THE NETLANDER MISSION: A GEOPHYSICAL NETWORK AIMED AT INVESTIGATING MARS ATMOSPHERE, SUB-SURFACE AND DEEP INTERIOR. J. L. Counil, F. Ferri, Ph. Lognonne, O. Marsal, F. Rocard, and R. Bonneville.

The NETLANDER mission aims at deploying on the surface of Mars a network of four identical landers which will perform simultaneous measurements in order to study the internal structure of Mars, its sub-surface and its atmosphere. It will then be the first mission of its kind.

The NETLANDER program is conducted in a European and international co-operative framework under the leadership of the French CNES. A NETLANDER consortium composed of France, Finland, Germany, Belgium has been established in 1999 and a dozen of international partners have hardware contributions to the Payload (nine instruments). The NETLANDER mission will be launched in 2007 together with the CNES Orbiter aimed at preparing the first sample return mission.

The scientific rationale of the NETLANDER project is to investigate the interior, the surface, the atmosphere and the interior of MARS planet. These investigations will be performed thanks to the first network of geophysical station ever installed on the surface of the red planet. Given our very poor knowledge of the planet and in particular of its subsurface and interior, the scientific objectives of the mission are of first priority with respect to MARS exploration.
The NETLANDER mission will be able to answer to crucial question with regard to MARS formation and evolution such as: is there a core like on Earth and how deep is it? is this core liquid or solid? is there still seismic activity? what has been the role of the magnetic field in the evolution of the planet (atmospheric depletion, surface radiation rate…)?
The becoming of the water is also a key question. Although clear evidence of flooding can be seen on the surface, and sedimental layers have been recently evidenced, the today localization and abundance of water is still unknown. NETLANDER will be able to quantitatively answer whether or not the water is frozen in the uppermost layers of the subsurface.
All the recorded data will be used to determine the physical state of the Mars interior (mineralogical composition, conductivity profiles, thermal profiles,…) to characterize the surface process (regolith composition,…), the surface-atmosphere coupling (dust devil triggering and propagation), and the global atmospheric circulation (seasonal and secular variations, …).

To fulfil the overstated objectives with respect to MARS interior, subsurface, atmosphere and ionosphere investigation, the NETLANDER mission will carry a payload composed of nine instruments:
SEISM: Seismometer; PI: Ph. Lognonné, IPG, France
PANCAM: Panoramic camera; PI: R. Jaumann, DLR, Germany
ATMIS: Atmospheric sensors, PI: A.M. Harri, FMI, Finland
ARES-ELF: Atmospheric electricity sensor, J. J. Berthelier, CETP, France
NEIGE: geodesic and ionospheric measurements, PI: J.P. Barriot, GRGS, France
SPICE: Spoil properties measurements, PI: T. Spöhn, univ Münster, Germany
GPR: Penetrating Radar, PI: J. J. Berthelier, CETP, France
MAGNET: Magnetometer, PI: M. Menvielle, CETP, France
MICRO: Microphone, PI: G. Delory, Univ. Berkeley, USA

Mission scenario

The NETLANDER mission scenario is as follows:

- The 4 NetLander probes are launched in 2007 : during the launch and the cruise phase to Mars, they are attached to the carrier responsible in particular of the propulsion,
- On arrival at MARS, they are ejected from the carrier according to a sequence depending on the choice of their landing sites. In order to allow precise orbit determination during the NetLander separation, 4-day intervals are necessary between two lander separations. Hence, the separation sequence starts several weeks before arriving at Mars
- After the coast phase and the atmospheric entry phase, the probes land on Mars. The landers are initialised and their antenna is deployed to begin exchanging data and commands with the Earth,
- During their operations on the surface of Mars, the NetLander probes communicate with the Earth via an Mars orbiter (the CNES 2007 orbiter and/or any telecom satellite in Martian orbit)

Landing sites

The choice of landing sites will result from a compromise between scientific objectives and technical constraints.
The technical constraints are mainly the co-ordinates (reachable from the orbit), the altitude (a too high altitude prevents the parachutes to work properly), the site characteristics (slopes, rocks percentage, …)
The scientific requirements are primarily driven by the objectives of network science, which are expressed in terms of network shape, latitudinal and longitudinal coverage, distances between the stations. Each network experiment

(seismology, magnetism, meteorology) has its own requirements. In addition, the network must be robust to the accidental lose of one NETLANDER during the cruise, at landing or during operations at MARS. Sites of specific interest have also been identified (e.g. sites where water reservoirs can be expected at low depths) and should be as much as possible included in the network.
The final configuration that can impact the NETLANDER design is expected to be settled at the end of phase B.

NetLander design

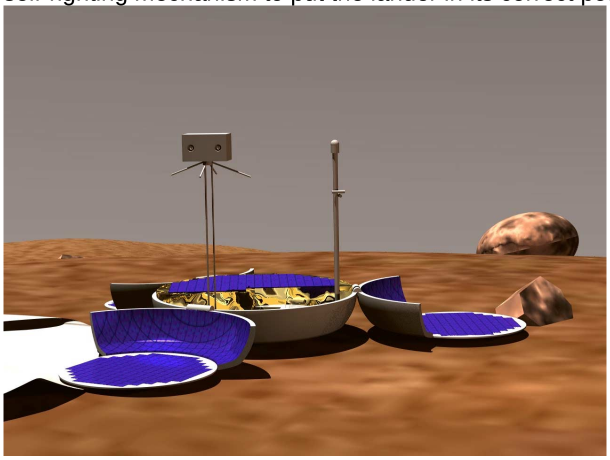
Each NetLander probe comprises two main sub-assemblies :
- the Surface Module,
- the Entry, Descent and Landing System (EDLS).

The EDLS function is to protect the Surface Module during all mission phases until its deployment on the surface of Mars. The atmospheric phase begins when the atmosphere is detected by accelerometer measurements. During the entry phase, the heat-shield reduces the velocity of the probe and the parachute system is activated when the probe velocity is low enough to allow parachute deployment. These conditions have to be obtained at high enough altitudes to maximise the efficiency of the parachute phase. Because of the low atmospheric density on Mars, the efficiency of the parachute system is limited : an additional landing system is necessary to reduce the landing shock.

After landing, first operations will consist in the deployment of the solar arrays and the telecommunication antenna. The scientific instruments are then activated and checked. Before starting the network mode, first camera images will be acquired in order to characterise the landing site, and radar measurements will be performed.

The NetLander mission duration is expected to last over one Martian year.

During the surface operations, solar panel provide energy during day-time. Rechargeable batteries are used to store energy for night-time operations. In order to provide enough solar energy, deployable solar arrays are necessary : they are located on the internal surface of petals which are unfolded after landing. One of the petals also serves as a self-righting mechanism to put the lander in its correct position if it lands upside down.



NETLANDER in deployed configuration

The total mass of the NetLander probe is 66 kg when it enters the Martian atmosphere. After landing and ejection of all EDLS elements, the mass of the Surface Module is 22 kg, of which 5,2 kg are allowed for scientific instruments.