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RESILIENT CISLUNAR ARCHITECTURE TO ENABLE KEY MARS TECHNOLOGIES AND OPERATION CONCEPTS

Abstract

Multiple agencies and industry partners are defining concepts to extend human presence to lunar space and beyond to Mars. Any architecture for lunar space exploration must satisfy two primary goals – the demonstration of Mars mission readiness and flexibility and resiliency to multiple variables. Mars mission readiness is demonstrated through selection and testing of applicable spacecraft technologies and operation techniques. Lunar proving ground missions will, by their nature, mature promising technologies but must be able to accommodate and adapt to changing international budgets, priorities, schedules and unforeseen challenges.

Boeing recently developed a cislunar proving ground architecture and operation concept addressing these fundamental goals that is based upon the heavy lift capability of the Space Launch System (SLS) and the integrated capability to co-manifest a 10t element with Orion on a single launch to cislunar space. The architecture seeks to maximize utilization of available capabilities to maintain a consistent human cislunar presence and develop Mars mission readiness. Key Mars technology and operations demonstrations include deep space environment mitigations, advanced closed loop ECLS systems, electric propulsion, automated rendezvous docking, operating with significant communications lag and telerobotic operations. Flexibility and resilience features include distributed and redundant systems functionality and a capability to respond to changing mission plans and auxiliary elements.

This paper describes the elements and concept of operations of the Boeing architecture and analyzes the extent to which the architecture enables the demonstration of technologies and mission operations required for a Mars mission. The flexibility and resilience of the architecture are also examined. Key elements of achieving that flexibility include distribution of key functions of space craft C&DH, attitude control, basic life support, etc among initial modules such that the architecture can support launch order independence. The use of a modular plug and play architecture allows other subsystems that are supported in a single element only to be integrated late in processing flow. Standards for interfaces such as data, power, docking, rendezvous, and communication allow for multiple commercial and international partners to develop and integrate their own enabling technologies/subsystems. The Boeing architecture demonstrates that near term objectives, such as lunar surface interactions and asteroid exploitation, can be accomplished while steadily building a Mars capability.