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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 AND INTEGRATION OF MODULAR DEEP SPACE HABITAT USING A ROBUST OPTIMIZATION FRAMEWORK

Abstract

The aim of this study is to provide a Systems of Systems framework that can guide the design and production of a multi-sourced, modular, deep space crew vehicle. This vehicle could be used to provide crew habitat for the exploration of cislunar space, near earth asteroids and Mars. The goal is to allow an entity, such as NASA, to leverage assets such as commercial and international partners by using near term or pre-existing hardware in a modular fashion. There exist today countless different pieces of space hardware, modules and vehicles that differ in their development level from preliminary designs to flight tested hardware. The ability to add or subtract modules at different points in a timeline could fall in line with the stepping stones approach NASA wishes to take. A portfolio optimization technique is used to explore combinations of pre-existing or near term hardware that work cohesively to meet overarching capability objectives. This approach also allows for the performance uncertainty of development stage hardware. Connectivity constraints of hardware are addressed through the use of network theory. This approach offers benefits such as robust design and the ability to spread a space budget across multiple sources of funding. The evolutionary capability of such an approach allows for early vehicle and hardware testing similar to the progression of the International Space Station. Disadvantages include the lack of complete control over portions of the every system and the added complexity in combining hardware. The aim of this study is to provide a useful metric when comparing to a single source monolithic space vehicle. Example scenarios explored at the end of this paper include the application of this method to exploration class missions including near Earth architectures, Mars architectures and an Earth-Mars cycler.