A Sustainable Architecture for Lunar Resource Prospecting from an EML-based Exploration Platform.
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Introduction: We present a point of departure architecture for prospecting for Lunar Resources from an Exploration Platform at the Earth – Moon Lagrange points. Included in our study are launch vehicle, cislunar transportation architecture, habitat requirements and utilization, lander/rover concepts and sample return.

In our current point of departure architecture, we envision the use of the NASA Space Launch System to launch large elements of the system directly to an EML camp once it has been deployed.

Transport to L2: The benefits derived by integrating high and low energy transfers range from system design and support to overall mission design mass savings and re-supply strategies. Different transfer design techniques can be explored by mission designers, testing various propulsive systems, maneuvers, rendezvous, and other in-space and surface operations. Understanding the availability of high and low energy trajectory transfer options opens up the possibility of exploring the human and logistics support mission design space and deriving solutions never before contemplated. For sample return missions from the lunar surface, low-energy transfers could be utilized between EML platform and the surface as well as return of samples to EML-based spacecraft.

Human Habitation at the Exploration Platform: Telerobotic and telepresence capabilities are considered by the agency to be “grand challenges” for space technology. We invite the lunar science community to consider the priority scientific tasks that such on-orbit operations might enable. While human visits to the lunar surface provide optimal opportunities for field geologic exploration, on-orbit telerobotics may provide attractive early opportunities for geologic exploration, resource prospecting, and other precursor activities in advance of human exploration campaigns and ISRU processing.

The Exploration Platform provides a perfect port for a small lander which could be refueled and used for multiple missions including sample return. This reuse of expensive spaceflight hardware is an essential element of a sustainable space program. The EVA and robotic capabilities of the EML Exploration Platform allow the lander to be serviced both internally and externally, based on operational requirements. The placement of the platform at an EML point allows the lander to access any site on the lunar surface, thus providing the global lunar surface access that is commonly understood to be required in order to enable a robust lunar exploration program. Designing the sample return lander for low-energy trajectories would reduce the overall mass and potentially increase the sample return mass. Of course, following the commencement of ISRU production, locally-derived resources could be leveraged to refuel the lander, further reducing the fuel supply chain from Earth.

The Initial Lunar Mission: Building upon Apollo sample investigations, the recent results of the LRO/LCROSS, international missions such as Chandrayaan-1, and legacy missions including Lunar Prospector, and Clementine, among the most important science and exploration goals is surface prospecting for lunar resources and to provide ground truth for orbital observations. Being able to constrain resource production potential will allow us to estimate the prospect for reducing the size of payloads launched from Earth required for Solar System exploration. Flight opportunities for something like the NASA RESOLVE instrument suite to areas of high science and exploration interest could be used to refine and improve future Exploration architectures, reducing the outlays required for cis-lunar operations. Mobile explorers are the required next missions to explore polar regions (volatiles) and non-polar regions (e.g., mature Ti-rich soil for solar wind implanted H, pyroclastic deposits for indigenous volatiles, etc.). These prospectors will incrementally address science, exploration, technology, commercial and public outreach objectives by:

- Defining the composition, form, and extent of lunar resources;
- Characterizing the environment in which the resources are found;
- Defining the accessibility/extractability of the resources;
- Quantifying the geotechnical properties of the lunar regolith in the areas where resources are found;
- Identifying resource-rich sites for targeting future missions,
- Offering immersive and unparalleled opportunities for public engagement and citizen science.

Summary: EML points are excellent for placement of a semi-permanent human-tended Exploration Platform both in the near term, while providing important infrastructure and deep-space experience that will be built upon to gradually increase long-term operational capabilities for deep space exploration.