

AISsat-1

Monitoring the Shipping Traffic from Space

To meet this goal Norway will launch an experimental nano satellite named AISsat-1 in the first quarter of 2010 to find optimal techniques for a future operational system. Placed in a low polar orbit of an Indian PSLV launcher, the satellite can monitor the high North and the high South fifteen times a day, thus, continuously monitoring the oceans Norway is responsible for and has an interest in.

The project is mainly carried out by Norwegian companies on behalf of the Norwegian Space Agency, but the satellite platform is based on a Canadian construction. The main participants involved in the project are Norwegian Defence Research Institute (FFI), University of Toronto, Kongsberg Seatex and Kongsberg Satellite Service. FFI has been the initiator for the project, and also carries the main responsibility. The Space Flight Laboratory at the University of Toronto (UTIAS) has developed and built the satellite platform, Kongsberg Seatex developed and built the AIS sensor including software and Kongsberg Satellite Service will operate the ground station.

Why a Satellite Based AIS System?

The coastal station - based system has a very important restriction. It is not suitable for monitoring the traffic on huge

The information in the following articles as well as the fact boxes are compiled and edited by Baard Kringen at NordicSpace based on information and documentation sources by among others in:

A Norwegian Satellite for Space-based Observations of AIS in the High North. Bjørn T. Narheim et.al.



*Handover of the first model, Bjørn Narheim from Defense Research Institute at right handover to Norwegian Space Centre, here represented with Bjørn Ottar Elseth.
Photo credit: Norwegian Space Centre*

ocean areas. The communication is line-of-sight allowing countries to monitor ships within about 50 -70 km of their shores. Norway has the jurisdiction over ocean areas several times larger than the mainland. This huge area, where much of the international traffic takes place, is of great economical interest to Norway in connection with fisheries and oil and gas production. Monitoring these areas has so far been carried out by ships from the Coastguard and aircrafts from the Norwegian Defence authorities. This general monitoring can be supplied with special monitoring due to suspicion about unwanted occurrences. However, this is an expensive method that ties up too many resources.

Being able to monitor the traffic from space has therefore been an expressed goal for the authorities for years. Satellites in polar orbits can monitor the whole area several times a day and resources from the Coastguard or others can be called upon

if some irregularities are detected. The result may be a cheaper service where the resources can be concentrated to special areas of concern.

To test techniques for a future operational system the Norwegian Government has granted financial resources for a very small but advanced satellite where the platform is purchased in Canada, but where the payload has been developed and built by Norwegian companies. The satellite is only six kilograms and has a cubic form of 200 millimetres. Only 30 % of the weight is mission specific payload and it is clear that with a payload of only about two kilograms it requires miniaturising of the components.

One challenge is the large quantity of data the satellite can receive. Today 52 000 ships have installed the necessary equipment to transmit the ordered information, the so-called Class A

equipment. In addition, the demand of Class B equipment for smaller vessels will increase the number of reports considerably. The amount of information is therefore extensive. Every ship delivers 90 to 450 messages over a fifteen minute period. Some of the tasks for the satellite and the ground station are to filter out the data that are of no relevance, but at the same time be able to add to the sources and time information that is necessary to separate satellite information from information to coastal stations.

Although only a part of these vessels will report to the satellite, sorting the received messages is necessary. AISSat-1 will concentrate the operations on the Northern areas, an area where the traffic is not as frequent as the more central places of the world. In addition, the satellite does not receive all information the AIS transmitter broadcasts. Only data about identification of the ship and so-called dynamic information are of interest for the satellite.

