InnoSat and MATS – An Ingenious Spacecraft Platform applied to Mesospheric Tomography and Spectroscopy
Presentation outline

• Call for Ideas by Swedish National Space Board
• InnoSat platform consortium
• InnoSat concept and system design
• The first mission: MATS
• Summary and Conclusions
2011: Call for Ideas by Swedish National Space Board

- Low-cost, top science missions, made feasible by innovative approaches
- Long-term programme with very low total cost
- Swedish participation
InnoSat Platform Consortium

Small-sat systems integrator (Freja, Astrid 1 &2, Odin, SMART-1, PRISMA)
Satellite operations (currently Odin and PRISMA)
AOCS and Propulsion subsystem provider for ESA and telecom missions

Provider of fault tolerant products, systems and solutions for small satellites
InnoSat Concept

- Only LEO missions considered
- Compatible with four proposed science missions
- 600 km dawn/dusk orbit assumed
- Optimized for piggyback launch

Four LEO missions
- MATS
- SIW
- SPHINX
- ALFVÉN

Generic bus specification

Generic spacecraft bus
InnoSat Key Performance Factors

**Mass**: 40 kg

**Size**: 70x60x85 cm

**Max payload size**: 65x53x48 cm

**Max payload mass**: 15 kg

**Max payload power**: 40 W (orbit average)

**Design lifetime**: 2 years

**Downlink bitrate**: 3-5 Mbps

**Stabilization**: 3-axis with Star Tracker and RW

**Pointing performance**:
- Max 0.05 deg absolute pointing error
- Max 0.01 deg attitude reconstruction error

**Orbit determination**: On-board GPS

**Payload can be Earth- or Space-facing**
Possible extensions

High power option

Propulsion
Possible payload accommodation

X-ray physics

Submillimeter radiometry

High resolution imaging
System architecture and re-use approach

InnoSat Core Platform Components
- OBC
- SpW Router
- Mass Memory
- Equipment Handling SW
- TT&C RTU
- AOCS RTU
- Power Controller
- TM/TC & OPS Services SW

InnoSat Equipment Baseline
- Transceiver
- S-band Antenna
- Reaction Wheel
- Magnetic Torquers
- GPS
- Solar Cells
- Star Tracker
- Magnetometer
- Battery Cells
- Thermal HW
- Solar Panel

InnoSat Reference Designs
- Structural / Thermal Design
- Power S/S Sizing
- Electrical Architecture
- Application Software
- Reference Payload

InnoSat Baseline Architecture
- InnoSat Baseline Platform

InnoSat Mission Control Centre
- Mission Control System
- Operational Simulator
- Flight Dynamics System
- Automation Server

Ground Segment Tuning
- Simulator Tuning
- TM/TC Database Update

Mission Tuning and Spacecraft AIT
- OBSW Tuning
- Mech. / Thermal Tuning
- AIT

External Ground Station

Payload

Complete Mission Specific System
- Mission Specific Spacecraft
- Launch Service
- Flight Operations
- Mission Specific MCC
- External Ground Station

Recurring Engineering
Key satellite design items

• High performance data handling system (ÅAC Microtec)
• High-efficiency power distribution unit (ÅAC Microtec)
• SPARTAN software framework with PUS protocol stack (OHB Sweden)
• Autocoded AOCS software based on PRISMA GNC software (OHB Sweden)
• RAMSES Mission Control Centre (OHB Sweden)
• New all-soft System Simulator (OHB Sweden)
First mission: MATS

• Mission prime: MISU @ Stockholm University
• Instrument prime: Omnisys (Gothenburg)
• MATS: Mesospheric Airglow/Aerosol Tomography and Spectroscopy
• Two instruments: Limb viewer and Nadir viewer
• The Limb viewer will look into the mesosphere and acquire a continuous image sequence that can be used to construct tomographic images.
• The Nadir viewer will take images of noctilucent clouds
• The objective is to study atmospheric structures and wave patterns to gain a better understanding of the coupling between the mesosphere and other atmospheric layers.
Scientific observations

Noctilucent clouds over Stockholm
MATS payload accommodation

- Optical bench
- Star tracker
- Radiators
- Limb baffle
- Connector plate
- Power unit
- Nadir baffle
Platform summary for MATS

InnoSat baseline configuration, plus:
- Minor structural modification
- Improved AOCS with fiber-optic gyros (needed to fulfil the pointing stability requirements, 30 arcsec over 5 seconds)

Satellite will be ready for launch in 2018
Conclusions / InnoSat Summary

System Specification: Provides the performance envelope to the science teams and eliminates high non-recurring costs for each mission.

Optimized for Science: 3-axis stabilized platform with high power and data downlink capabilities. Large, un-obstructed payload accommodation volume.

Affordable Launch Solution: The satellite is designed to fit several rideshare launch options.

Maximum Heritage Re-use: Plug and play electronics from ÅAC Microtec, application software and mission control system from OHB Sweden.

Microsat COTS FM hardware: Now available thanks to many other low-cost missions.

Extendible: The current baseline configuration is only one of several possible reference designs.