Space Launch System Co-Manifested Payload Options for Habitation

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Abstract

The Space Launch System (SLS) has a co-manifested payload capability that will grow over time as the rocket matures and planned upgrades are implemented. The final configuration is planned to be capable of inserting a payload greater than 10 metric tons (mt) into a trans-lunar injection trajectory along with the crew in the Orion capsule and the service module. The co-manifested payload is located below the Orion and its service module in a 10-meter high fairing similar to the way the Saturn launch vehicle carried the lunar lander below the Apollo command and service modules. A variety of approaches have been explored that utilizes this co-manifested payload capability to build up infrastructure in deep space in support of future asteroid, lunar, and Mars mission scenarios. This paper is a report on the findings from the Advanced Concepts Office study team at the NASA Marshall Space Flight Center, working with the Advanced Exploration Systems Program on the Exploration Augmentation Module Project. It includes some of the possible options for habitation in the co-manifested payload volume on SLS. Findings include module designs that can be developed in 10mt increments to support these missions, including overall conceptual layouts, mass properties, and approaches for integration into various scenarios for near-term support of deep space habitat research and technology development, support to asteroid exploration, and long range support for Mars transfer flights.

Introduction

The initial destination for the missions under consideration is the lunar distant retrograde orbit (LDRO) that passes through or near the earth-moon Lagrangian points, L1 and L2. The LDRO is a stable orbit that is ideal for the asteroid retrieval mission and is also suitable for Mars transfer vehicle assembly, Mars habitat refurbishment between missions, and lunar lander refurbishment between missions. A location and implementation strategy with this kind of flexibility offers opportunities for reusability that have not always been practical from staging points at other locations.

The initial plan for the co-manifested payload on SLS is to provide an augmentation module with the capability of extending the Orion's crew life support system for a crew of 4 from 21 days up to 60 days. With additional habitable volume on the augmentation module it is envisioned that laboratory space can be outfitted to begin testing of systems in deep space that are critical for long-term exploration missions. This includes both advanced vehicle subsystem and human healthcare research and technology development.

With the planned arrival of an asteroid retrieval vehicle in the mid-2020s there will be a need to build up the LDRO facility to expand the exploration habitation systems with

an airlock for crew extra-vehicular activity (EVA), and possibly some robotic systems to assist the crew with EVA on the asteroid to collect samples and set up resource utilization experiments.

Mars mission planning includes a transit habitat in the 2030s that can accommodate a crew of 4 for up to 1000 days. The working assumption is that a standard design for a habitat could be developed to accommodate a variety of mission options including Mars flybys, Phobos or Deimos exploration, or Mars surface exploration for both short 30-day or long 500-day surface exploration timeframes. Habitats within the 10mt co-manifested payload limit were found to be too small for the Mars transit mission, so emphasis was placed on large volume modules with minimal systems that could accommodate outfitting from later flights. Multiple modules were utilized to develop safe haven concepts and build up the full capability required for the long duration missions to Mars.