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

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CARGO FIXING ASSEMBLY MODULE FOR INTERPLANETARY TRANSPORT MISSIONS

Abstract

With the NewSpace ecosystem developing rapidly and humanity facing increasing existential risk, the reality of multi-planetary settlement is fast approaching. We are seeing increasing interest and investment from the public and private space sectors to undertake further human and robotic space exploration missions. These early missions will provide the foundation for humanity's continued presence on the Moon and Mars. They will be vital for integrating the necessary systems to support our energy needs, health and wellbeing, communication, transportation, and general advancement of our capabilities in new worlds.

As more permanent infrastructure is established, we will see increasing demand for new types of complex systems to be transported into space. Such systems include - but are not limited to - agricultural technology, communications stations, in-situ resource utilisation (ISRU) technology, and nuclear plants. We are beginning to move away from cargo launches containing only spacecraft and station supplies, and towards a reality where a range of complex systems are being transported on interplanetary missions to support the improvement of human capabilities off-Earth.

The current state-of-the-art method for integrating arbitrary, non-robust cargo into launch vehicles involves the design and production of custom interfaces, or the introduction of standard payload adapter fitting (PAF) compatibility as a system-level requirement for the design of the cargo itself. There are currently no operational concepts for cargo transportation interfaces capable of transporting a range of planetary infrastructure cargo from payload integration point to planetary surface location.

With development of a permanent Lunar base already underway with the Artemis program - and crewed Mars missions proposed for as early as 2029 - it is clear that the design of a bespoke interface for each individual type of infrastructure cargo would be expensive and complex. Proposals such as those by SpaceX to send over 1000 vehicles containing humans and cargo to and from Mars every 24 months over the coming decades could gain large economic and programmatic benefits from a versatile cargo interface system capable of accommodating all or most types of payloads used in the development of infrastructure for the NewSpace ecosystem.

This project details a systems-engineering approach to the design of a sustainable cargo fixing assembly module (CFAM) to support reliable, high-capacity transportation of a range of planetary infrastructure cargo from payload integration point to planetary surface location. Such a system will reduce the cost and complexity of inter-planetary cargo transportation and increase access to space for all.