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

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EDEN: EXTRATERRESTRIAL DISTRIBUTED ECOCULTURE NETWORK

Abstract

Astronaut crew will need ample supplies for the long Mars expedition, which will take at least six months of one-way transit in interplanetary space. Crews on the International Space Station are currently fed dehydrated Earth food which is produced and delivered to Low Earth Orbit on a periodic basis for an enormous cost of around $72,000/kg. Extended human presence in cislunar space, on the lunar surface and en route to Mars will simply not be sustainable on finite rations from Earth resupply. In contrast, the Moon is the closest, largest geocentric satellite with enormous solar potential and vast, natural, pristine surface available for extraterrestrial farming. And at 1/6th the gravity well of Earth, the Moon affords tempting, sustainable cost advantages for transportation of fresh crops from the lunar surface into both cislunar orbit and even to LEO at a lesser delta-V than traditional Earth-based resupply. Therefore space architectures which enable lunar agriculture offer an attractive option to realizing a self-sustaining, space-faring society.

In this proposed Extraterrestrial Distributed Ecoculture Network (EDEN) architecture, the feasibility of lunar surface agriculture to sustain human presence on the lunar surface and in lunar orbit is considered in context of NASA's current Lunar Exploration Campaign Roadmap.

A long-term vision is presented depicting the engineering of a crop cycle on the lunar surface by staggering greenhouse modules across longitudes following the natural diurnal lunar phase. Crops are ferried between the lunar surface and lunar orbiting stations to complete their lifecycle. The architecture is evolved in phases, and a detailed design for Phase 1 of the architecture is presented in the form of a remote demonstration of a mobile greenhouse spacecraft ready by 2022. The critical deliverable of the design is a versatile, reusable lunar ascent/descent utility lander capable of sub-orbital hops and injection into Lunar Orbit, where it may rendezvous with stations like NASA's Lunar Orbiting Gateway. Strategies for crop production, distribution and recycling are considered, and are fed forward into agricultural cost/benefit models and mission budgets. Finally, associated challenges to the architecture are identified, and future phases of EDEN are assessed.