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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human Exploration of Mars (2)

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MARS VISION 2030: A HUMAN EXPLORATION ARCHITECTURE FOR ESTABLISHING A LONG-TERM PRESENCE ON MARS

Abstract

Mars Vision 2030 is an exploration architecture for a campaign of round-trip conjunction-class crew missions to the Mars surface in the 2030-2040 timeframe. This architecture was designed as an alternative to NASA's Design Reference Architecture 5.0 (DRA 5.0) with three overarching goals: 1. Minimize mission cost through the reuse of architecture elements where possible 2. Develop an in-space infrastructure to enable future, larger-scale missions to Mars 3. Establish a permanent Mars surface station capable of supporting future missions beyond this initial architecture

At the start of the campaign, several elements are pre-deployed to the Mars surface. These elements are (1) the primary habitat module with crew quarters and closed-loop life support systems, (2) a resupply habitat module with food and consumables for the first surface mission, (3) a nuclear-fission power system, pressurized rover, and other surface equipment.

Before the first mission, a Crew Transfer Vehicle (CTV) consisting of an in-space habitat, lander, Mars Ascent Vehicle (MAV), and propulsive stage is assembled in a Distant Retrograde Orbit (DRO) around the Moon. Once the CTV is assembled, the crew is delivered to DRO using an Earth Return Vehicle (ERV). The CTV then departs DRO (without the ERV) and transfers the crew to Mars orbit. Once the surface mission is complete, the CTV returns the crew to DRO. The crew then returns to Earth in the ERV.

For subsequent crew missions, the transfer habitat and propulsive stage of the CTV are reused. The propulsive stage is refueled, and the transfer habitat is refurbished with new outfitting and consumables. Similarly, the surface habitat modules are reused; a new resupply module is delivered direct to the Mars surface ahead of each crew. The crew uses the pressurized rover to transfer from the lander/MAV and the surface base.

In-space propulsion is provided by Nuclear Thermal Propulsion (NTP). Mars descent and ascent propulsion is provided by chemical rocket engines. The in-space and surface habitats rely on fully closed water and air life support systems; food and crew consumables are provided for each mission.

Details of the engineering analysis are provided in the paper, including interplanetary trajectory analysis to determine mission C3 requirements and available launch windows and engineering diagrams and mass breakdown statements for all of the architecture elements. Programmatic factors such as mission cost, technology development, and mission dependencies are also discussed.