Mars MetNet Precursor Mission Status

A.-M. Harri [1], S. Aleksashkin [2], H. Guerrero [3], W. Schmidt [1], M. Genzer [1], M. Genzer [1], L. Vázquez [4] and H. Haukka [1]

(1) Finnish Meteorological Institute, Earth Observation, Helsinki, Finland (ari-matti.harri@fmi.fi), (2) Lavochkin Association, Moscow, Russia, (3) Institutio Nacional de Tecnica Aerospacial, Madrid, Spain, (4) Universidad Complutense de Madrid, Madrid, Spain

Finnish Meteorological Institute
Russian Space Research Institute
Lavochkin Association, Russia
INTA, Spain

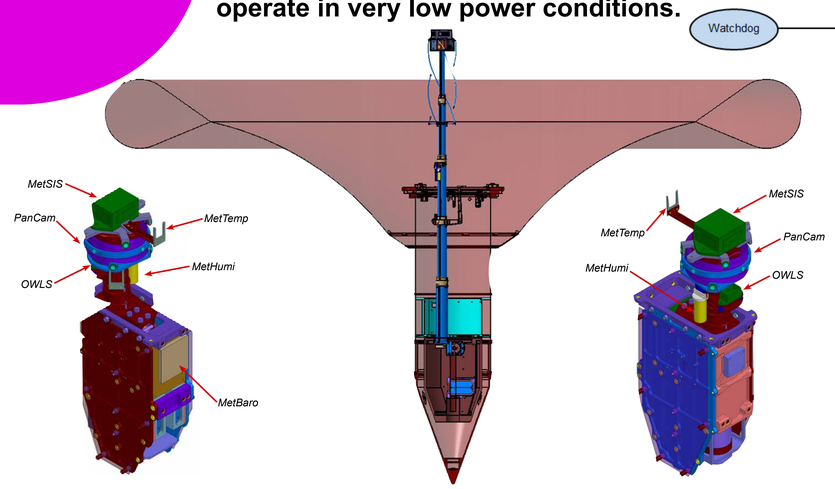
MetNet
The Next Generation Lander Mission For Martian Atmospheric Science

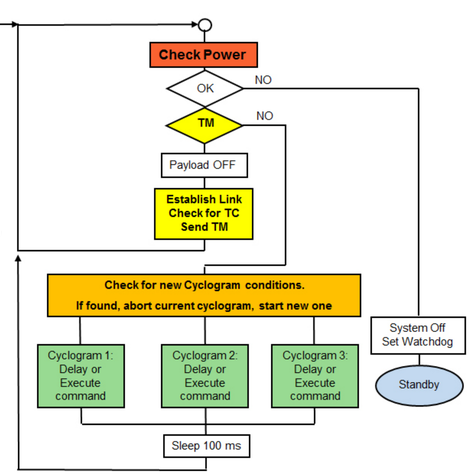
Mission Scientific Objectives

- Atmospheric dynamics and circulation
- Surface to Atmosphere interactions and Planetary Boundary Layer
- Dust raising mechnanisms
- Cycles of CO_2, H_2O and dust
- Evolution of the Martian climate

A new kind of planetary exploration mission for Mars is being developed in collaboration between the Finnish Meteorological Institute (FMI), Lavochkin Association (LA), Space Research Institute (IKI) and Institutio Nacional de Tecnica Aerospacial (INTA). The Mars MetNet mission is based on a new semi-hard landing vehicle called MetNet Lander (MNL).

The main idea behind the MetNet landing vehicles is to use a state-of-the-art inflatable entry and descent system instead of rigid heat shields and parachutes as earlier semi-hard landing devices have used. This way the ratio of the payload mass to the overall mass is optimized and more mass and volume resources are spared for the science payload. MetNet Mission payload instruments are specially designed to operate in very low power conditions.





Lander Control System Flow Diagram. Image: FMI / W. Schmidt.

Payload Instruments

MetBaro Pressure Device: The MetBaro pressure device instrument is based on Vaisala Inc. Barocap® micromachined capacitic silicon sensor and Vaisala transducer technology.
- Weight about 100g with the FPGA card (FPGA is shared with the MetHumi humidity device)
- Resolution: 0.5 Pa; Range: 0 – 1015 hPa
- Accuracy: BOL 5 Pa, EOL 8 Pa

MetHumi Humidity Device: Miniature MetNet Humidity Instrument is based on MSL/REMS design and Vaisala Inc. Humicap® sensor and transducer electronics that have been used in Vaisala radiosondes.
- Weight about 20g without the wires
- Resolution: 0.5 %RH; Range: 0 – 100 %RH
- Accuracy: ±2 %RH at -20 °C, ±4 %RH at -40 °C, ±8 %RH at -70 °C

Panoramic Camera: CCD technology based camera takes panoramic photos of the surrounding environment of the MetNet Lander. PanCam consist of four lenses with 90 degree of FOV. Weight about 100g.

