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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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GATEWAY AT THE CROSSROADS OF SUSTAINABLE LUNAR EXPLORATION

Abstract

The Gateway Program has made substantial design and development progress toward delivering a small, human-tended lunar space station purposefully designed to enable sustainable human exploration. The Program integrates international partners and providers organizationally and physically as part of the spacecraft. The Power and Propulsion Element (PPE) and the Habitation and Logistics Outpost (HALO) with the European System Providing Refueling, Infrastructure and Telecommunications (ESPRIT) HALO Lunar Communications System (HLCS) have begun manufacturing the long lead components and will be launched first as a Co-Manifested Vehicle (CMV). The International Habitat (I-Hab) and ESPRIT Refueling Module (ERM) are passing life cycle milestones and include capabilities key for human crewmembers, such as windows, private sleeping quarters, and galley functions. The Logistics Module (LM) may provide a variety of services to Gateway depending on each mission. Requirements for the airlock have been developed, including requests that it support the integrated spacecraft with functions like augmenting heat rejection capabilities, and interfaces with new spacesuits will soon be developed in more detail. As a critical element of the architecture for solar system exploration, Gateway implements key tenets and features of international interoperability standards necessary to operate with multiple visiting vehicles and lunar assets, especially avionics, communications, and docking. Specific choices such as software architecture and standards, power standards, and robotics standards make it possible to utilize heritage or proprietary technology, yet still operate as one spacecraft. Engineering teams are evaluating many possible future missions to be executed at or utilizing the Gateway. The system architecture protects for an evolvable, extensible, and flexible capability. Designing systems robust enough to serve as a cornerstone of exploration activities for decades while remaining adaptable is not without its challenges. The detailed integration activities have revealed challenges and the need to mature key technologies. Refueling is a key component of achieving long life for Gateway, with unique operations to plan, safety concerns to mitigate, and risk reduction activities to conduct to better understand the system. The constraints and impacts of the design of visiting vehicles is also an important concern, with orientation constraints, control of attitude and orbit of the Gateway with docked visiting vehicles. Tradeoffs between robust maintainable systems and lightweight, compact systems must be balanced. Opportunities still exist for adding additional advanced capabilities to increase and extend Gateway's benefits, such as intravehicular robotics, autonomous Guidance Navigation and Control (GNC), and augmented control propulsion, heat rejection, or other services.