vibrations, while a passive magnet ensures alignment of the spacecraft's z-axis with the Earth's magnetic field. The attitude of the spacecraft is therefore stabilised about two axes with one remaining, but fully characterised, degree of freedom about the z-axis. The pointing error is expected to be lower than five degrees. The Attitude Determination System consists of a pair of sun-sensors and a three-axis magnetometer, allowing determination of the attitude with respect to the magnetic field lines of the Earth and the sun.

CAM (Aalborg, Denmark)
The on-board camera (CAM) is based on a colour complementary metal oxide semiconductor (CMOS) sensor and an instrument control unit. In order to adjust for varying brightness, the camera can be fully calibrated in orbit. It is adapted from the AAUSAT-1 pico-satellite mission. The optical section of the camera consists of a specifically designed and manufactured lens system constructed of radiation-hardened glass. The ground resolution of the camera is about 100m per pixel, with an image size of 1280 by 1024 pixels.

EPS (Naples, Italy)
The Electrical Power System (EPS) is based on the concept of power generation by body-mounted photovoltaic cells. The energy is stored in a rechargeable Lithium-ion battery to ensure power is available during eclipse phases or during low sun-light periods, when there may be insufficient power input from the solar cells. Each of the other subsystems is supplied by dedicated power lines from a regulated 28V power bus. Ten separate strings, each of fifteen triple-junction Gallium-Arsenide (Ga-As) photo-voltaic cells with an estimated efficiency of around 22%, are used. They are mounted on the four lateral sides of the spacecraft, each of which is covered by approximately 100cm ^{2} of solar-cells.

PIC (Lausanne, Switzerland)
The Propulsion Instrument Control (PIC) unit is affectionately referred to as the “MAGIC” box. This subsystem processes commands related to the propulsion system, controls the thruster valves and performs data acquisition from the various thermistors and pressure transducers. It is also designed to provide a high current pulse to detonate the pyrotechnic valve.

OBC (Aalborg, Denmark)
The On-Board Computer (OBC) controls the spacecraft during nominal and payload operations. It collects all telemetry and payload data for subsequent transfer to the ground. Commands can be uplinked into the computer's flight plan from the ground stations via the UHF radio communication system. At its core is an AMTEL ARM 7 processor. The surrounding hardware and software architecture was entirely student-designed.

PROP (Stuttgart, Germany)
The propulsion (PROP) payload is an attitude control cold-gas system with four low-pressure thrusters, fed by a pressure regulation system. The tank (derived originally from fire-fighter air tanks) contains six litres of gaseous Nitrogen at a pressure of 300bar. The pressure is managed by a series of valves and regulators and secured for safety during the launch by a pyrotechnic valve. These components are connected by stainless-steel high-pressure tubing.

S-Band ANT (Wroclaw, Poland)
The S-band patch antennas (S-Band ANT) are adapted from the ESEO microsatellite. A set of three directional patch antennas are used, outputting a total of 3 watts of circularly polarised radiation at 2401.84 MHz. The half-power beam width is approximately 70 degrees. The main lobes are directed along the spacecraft's z-axis, which will face nadir during transit of most of the northern hemisphere, and along the spacecraft's positive and negative x-axis.

SUBSYSTEMS

S-Band TX (AMSAT-UK)
Radio Amateurs from the United Kingdom have developed the S-Band transmitter (S-Band TX). It serves a dual-function; providing both high-speed mission data downlink at 38400bps and also, in combination with the UHF system, a single-channel audio transponder which will be freely available to the global amateur radio community whenever the other payloads are not in use.

STRU (Porto, Portugal)
The primary load-bearing spacecraft structure (STRU) consists of honeycomb panels configured in a similar way to the famous “tic-tac-toe” game. The secondary structure consists of 1mm aluminium outer lateral panels, serving as mounting surfaces for the solar cells, sun-sensors and other lightweight equipment. A titanium ring inside the structure ensures proper load distribution onto the launch adapter. Aluminium inserts glued into the honeycomb panels provide mounting points. The structure team is also in charge of designing the configuration of all subsystems with respect to balance, mass distribution, harnessing and thermal issues.

T-PODs (Toronto, Canada)
The Tokyo Pico-satellite Orbital Deployers (T-PODs) will be used to store three passenger CubeSats during the launch and then deploy them from SSETI Express once orbit is achieved. They have an interface to the ground support equipment for charging the passengers and arming the release mechanisms.

UHF (Radio amateur, Hohhenbrunn, Germany)
The Ultra-High Frequency (UHF) unit contains a radio and a Terminal Node Controller (TNC) and is the primary communications system of the spacecraft. It provides uplink of telecommands from the ground station, audio uplink from amateur radio users, and downlink of mission data at 9600bps, all via a top-mounted rigid monopole antenna.

PASSENGERS

SSETI Express will carry and deploy three educational CubeSat pico-satellite passengers:

Ncube II
The main payload of Ncube II is an Automated Identification System (AIS), which is a system used onboard ships to receive GPS signals and return, by certain AIS frequencies, information such as the ship's current location, heading and expected time of arrival. These AIS signals of Ncube II will be detected, stored and forwarded to the Ncube ground stations, allowing them to track the satellite. To test this technology, a reindeer, named Rudolf, will be equipped with a collar containing a complete AIS transmitter and tracked as it walks around the Hardangervidda national park of Norway during the the mission.

This CubeSat was developed and constructed by:

- Narvik University College
- Norwegian University of Science and Technology
- Norwegian University of Life Sciences
- University of Oslo

The work was coordinated by Norwegian Space Centre and Andøya Rocket Range.

UWE-1 (University of Würzburg's Experimental satellite 1)
The main objective of UWE-1 is to conduct tele-communication experiments, related to the optimisation of an Internet related infrastructure for space application. Various Internet protocol variants will be tested, analyzed and optimized in space during the mission of UWE-1. In particular, typical space environment characteristics such as delays, noise, interruptions, low bandwidth and high packet loss rates will be taken into account.

The second objective is to establish and efficiently interlink a network of ground control stations via terrestrial Internet. In this context a ground control station has been set up in Würzburg, as well as the software infrastructure for the coordination of several ground stations. This infrastructure will be tested and further optimized during the UWE-1 mission.

Finally, the key educational aspect of UWE-1 is to learn about system design approaches in interdisciplinary teams of students by addressing the motivating and challenging project tasks of implementing a pico-satellite. Here modern miniaturization techniques for electro-mechanical components provide essential contributions to an efficient implementation of such small satellites of 1 kg mass within the framework of the international CubeSat programme.

Xi-V
Xi-V is the second nano-satellite built by the University of Tokyo's Intelligent Space Systems Laboratory (ISSL). Its primary mission is the demonstration of newly- developed Cu(In,Ga)Se2 (CIGS) solar cells in space. Other than CIGS cells, GaAs cells are also tested on Xi-V, which will be used on ISSL's next remote-sensing nanosatellite "PRISM". Other mission objectives include the acquisition of Earth images by a commercial off-the-shelf digital camera and the operation of a message transmission service, using an amateur radio frequency.