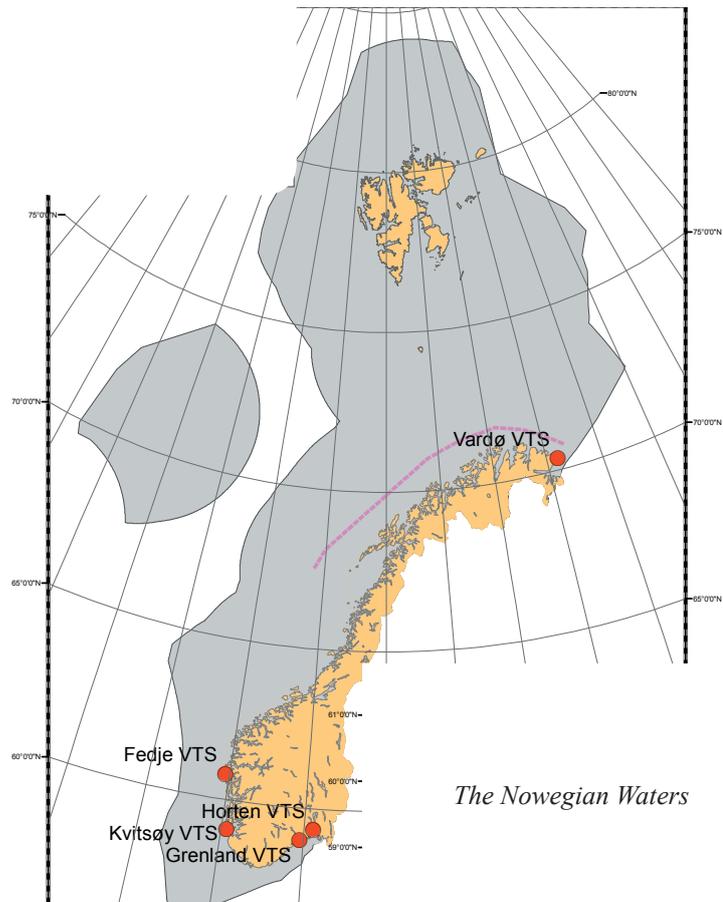
The satellite will transmit data 10 minutes every orbit in the time the satellite is in sight of the ground station at Svalbard. The next possibility will be at the next orbit, 90 minutes later.

The satellite neither will receive data from all orbits and not for the whole orbit. The area of solar cells is too small to continually give sufficient power, and the activity will therefore normally be carried out at some orbits and for the interesting parts of the orbits.

The ground station located in Svalbard will acquire data from AISSat-1 during all 15 daily passes over Norwegian ocean areas. KSAT (Kongsberg Satellite Services) already has a major facility for communicating with numerous satellites. The Svalbard Ground Station (also referred to as SvalSat), is located at 78.216° N, 20° E on the Norwegian Svalbard archipelago near the town of Longyearbyen.

Stored and real-time data from the satellite will be acquired and stored at the ground station for subsequent forwarding to the mission control center located at FFI in southern Norway. AIS data from the high south will be stored onboard and forwarded to the users while the satellite is in sight of the receiving station.

Information that is not received in real time must therefore contain additional information about observing time and it must also separate between information compiled of the satellite or the coast based AIS network.



Operations

After launch the commission phase AISSat will enter into two succeeding phases.

Phase -1 will be an experimental phase where mainly FFI will perform analysis of the space AIS concept in general, and where data from the satellite will be analyzed and compared with the results from the detection probability modeling, particularly for the Norwegian ocean areas in the high north. In this phase, the satellite will primarily store and forward AIS data, but will also push AIS data in real time to ground during periods of ground contact. Distribution of data to selected users will also be tested.

Phase 2 will be an operational demonstration phase where AISSat-1 will deliver data to selected users in an agreed form until end of the satellite's life. Some limited experimentations will also be performed during this phase.

The satellite is assessed to hopefully last at least three years. The satellite is built according to industrial standard, not according to space standard, meaning it will last somewhat less than the large commercial satellites and space probes. However, the first Canadian satellite of this type has been in space for five years and is still in function.

Funds for further development of this system has been earmarked in the Norwegian state budget for 2010, thus, the hope for a productive satellite seems more accessible.

FACTS About the AISSat Satellite

AISSat-1 is a six kilograms nano-satellite, being constructed on behalf of the government of Norway by Canadian and Norwegian institutions and industrial companies. The primary mission is to investigate the feasibility and performance of a spacecraft-based Automatic Identification System (AIS) sensor in low-Earth orbit as a means of tracking maritime assets, and the integration of space-based AIS data into a national maritime tracking information system. AISSat-1 is intended as both a research and development platform, and a demonstration mission for a larger operational capability.

