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REUSABLE IN-SPACE TRANSPORTATION ARCHITECTURE OPTIONS FOR HUMAN MARS EXPEDITIONS

Abstract

NASA's Mars Study Capability Team and the Mars Integration Group continues the agency's efforts to study and refine the nation's plan to field a sustainable human Mars campaign. Building upon the success of the Evolvable Mars Campaign, the Mars Study Capability Team is further developing capabilities to improve the fidelity of the Mars campaign and to continue exploring the design trade space to assess the impact of technology investments and architecture decisions for missions to Mars in the 2030s. NASA has been investigating the use of Solar Electric Propulsion, Chemical Propulsion, and Nuclear Thermal Propulsion systems to deliver crew and cargo to Mars orbit in support of expeditions to the Martian surface. Chemical Propulsion systems have been utilized for all human exploration missions to date. Solar Electric Propulsion systems have been utilized for long duration science missions to outer planets and has been proposed as an option to deliver cargo in support of human expeditions. Nuclear Thermal Propulsion systems have been proposed to field long duration human missions since the Apollo program. Advancements in technologies have prompted NASA to evaluate each of the transportation options for updated Mars expedition architectures. Additionally, NASA has been investigating the Hybrid transportation architecture, which combines chemical propulsion system with solar electric propulsion system into a single integrated design. This paper presents the in-space transportation system architecture options in support of human Mars expeditions. System level trade studies will be presented to show how each of the systems perform to field a series of Mars missions across multiple mission opportunities. Each propulsion system element will be designed to deliver both crew and cargo elements to the Martian orbit. Sensitivity analysis will show how each transportation architecture responds to changing payload requirements, varying Mars landing sites, and fielding missions in off-nominal mission opportunities. Additionally, each architecture option will be evaluated for reusability, which has been a primary focus of NASA's effort in designing missions to Mars. The paper will provide an overview of the team's continuing efforts to update and refine the agency's analysis capabilities in planning for the eventual human Mars expedition.