EPSC Abstracts
Vol. 5, EPSC2010-739, 2010
European Planetary Science Congress 2010

MetNet Network Precursor Mission

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Abstract

After more than a decade of development following different approaches for a sophisticated, but lightweight Martian meteorological surface station capable of forming an element of a planetary-wide meteorological station network, the MetNet Network Precursor Mission (MMPM) is close to completion for its first deployment. We present the mission concept and implementation for the first flight model which has already passed most qualification tests.

1. Introduction

For any future manned missions to Mars the knowledge of the climate and its development is essential and can only be established by a network of meteorological stations deployed at many latitudes and altitudes. This requires a low-mass landing vehicle with as little system requirements as possible. The current design was started already in the year 2000, using a state-of-the-art inflatable entry and descent system instead of parachute or active retro-rocket solutions. This reduces the complete deployable mass to 22.2 kg per unit with a 4 kg mass allocation for the payload.

2. Deployment Scenario

For the precursor mission, the MetNet Lander (MNL) [1] will be separated from the spacecraft during the Mars-approaching trajectory before it enters the orbit around the planet. The exact time of separation defines the location of the landing ellipse.

After a flight time of about 36 hours the Main Inflatable Breaking Unit (MIBU) with its ceramics heat shield cover is pressurized half an hour before the expected entry into the upper atmosphere. Altitude: 120 km, entry-velocity 5 km/s at an entry angle of about -10º.

Once the velocity is reduced to about 180 m/s at an altitude between 5 and 11 km (Mach number about 0.8) the Additional Inflatable Breaking Unit (AIBU) is pressurized and will slow down and stabilize the final descent.

The separation of the MIB after the AIBU deployment also extracts the front cone of the landing unit and locks it into place. Depending on landing altitude and atmospheric pressure the impact velocity will be around 50 m/s after a descent through the atmosphere for about 8 minutes.

During the final impact the hardened cone tip burrows into the ground thereby ensuring that the instrument mast with its telecommunication antenna will be oriented in a near vertical position. The shock experienced by the internal payload bay is damped by crash rods which separate the outer shell from the tube-shaped internal payload structure, see Figure 1.

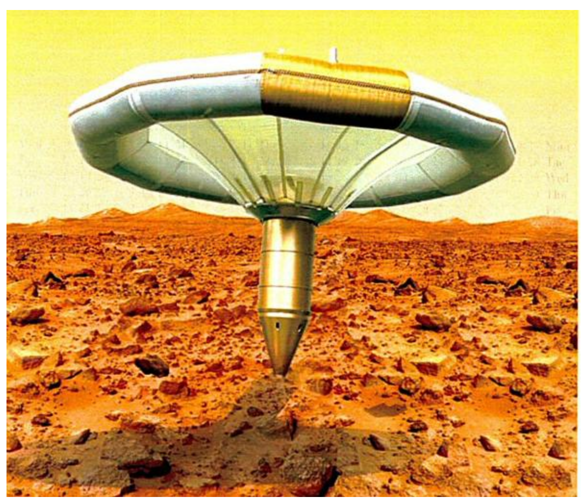

Figure 1: Artistic view of the Mars MetNet Lander.
Photo: Lavochkin Association, Russia.

The precursor version of the MNL includes two radio beacons to monitor the dynamic status after separation and during the descent through the Martian atmosphere. The information is collected by the central processor and transmitted through the small additional antennas attached to the IBUs

3. Operation

After the semi-hard landing the AIBU is deflated and a telescopic mast with main antenna and some of the instruments is deployed. The long-term operation is completely autonomous based on sets of predefined command sequences which are selected according to the predominant circumstances. The Lander is powered by a battery re-charged from flexible solar panels, which are attached to the upper side of the AIBU providing about 300mW on average. Telemetry is uplinked to the orbiter when a hailing signal is detected. It is the intention to continue the operation for at least one Martian year to get some time overlap with the planned follow-up missions.

4. Landing Site Candidates

The landing site options for the MMPM are limited by the transfer trajectory to a latitude range of ±5°. To increase the probability for a safe landing only low altitudes will be chosen, extending the descent time and thereby the effectiveness of the AIBU as much as possible, see figure 2. The areas marked yellow or brown are excluded due to altitudes above 2 km.

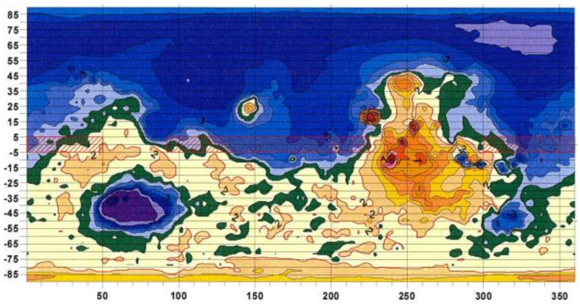

Figure 2: Landing site options for the MMPM. Lavochkin Association, Russia.

References

[1] Project web-site http://metnet.fmi.fi