DEVELOPMENT OF A LUNAR SURFACE ARCHITECTURE USING THE DEEP SPACE GATEWAY.
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Before sending crews to Mars – a journey of unprecedented autonomy – the capability to perform activities and use technology intended for Martian missions must be thoroughly tested and successfully demonstrated in a similar environment. The Earth's moon provides a great deep-space analog where unanticipated risks and challenges can be identified and best practices and recommendations established.

NASA's NextStep-2 program is an incremental approach to the Journey to Mars, which includes the Moon as a proving-ground and utilizes both a Moon-orbiting Deep-Space Gateway (DSG) habitat, and a Mars-bound Deep-Space Transit (DST) spaceship. As part of this architecture, a Lunar Lander descending from the DSG to the surface of the Moon, carrying crew and equipment, presents a renewed opportunity to test surface technologies and operations in support of deep-space exploration. [1]

The rationale justifying this addition to the NextStep-2 program lies in the comparison of current strategic knowledge gaps (SKG's) and technology area (TA) roadmaps for both Lunar and Martian surface operations. [2, 3, 4, 5, 6,] The comparison shows that similar knowledge gaps exist for both the Moon and Mars. If the same questions exists for two destinations, why not begin with attempting to answer them in the closer of the two? Upon identifying overlapping items for both environments, our team produced a concept of operations for a lunar surface mission addressing these topics and other key research areas applicable to Moon and Mars. By generalizing lunar lessons to the Martian environment, this surface mission fits within the scope of the "proving ground" objective of NextStep-2.

Under the constraints of three total landings, four crewmembers, thirteen metric tons per cargo module, and a six-week mission duration including one lunar night, our team analyzed the logistics and feasibility of a DSG-enabled, lunar surface mission, and optimized a base layout design in order to accommodate all identified surface objectives. The proposed timeline is shown in Figure 1. During this mission, the DSG will provide support for:

a) Communications
b) Telerobotics
c) Advanced scientific research
d) Contingency operations

This paper explains our architectural approach and trade studies for several design factors, including the utilized equipment, mass, volume, power, and mobility hardware required for such a long-duration

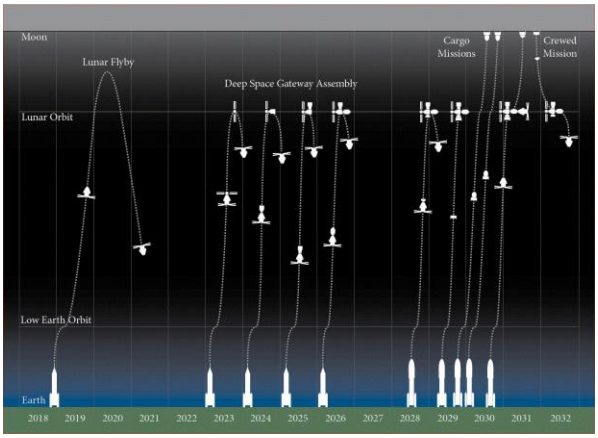

Figure-1. Mission Sequence

Deep-space surface mission. The integration of lunar landings with the NextStep-2 architecture, and the logistical interface between the lunar surface facilities and the Deep-Space Gateway are discussed. A mission schedule plan detailing weekly tasks and activities is provided in order to demonstrate the types of data and results that could be harvested from this effort.

References:

[1]Duggan, M., Engle, J.M., Moseman, T.A., Simon, X. (2017) AIAA SPACE and Astronautics Forum and Exposition, AIAA SPACE Forum, (AIAA 2017-5147)

[2] NASA. "Strategic Knowledge Gaps Theme 1" https://www.nasa.gov/sites/default/files/atoms/files/skg-sat-theme-1-sept-2016.pdf

[3]NASA. "Strategic Knowledge Gaps Theme 2" https://www.nasa.gov/sites/default/files/atoms/files/skg-sat-theme-2-sept-2016.pdf

[4] NASA. "Strategic Knowledge Gaps Theme 3" https://www.nasa.gov/sites/default/files/atoms/files/skg-sat-theme-3-sept-2016.pdf

[5] NASA "NASA Technology Roadmaps- TA 6: Human Health, Life Support, and Habitation Systems" https://www.nasa.gov/sites/default/files/atoms/files/2015_nasa_technology_roadmaps_ta_6_human_health_life_support_habitation_final.pdf

[6]NASA "NASA Technology Roadmaps TA 7: Human Exploration Destination Systems" https://www.nasa.gov/sites/default/files/atoms/files/2015_nasa_technology_roadmaps_ta_7_human_exploration_destination_final.pdf