CIS-LUNAR SYNERGIES WITH HUMAN MISSIONS TO THE MARTIAN MOONS. M. L. Lupisella[1], D. D. Mazanek[2], J. Antol[2], D. Bass[3], D, Beaty[3], K. Daugherty[2], L. Graham[4], and R. Lewis[1]

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Introduction: The Human Spaceflight Architecture Team (HAT) has been developing a preliminary Desination Mission Concept (DMC) to assess how a human orbital mission to the Martian moons, Phobos and Deimos, might be conducted as a possible first step before landing on Mars. As part of this broader effort, a sub-team was formed to examine potential synergies of cis-lunar missions that could contribute to preparation for a human Mars-Phobos-Deimos (MPD) mission. The Cis-lunar Synergies Team has completed a preliminary analysis of potential synergies, and this presentation will review those findings.

Drawing in part from previous work of the HAT Cis-lunar Destination Team, and informed by the degree to which they supported MPD science and exploration objectives, the MPD Cis-lunar Synergies Team identified eight areas and prioritized activities within those areas. The eight areas for potential synergies are: 1) human research; 2) telerobotics; 3) mission systems and support; 4) long-term deep-space operations; 5) proximity operations; 6) sample return; 7) forging partnerships; and 8) public engagement.

Prioritization: Prioritization was based primarily on three factors: 1) the extent to which the activity supports MPD science and exploration mission objectives; 2) whether there is a combination of high potential benefit along with high level of operational uncertainty; and 3) feasibility (including benefits from other cis-lunar activities that may increase feasibility).

Activities: This presentation will review a number of activities that appear to be worth pursuing so that near-term human cis-lunar missions can feed-forward to a human mission to the Mars system.

Human Research. Most human research interests can be advanced substantially during human cis-lunar missions, including radiation mitigation, microbiology, behavioral health and performance, and possibly testing artificial gravity countermeasures.

Telerobotics. Low-latency telerobotics could be a less expensive and more near-term alternative to landing humans on the Martian surface and has high potential for exploration and science objectives for Mars and its moons, but there are key uncertainties. For example, a potentially difficult challenge for science is the motivation and need, technically and operationally, for the capability to allow a small crew to make good science decisions fairly quickly (e.g., what samples or measurements to acquire next).

Long-Term Deep Space Human Operations. A primary challenge for longer-term deep space operations is crew autonomy. Because of the extended communications delay, and because the crew cannot return quickly to Earth, the crew will likely need significant capabilities and robust operational protocols to operate autonomously when necessary.

Proximity Operations. Human proximity operations near low-gravity bodies, such as Phobos and Deimos, are insufficiently understood and undemonstrated. Tests in cis-lunar space could improve our ability to conduct proximity operations, including possibily building a sufficient analog or perhaps returning a small near-Earth asteroid to a cis-lunar location [1].

Sample Return. It is possible that a human mission to the Mars system could return samples that had been previously cached in orbit (e.g., from the envisioned robotic Mars Sample Return missions). It is also possible that surface samples could be obtained via low-latency telerobotic operation and returned to a crew vehicle in Mars orbit for subsequent return to Earth. Both of these approaches could be tested in cis-lunar space. Additionally, if for some reason the amount of sample were to exceed what can be returned to the Earth's surface with the crew (total return mass is presently 100 kg, so the actual sample mass would likely be substantially less), those larger amounts of sample could be returned to a cis-lunar receiving facility if planetary protection requirements could be met. The planetary protection category of the Mars moons is presently under review.

Summary: There are a number of promising activities to conduct in cis-lunar space to help prepare for a human mission to Phobos and Deimos, as well as Mars orbital operations and surface teleoperations. Radiation mitigation, low-latency telerobotics, crew autonomy, proximity operations, and sample return are examples of key areas that can be investigated and tested during human cis-lunar missions.

Reference: [1] Asteroid Retrieval Feasibility Study (2012), Keck Institute for Space Studies, California Institute of Technology Jet Propulsion Laboratory, http://kiss.caltech.edu/study/asteroid/asteroid_final_report.pdf