Temperature Sensors: Temperature observations, performed at two positions along the mast, are used to investigate the heat gradients and fluxes and other surface-to-atmosphere interactions. The sensors are lightweight, 2g each, redundant thermocouples.

MOURA Magnetometer / Gradiometer: MOURA is for the measurement of the magnetic field vector, based on two sets of triaxial magnetometers (permalloy stripe detectors). MOURA is a complex system composed of the following sensors: Two triaxial magnetometers shifted in the Z direction with the double objective of redundantce and the capability of performing gradiometry. One triaxial inertial sensor as orientation reference. One temperature sensor for thermal compensation of the magnetic and inertial sensors.

MetSIS Solar Irradiance Sensor: SIS is provided with optical wireless communication for command and data transmission. It is capable of measuring both direct and diffusse solar irradiance in up to 11 bands, ranging from UV to near IR. SIS integrates 27 spectral detectors: Si and CSi PIN photodiodes with optical filters, dedicated detectors for H_2O, O_3 bands, UV bands and dust optical depth measurements, reference sensor to evaluate the degradation in the photodiodes due to radiation effects, 2 temperature sensors and one angle sensor to determine the relative position of the Sun.

Dust Sensor (DS): Measures the particle size distribution of the airborne dust on the Martian surface. The DS is composed of a multispectral detector, a pulsed emitter, both in MWIR and a SMA actuator for automatic calibration. DS measurement principle is IR Mie scattering.

Operations Constraints

Energy:
- Only pre-charged batteries for descent (40 Wh)
- Solar panel generators for charging on ground: 20 x 6V / 50mA = 6W max. average: 600mW

Telemetry:
- Link speed: 0.5 to 5 kbit/s, adjustable according to distance
- Daily data volume: 0.25 to 0.75 Mbit
- No commanding possibility needed after separation from orbiter but possible if orbiter provides commanding capability

Absolute timing:
- Phobos eclipses measurement at pre-calculated times
- Automatic Sunrise / Sunset time determination for operations optimization

Operations control concept

- Activation of processor at regular time intervals, once per 100 ms
- Check of battery status after each wake-up
- Check of possible link connection to orbiter
- Battery-low status or TM-link interrupts any payload operation
- Control of programmable operation via relative time "Cyclogram"
- Up to 20 independent cyclograms with parameter-dependent autonomous selection, based on day/night, humidity, solar incident angle, absolute time, telemetry buffer space and power availability.
- Each cyclogram entry contains: time delay to previous activity; subunit/instrument ID; activity: command with parameters or macro-command for predefined command groups. Each command can automatically be disabled if predefined conditions are not met.

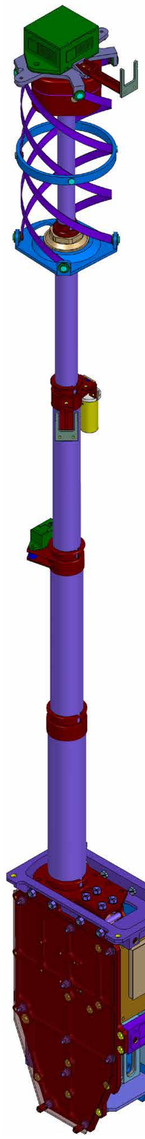
Recent Activities

Full Qualification Model (QM) of the MetNet landing unit with the Precursor Mission payload is currently under functional tests. During the next few months the QM unit will be exposed to environmental tests with qualification levels including vibrations, thermal balance, thermal cycling and mechanical impact shock.

One complete flight unit of the entry, descent and landing systems (EDLS) has been manufactured and tested with acceptance levels. Another flight-like EDLS has been exposed to most of the qualification tests, and hence it may be used for flight after refurbishments. Accordingly two flight-capable EDLS systems exist.

The eventual goal is to create a network of atmospheric observational posts around the Martian surface. Even if the MetNet mission is focused on the atmospheric science, the mission payload will also include additional kinds of geophysical instrumentation.

The next step in the MetNet Precursor Mission to demonstrate the technical robustness and scientific capabilities of the MetNet type of landing vehicle. Definition of the Precursor Mission and discussions on launch opportunities are currently under way. The baseline program development funding exists for the next five years. Flight unit manufacture of the payload bay takes about 18 months, and it will be commenced after the Precursor Mission has been defined.



Atmospheric Instruments

- Pressure Device MetBaro (FMI)
- Temperature Sensors (IKI)
- Humidity Device MetHumi (FMI)

Optical Devices

- Panoramic Camera (LA)
- Solar Irradiance Sensor MetSIS (INTA) with Optical Wireless Link System OWLS
- Dust Sensor, DS (INTA)

Composition and Structure Devices

- Tri-axial magnetometer MOURA (INTA)
- Triaxis System Accelerometer and Gyroscope (FMI)

More information from the Mars MetNet Mission website http://metnet.fmi.fi

Poster design: Harri Haukka, FMI
Background image: NASA