PLANNING FOR A MARS LONG-LIVED WEATHER NETWORK

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Introduction:

Over the last three decades, several mission concepts have been considered that would investigate the weather on Mars with a combination of landers and orbiters. These missions would allow characterization of the Martian atmosphere as well as surface and internal phenomena. The following network missions have been studied in a European context: MarsNet, InterMarsNet, NetLander, MarsNExT and the Mars Network Science Mission (MNSM)[1-5]. Every mission concept stated here, was driven by scientific interest in order to improve our understanding of the both the past and present state of Mars.

Our understanding of Mars's history, potential for life and environmental conditions will improve with the upcoming ExoMars and Mars Sample Return (MSR) missions. These missions will also exercise European technologies and capabilities for access to Mars orbit, Mars surface (with mobility) and sub-surface, as well as the first round-trip journey between Earth and Mars.

ESA is currently preparing to contribute to eventual human exploration of Mars. For this endeavour, key strategic knowledge gaps remain. Currently, a Mars weather network mission can be considered as a multipurpose mission since it would be able to fulfil both scientific objectives and close strategic knowledge gaps to prepare for future human exploration of Mars, as described in the Terrae Novae 2030+ Strategy Roadmap[6].

These include the origin of dust storms, global, regional and local winds, dust properties and transport as well as the understanding of the long-term behavior of the atmosphere.

Current status:

Following a successful ESA internal study[7] in the Concurrent Design Facility (CDF), a long-lived weather network mission comprising several orbiters and landers is currently under industrial study. With a reference launch date in the early- to mid-2030s, this mission would be the first coordinated global, regional and local network of atmospheric science and weather stations at Mars. While intended as an ESA-led mission, the concept lends itself very well to partnership opportunities with international partners while maintaining manageable interfaces.

The primary science objectives would be addressed by meteorological and dust transport measurements from both the orbital elements and the landed platforms. In addition, the landers would also contain a radio science, seismology and heat flow payload suite to address other geophysical science objectives.

The initial CDF study results show the technical feasibility of such a mission to be undertaken in the 2030s at landing sites between 0° and 20°N, using existing European heritage in chemical propulsion Orbiters and ballistic Entry, Descent and Landing (EDL) technology. Challenges for the lander elements include the need for radioisotope heater units (RHUs), large solar arrays with dust-removal systems, and energy-efficient platform and payload operations. These are all driven by the need to survive for multiple Martian years on the surface with the ability to maintain science operations through potential global dust storms.

Summary:

This paper gives an overview of the mission architecture and system design, the science objectives and payload suites for each space element, the concept of operations of the network, risks and technology development activities and preliminary results available from ongoing industrial studies.

Bibliography:

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[2] InterMarsNet, 1996, Planetary and Space Science Volume, 44, Issue 11, p. 1221-1470

[3] CDF Study Report CDF-19(A) 'Probe Network On Mars Surface' Mars Network Science (NetLander), 2003

[4] CDF Study Report CDF-63(A) 'Technology Demonstration for Future Mars Missions' (Mars NExT), 2008

[5] CDF Study Report CDF-124(A) 'Assessment of Mars Network Science Mission' (MNSM), 2011

[6] Terrae Novae 2030+ Strategy Roadmap http://youbenefit.spaceflight.esa.int/terrae-novae-2030-exploration-strategy-roadmap/

[7] CDF Study Report CDF-214 (C), 2021 'FAHRENHEIT – First mArs High-resolution Regional Environmental monitoring Network for Human Exploration-related climate Investigations and dust Transport'