

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

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TIME AND ENERGY, EXPLORING TRAJECTORY OPTIONS BETWEEN NODES IN  
EARTH-MOON SPACE

**Abstract**

The Global Exploration Roadmap (GER) was released by the International Space Exploration Coordination Group (ISECG) in September of 2010. It describes Mission Scenarios that begin with the International Space Station and utilize its capabilities to demonstrate necessary technologies and capabilities prior to deploying systems into Earth-Moon space. Deployment of these systems is an intermediate step in preparation for more complex deep space missions to near-Earth asteroids and eventually Mars. In the two scenarios described in the GER, “Asteroid Next” and “Moon Next”, there are activities that occur in Earth-Moon space either at Earth-Moon Lagrange (libration) points or in lunar orbit. Although the nature of these activities are different depending on the next destination, there appears to be potential for taking advantage of common capabilities in either scenario. In this regard, the authors examine the relative advantages of each intermediate staging point in an effort to illuminate the transfer options among the different nodes and how they relate to eventual deep space missions.

This paper will describe several options for transits between Low Earth Orbit and the libration points, transits between libration points, transits between the libration points and lunar orbit, and transits between the libration points and interplanetary trajectories. The solution space provided will be constrained by selected orbital mechanics design techniques and physical characteristics of hardware to be used in both crewed missions and uncrewed missions. The relationships between time and energy required to transfer hardware between these locations will provide a better understanding of the potential trade-offs mission planners could consider in the development of capabilities, individual missions, and mission series in the context of the ISECG GER.