14TH IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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DESIGN CONSIDERATIONS FOR SPACECRAFT OPERATIONS DURING UNCREWED DORMANT PHASES OF HUMAN EXPLORATION MISSIONS

Abstract

NASA is transforming human spaceflight. The Agency is shifting from an exploration-based program with human activities in low Earth orbit (LEO) and targeted robotic missions in deep space to a more sustainable and integrated pioneering approach. Through pioneering, NASA seeks to address national goals to develop the capacity for people to work, learn, operate, live, and thrive safely beyond the Earth for extended periods of time. However, pioneering space involves daunting technical challenges of transportation, maintaining health, and enabling crew productivity for long durations in remote, hostile, and alien environments.

Subject matter experts from NASA's Human Exploration and Operations Mission Directorate (HEOMD) are currently studying a human exploration campaign that involves pre-deployment of assets for planetary exploration. This study, called the Evolvable Mars Campaign (EMC) study, has identified solar electric propulsion as the in-space transportation architecture which involves long duration periods of transit to destinations. The EMC study is also investigating pre-deployment of human rated systems like landers and habitats to the surface of Mars, which also will involve long periods of time when these systems are either in transit or staged on the surface. In order to enable the EMC architecture, autonomous vehicle operations must be utilized during these long periods of dormant operations to ensure the systems are ready for use when the astronauts arrive on the planet. Subject matter experts from HEOMD's System Maturation Team have identified additional critical capabilities, systems and operations that are needed to enable EMC missions especially during these dormant phases of the mission. Dormancy is defined by the absence of crew and relative inactivity of the systems. For EMC missions, dormant periods could range from several months to several years. Two aspects of uncrewed dormant operations are considered herein: (1) the vehicle systems that are placed in a dormant state and (2) the autonomous vehicle systems and robotic capabilities that monitor, maintain, and repair the vehicle and systems.

This paper will describe the mission stage of dormancy operations, phases of dormant operations, and critical system capabilities that are needed for dormant operations. This paper will compare dormancy operations of past robotic missions to identify lessons that can be applied to planned human exploration missions. The paper will also provide analysis regarding the complexity of systems needed for this unique type of operation. Finally, this paper will also identify future work and analysis planned to assess system performance metrics and integrated system operations.