LUNAR SCIENCE MOBILITY AS A SERVICE: THE LUNAR OUTPOST MOBILE AUTONOMOUS PROSPECTING PLATFORM (MAPP) ROVER

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Introduction: Mobile robotic systems for lunar surface operations are essential to provide mobility to lunar science instruments, perform ground-truthing of lunar resource data, and advance modeling efforts while advancing the Science Mission Directorate's Strategic Goal of enabling sustainable long-term exploration and utilization of space resources. NASA's Lunar Strategic Knowledge Gaps specify a requirement for robotic in-situ measurements of volatiles on the lunar surface, increasing the resolution of surface and subsurface science data at lunar areas of interest. Lunar Outpost is addressing these needs through development of the Mobile Autonomous Prospecting Platform (MAPP), a robust, cost-effective robotics platform for enabling greater science return by providing surface mobility services for lunar science instruments.

Figure 1: M1-MAPP / COLD-MAPP

Current MAPP capabilities include cryo-capable wheel drives; autonomous navigation, hazard avoidance, path planning, swarm robotics, and teleoperations software; and sensor capabilities including merging of vision-based navigation (VBN) and LIDAR point-cloud data for driving in high-contrast, deeply-shadowed, or dark conditions. With this flexibility, MAPPs can be configured for a mission spanning a single lunar day (M1 MAPP), surviving the lunar night (COLD-MAPP), exploring PSRs (PSR-MAPP), or providing mobility to larger payloads (HL-MAPP).

Mission 1 (M1) MAPP is designed as a lunar surface technology demonstrator. M1 MAPPs have a mass of 5kg, with an additional 5kg of instrument payload mass budget. M1 MAPPs fit into a CLPS lander payload volume of 44cm x 48cm x 35cm and provide 5 separate payload bays for scientific instruments and commercial payloads. M1 MAPPs provide a peak payload power of 35W and have a maximum drive distance of 8km. The M1 MAPP Technology Demonstrator will be undergoing TVAC, Vibe, EMI/EMC, and radiation testing in Q4 of 2020, and will be ready for integration with a CLPS lander in Q2 of 2021.

NASA has also funded Lunar Outpost to develop the M1 MAPP into the Cryogenic-Operation, Long-Duration MAPP (**COLD-MAPP**), a 15kg rover platform designed to survive one or more lunar nights. As COLD-MAPPs have substantially longer mission durations, they can drive up to 20km. To enable PSR exploration, an architecture which replaces the internal payload volumes of COLD-MAPP with additional batteries and thermal management systems has been developed, creating the **PSR-MAPP**. COLD-MAPP will be mission-ready in early 2022, with PSR-MAPP following shortly thereafter.

Since the beginning of MAPP development, Lunar Outpost has maintained a focus on scalability and portability of critical M1/COLD-MAPP subsystems, which may be utilized directly in Lunar Outpost's 300kg Heavy-Lift MAPP (**HL-MAPP**). HL-MAPP provides up to 80kg of payload accommodation and 85W of peak payload power for a 150 Earth day mission and can travel up to 35km away from the lander. HL-MAPP fits into a payload bay of 1.5m x 1.3m x 1.3m and will be mission-ready in late 2022.

Science Instrument Payload Accomodations. The Lunar Outpost MAPP reserves significant interior volume for science instrument payloads. These payloads may be mounted internally or externally to the body, depending on science and survival requirements.

Figure 2: MAPP Payload Volumes

Figure 2 illustrates the 5 available payload spaces available aboard the rover; internal volumes are shown in blue (1443 cm^3) and red (1215 cm^3), and external accommodations are shown in green (820 cm^3) and orange (426 cm^3). A composite cover may be added to the top of the rover, allowing the purple payload volume (1105 cm^3) to be adapted for both internal and external payloads, as desired.