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Author: Mr. Adam McSweeney
European Space Agency (ESA), The Netherlands, adam.mcsweeney@esa.int

Dr. Sanjay Vijendran
European Space Agency (ESA), The Netherlands, sanjay.vijendran@esa.int
Dr. Claire Parfitt
Systems Engineering & Assessment Ltd, United Kingdom, claire.parfitt@sea.co.uk
Dr. Andrew J. Ball
European Space Agency (ESA-ESTEC), The Netherlands, andrew.ball@physics.org
Mr. Hakan Svedhem
European Space Agency (ESA), The Netherlands, Hakan.Svedhem@esa.int
Dr. Csilla Orgel
European Space Agency (ESA-ESTEC), Netherlands Antilles, csilla.orgel@esa.int

ARCHITECTURE ASSESSMENT OF A POTENTIAL FUTURE EUROPEAN MARS WEATHER, CLIMATE AND ATMOSPHERE NETWORK MISSION CONCEPT

Abstract

Our current understanding of Mars's atmosphere and climate is informed by the wealth of data that has been returned from robotic missions but has usually been limited to measurements taken of a single parameter at a single location and at a single time. Current models of Mars's climate, atmosphere and circulation could now be better addressed with targeted missions able to perform systematic investigations, observing multiple parameters at multiple locations simultaneously in time. Such an investigation system will likely necessitate a network of multiple spacecraft and landers deployed in various locations at Mars. The data returned from such simultaneous network observations could address key scientific knowledge gaps and inform models used for understanding the present and predicted future state of the planet's atmosphere and climate. These inputs could therefore also inform planning and reduce risks for future human exploration of Mars.

To respond to this objective, ESA's Exploration Preparation, Research and Technology team within the Directorate of Human and Robotic Exploration are studying mission concepts to deploy a network of orbiters and landers for dedicated climate and atmosphere investigations in the 2030s.

The deployment of such a multi-spacecraft system presents a complex trade-space of candidate architecture options. This architecture assessment has been facilitated through the creation of sizing tools to perform rapid assessments of candidate concepts using lessons learnt from architecture studies for Mars Sample Return mission concepts.

The goal of this study is to identify candidate architecture concepts which could fulfil the mission objectives and are considered technically feasible for ESA-led implementation in the 2030s. This assessment covers a range of alternative transfer strategies, comparisons of chemical and electrical propulsion trajectories, and a multitude of trade-offs related to end-to-end transfer, configuration and deployment strategy. The key design drivers identified and a sensitivity assessment is made of alternative lander sizes corresponding to varying degrees of science objective fulfilment.

The paper concludes with an outline of example candidate mission architectures that appear technically feasible, and an overview is given of a reference concept which has been studied in the ESTEC Concurrent Design Facility.