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MARS EXPLORATION VEHICLE (MEV) ARCHITECTURE FOR HUMAN EXPLORATION OF MARS, WITH ARTIFICIAL GRAVITY AND MINI-MAGNETOSPHERE CREW RADIATION SHIELD

Abstract

This paper presents the conceptual Mars Exploration Vehicle (MEV) architecture, which includes a Mars Crew Transfer Vehicle (MCTV) with a crew of four, and two unmanned Mars Lander Transfer Vehicles (MLTVs). MCTV and MLTVs are assembled in low Earth orbit (LEO) from modules launched by four Space Launch System (SLS) and five Delta IV Heavy rockets. The MCTV and MLTVs individually escape from LEO, transit to Mars, brake into Mars orbit using propulsion and aerobraking, and rendezvous and dock in low Mars orbit (LMO). Each MLTV includes an Earth Departure stage (EDS), Mars Transfer Stage (MTS), Lander Service Module (LSM), and two landers: A Mars Personnel Lander (MPL) provides two-way transport of the four crewmembers between LMO and the surface. Three unmanned Mars Cargo Landers (MCLs) provide one-way cargo transportation and the functionalities of habitat and rover. Landers assemble on the surface to form a base. The MCTV includes two EDS, two MTS, and the following: (1) The Multi-Purpose Crew Vehicle (MPCV) transports the crew from Earth to LEO, provides propulsion, and returns the crew to Earth after completion of a nominal mission or in aborts. (2) Three Deep Space Modules (DSMs) provide life support consumables, passive biological radiation shielding, crew habitation space, and propulsion. DSMs are modified MCL habitat landers. (3) An Artificial Gravity Module (AGM) allows the MCTV to rotate and generate artificial gravity for the crew and provides photo-voltaic power generation and deep space communications. A miniature magnetosphere (Mini-Mag), a potential key enabler for human interplanetary exploration, is electromagnetically generated on the AGM and provides active crew biological radiation shielding. The MEV architecture incorporates significant modularity and could provide an economical approach to achieve progressively more ambitious "stepping stone" missions along a "flexible path" for human exploration of the solar system: starting with test flights in Earth and lunar orbit and progressing through missions to near-Earth asteroids and the moons of Mars, and culminating in the Mars landing mission.