Updated Mars mission architectures featuring Nuclear Thermal Propulsion

Mitchell A. Rodriguez[1], Thomas K. Percy[2]
[1]*Jacobs Engineering Group, Jacobs ESSSA Group, Huntsville AL 35806*
[2]*SAIC, Jacobs ESSSA Group, Huntsville AL 35806*

Abstract. Nuclear thermal propulsion (NTP) can potentially enable routine human exploration of Mars and the solar system. By using nuclear fission instead of a chemical combustion process, and using hydrogen as the propellant, NTP systems promise rocket efficiencies roughly twice that of the best chemical rocket engines currently available. The most recent major Mars architecture study featuring NTP was the Design Reference Architecture 5.0 (DRA 5.0), performed in 2009. Currently, the predominant transportation options being considered are solar electric propulsion (SEP) and chemical propulsion; however, given NTP's capabilities, an updated architectural analysis is needed. This paper provides a top-level overview of several different architectures featuring updated NTP performance data. New architectures presented include a proposed update to the DRA 5.0 as well as an investigation of architectures based on the current Evolvable Mars Campaign, which is the focus of NASA's current analyses for the Journey to Mars. Architectures investigated leverage the latest information relating to NTP performance and design considerations and address new support elements not available at the time of DRA 5.0, most notably the Orion crew module and the Space Launch System (SLS). The paper provides a top level quantitative comparison of key performance metrics as well as a qualitative discussion of improvements and key challenges still to be addressed. Preliminary results indicate that the updated NTP architectures can significantly reduce the campaign mass and subsequently the costs for assembly and number of launches.

Keywords: Nuclear Thermal Propulsion, NTP, Architecture, Transportation, Mars.