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VEHICLE DESIGN AND MISSION ARCHITECTURE FOR AN EXPLORATION EXCURSION VEHICLE FOR DEIMOS AND PHOBOS

Abstract

The Martian moons Deimos and Phobos present a unique resource within the Mars system as a testing ground for exploration technology, as well as being a potential hub for interplanetary missions, in-situ resource utilization, and as sources of valuable insight into the formation of the solar system. Their low gravity and ease of access from a standard interplanetary transfer make them desirable staging grounds for an incremental approach to the exploration of the Martian system. The possible presence of ice and valuable minerals beneath the surface of these moons opens the door for in-situ resource utilization to expand the range of operations of future missions. Spacecraft designed for sustainable interplanetary missions are commonly dedicated crew transit vehicles, with dedicated landing and exploration craft being delivered to the system in advance. This approach calls for a new, versatile mission and spacecraft design that is able to carry out multiple mission profiles including rendezvous and transfer procedures, in-system transit between mission destinations, and the delivery of scientific instruments to and from those destinations.

This work delivers a dedicated Exploration Excursion Vehicle design and mission architecture for the exploration of both Deimos and Phobos in a single sortie from a crew transit vehicle, including surface sample return. The mission profile includes all stages of development and deployment from design and launch to post-mission operations. Vehicle system and subsystem analyses are requirement driven and presented in detail, taking into account technical, social, political, and economic constraints across the mission structure. Novel technologies and applications are presented to overcome the unique challenges of a multiple-landing-and-takeoff capable vehicle and for delivery of the mission vehicle approximately two years prior to crew arrival. The mission architecture is designed for a maximum 30-day sortie from the time of crew arrival, including check-out and decommissioning operations, and relies minimally on unproven or undeveloped technology to allow for deployment within 20 years for under $1 billion USD$.