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From Earth Missions to Deep Space Exploration (05)
Cis-Lunar Outposts and other Exploration Missions (5)

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# CIS-LUNAR BASE CAMP

**Abstract**

Historically, when mounting expeditions into uncharted territories, explorers have established strategically positioned base camps to pre-position required equipment and consumables. These base camps are secure, safe positions from which expeditions can depart when conditions are favorable, at which technology and operations can be tested and validated, and facilitate timely access to more robust facilities in the event of an emergency. For human exploration missions into deep space, cis-lunar space is well suited to serve as such a base camp. The outer regions of cis-lunar space, such as the Earth-Moon Lagrange points, lie near the edge of Earth's gravity well, allowing equipment and consumables to be aggregated with easy access to deep space and to the lunar surface as well as more distant destinations, such as near-Earth Asteroids (NEAs) and Mars and its moon.

Extending existing in-space supply chains from Low Earth Orbit (LEO) to cis-lunar space enables increased experience and confidence outside of the Earth's Van Allen radiation belts while still allowing crew members to return home within a few days in the event of an emergency. The operational environment is similar to deep space, allowing technology and operational approaches to be tested and validated, and facilitates the scheduled initiation of more ambitious expeditions. Additionally, a cis-lunar base camp allows for the establishment of a human-tended scientific laboratory and sample return and quarantine facility, as well as a location for aggregating in-situ resources from NEAs or the lunar surface. This paper will discuss the evolved exploration capabilities that can be realized with a cis-lunar base camp approach.

If cis-lunar space is used as a base camp for deep space exploration, cost efficient delivery of cargo and crew is critical to programmatic success. Various trade options focused on leveraging existing and near term technologies are considered for a supply chain to a cis-lunar camp. Trade options include in-space transportation options using high-thrust propulsion, low-thrust propulsion, and a hybrid of both propulsive approaches. The ratio of mass launched to mass delivered will show the efficiency of each option, and will be used for mission equipment and consumables manifesting to provide insight into possible base camp aggregation concepts of operations. These manifests are then used to develop high-level cost estimates that enable cost-to-benefit comparisons of various supply chain options.