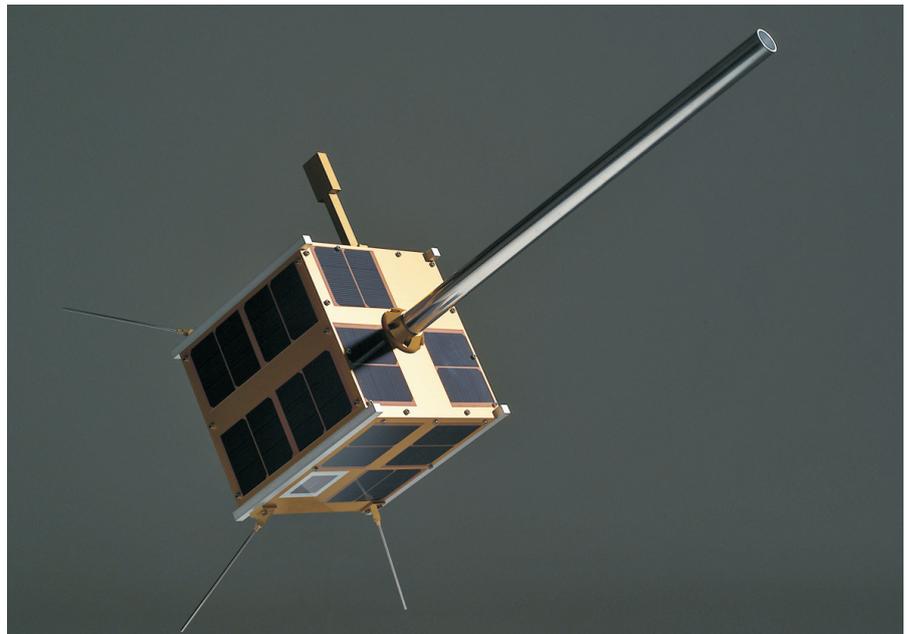
The satellite design is based on the Generic Nano-satellite Bus (GNB), a cube which measures 200 mm in size, and includes a full suite of advanced capabilities. This includes:

About 70 % of the mass is satellite structure and necessary subsystems. The rest, about two kilograms, is dedicated to mission specific payloads.

The GNB was originally developed for the BRITE and CanX-4/-5 missions, and is now being marked for other missions around the world.

The Power Supply

Power is generated with 36 body mounted Gallium Arsenide solar cells. These cells have a beginning of life efficiency of 26,8% delivering up to 967 mW at their peak power point at 28 degrees C. Energy is stored in a dual-5.3 Ah lithium-ion battery system allowing the satellite to operate in extended eclipse periods and to reduce depth of discharge on the individual batteries. The power system architecture contains peak power tracking functionality and provides switched power to the loads, and power regulation where required. Finally, over current protection is provided to prevent damage to the payloads.



The last model of AISSat-1. Photo credit. FFI

Communication

The platform contains two radio systems; a UHF receiver and an S-band transmitter. The UHF receiver, operating at 4 kbps, is used for data uplink from the ground station and uses four phased quad canted monopole antennas. The S-band transmitter will be used for data downlink. It is capable of data rates from 32 to 256 Kbps and uses two patch antennas mounted on opposite sides of the satellite for near Omni directional coverage.

Attitude Determination and Control

A full 3-axis attitude determination and control system provides attitude stabilization and fine pointing for AISSat-1. The satellite is able to point in either an inertial orientation, or an orbit-frame-fixed orientation, including on nadir. Attitude sensors consist of six sun sensors, a magnetometer and rate gyros. Three orthogonally mounted reaction wheels and three magnetorquer coils control the actuation of the satellite. The magnetorquer is used for de-tumbling

and momentum dumping while the reaction wheels provide fine attitude pointing capability. The attitude control system is able to maintain several degree level pointing accuracy and stability over the course of the entire orbit, including eclipse.

The Program

The satellite is funded by the Norwegian Space Centre, and the program is managed by the Norwegian Defense Research Establishment (FFI). The Space Flight Laboratory at the University of Toronto (UTIAS-SFL) is providing the spacecraft platform with necessary subsystems and the AIS VHF antenna. This institution also provides spacecraft-level management, systems engineering, assembly, integration, and test support, and will be responsible for launch and commissioning on orbit, after which the spacecraft will be delivered to FFI for operations. The payload is being developed by Kongsberg Seatex AS in cooperation with FFI, and Kongsberg Satellite Services AS will house the Earth station facility also provided by UTIAS-SFL.

The AIS system

The UAIS (Universal Automatic Identification System), mainly known as AIS, is a civilian automatic information system which makes it possible to exchange data between ship and land based stations. The system introduced by the International Maritime Organisation (IMO) is basically an anti-collision system for vessels at sea. However, the system is also well suitable for monitoring the ship traffic in coastal areas. A ship equipped with AIS continually transmits information on e.g. the ship's name, position, course, speed, draught, type of vessel along with data on the ship's cargo etc. The information then is transmitted via radio communication to other ships equipped with AIS as well as land based AIS stations. The land based stations can send short messages to AIS equipped ship within in a given area, thus providing shipping traffic with important traffic data on the area concerned.

The system contains base stations around the coastal areas, which collect AIS-data received from the ships. In addition, a number of small AIS-receivers are established on oil rigs and selected harbours.

Those who developed AISSat-1

FFI

FFI, the Norwegian Defence Research Establishment is an independent civilian R&D institute responsible to the Ministry of Defence. The institute's division for sea and land systems is involved in a variety of space-related activities, ranging from space physics to satellite surveillance.

Problems with radio communication in the northern areas were the basis for establishing the institute.

FFI has contributed to studies of phenomena in the atmosphere, ionosphere and magnetosphere (altitudes 10-450 km) since before 1962, when the first sounding rocket was launched from Andøya. Using sounding rockets, lidars and radars, FFI has carried out studies on a number of scientific topics, such as turbulence and atmospheric waves, plasma processes, ozone and phenomena in the 80-90 km altitude region that may be related to climatic changes. FFI has also played an important role in the development, building and testing of sounding rocket and satellite payloads.

FFI R&D activities were instrumental in the development of the satellite-based services that made Norway the first nation to use commercial radar satellite images for surveillance of oil pollution and fisheries. Based on experience from Cluster and Cassini scientific missions, the institute has built up the necessary experience to manage the development of small satellite projects like AISSat-1.

See more at: www.ffi.no

Kongsberg Seatex AS

Kongsberg Seatex AS develops, builds and sells advanced instrument- and position solutions to the oil and gas market offshore and other professional maritime markets. Kongsberg Seatex is also engaged in developing the Navigation system Galileo. Kongsberg Seatex is a part of the Kongsberg Group and localized in Trondheim, Norway.

See more at: www.kongsberg.com

University of Toronto

The Space Flight Laboratory at the University of Toronto Institute for Aerospace Studies (UTIAS/SFL) was established in 1998 to combine theoretical education with practical skills. It has a staff of professionals, design, assembly and test facilities to develop low-cost spacecrafts. The Space Flight Laboratory can build and retain low-cost micro satellites (satellites under 100 kg) and nano satellites (satellites under 10 kg).

The objective is to involve Master students in the complete spacecraft development cycle, from mission conception through actual on-orbit operations, by the time they complete their Masters degree.

See more at: www.utias-sfl.net

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Automatic Information System (AIS) For the Norwegian Coast

International shipping traffic is constantly increasing, not least in the northern areas. Fisheries, oil and gas exploration and international traffic are all activities that pose a threat to the vulnerable areas near the Arctic. The need for monitoring and managing this traffic is therefore a must for both Norwegian and International authorities.

Norwegian waters amount in total about more than 2 million square kilometres, comprising the 200 nautical mile-long economic zone, the fishery- zone surrounding Jan Mayen, and the fishery protection- zone surrounding Svalbard. These areas are of great value, seen both from economical and environmental points of views. Previously, traffic in these areas was free; however, an increasing need for control has developed, thus, different control mechanisms have been designed in line with the technological evolution. The current method is based on the Universal Automatic Identification System, known as AIS, a civilian information system which makes it possible to exchange data between ships and between ships and land based stations. Norway has more than 40 such base -stations that receive messages from the traffic.

The Norwegian AIS System, after several years of developing and building, was finally declared operational in 2005. The system is managed by the Norwegian Coastal Administration and consists of five traffic control centers; located along the long Norwegian coastal line and with largest density along the most commonly used routes. The traffic centers operate civilian traffic by monitoring, controlling and guiding traffic in addition to offering



other services. The main purpose is to increase safety and accessibility in the areas with relatively dense and complicated traffic patterns. However, the system is also useful in terms of monitoring all traffic along the coast.

Monitoring Tankers

On a daily basis, some 25-30 tankers pass our coastal areas. This traffic should be followed with especially critical eyes from the traffic center. All ships transmit data about their cargo, and with a few keystrokes on the computer, the traffic managers can check how many tankers that sail along the coast at any time, and location of the nearest tug in relation to these. The information on the screen has its own color code, thus making it easier to distinguish them from each other.

The AIS network will primarily be used by the Coastal Administration traffic control centers as a sensor for

information about the vessel's position, course, speed, identity, and more. Coastal Administration's traffic officers will also use the AIS network to send out security-related messages to the vessels. In certain cases, a traffic manager using the AIS network will ask for AIS messages from ships or reduce the reporting interval for these.

Norwegian Coastal Administration will also use the AIS network for purposes other than direct traffic monitoring. For oil spill preparedness, access to AIS data provides immediate information about the traffic situation around a reported oil spill. Furthermore, for example, pilot boat drivers can more easily plan pilot services.

In addition to the Norwegian Coastal Administration, other public agencies such as the defense, Joint Rescue Coordination Centers, the police, regular ports etc. also use data from the AIS network.