ADVANCES IN LUNAR SCIENCE RETURN VIA DISTRIBUTED INSTRUMENT MOBILITY AND SWARM ROBOTICS: THE LUNAR OUTPOST MOBILE AUTONOMOUS PROSPECTING PLATFORM (MAPP) ROVERS

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Introduction: Mobile robotic systems for lunar surface operations are essential to provide mobility as a service to lunar science instruments and enable drastic advancement in lunar exploration. Lunar Outpost is addressing these needs through development of the Mobile Autonomous Prospecting Platform (MAPP), a mass-produced, cost-effective robotics platform for enabling greater science return by allowing suites of instruments to be deployed in multi-instrument campaigns hosted across multiple small rovers. Groups of MAPPs can navigate and operate cooperatively in swarms to maximize areal coverage, deploy large instrument networks, and investigate science sites in higher resolution than ever before. With missions currently contracted in 2022 and 2023, multi-rover swarms of MAPPs will be navigating the lunar surface within the next 5 years.

Figure 1: M1-MAPP / COLD-MAPP

Current MAPP capabilities include cryo-capable wheel drives; autonomous navigation, hazard avoidance, path planning, cooperative 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, swarms of 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 to carry lunar science instruments for missions lasting a single lunar day. M1 MAPPs fit into a CLPS lander payload volume of 44cm x 48cm x 35cm and provide 5 separate payload bays for instrument payloads up to 10kg. M1 MAPPs provide a peak payload power of 35W and have a maximum drive distance of 8km. The M1 MAPP Technology Demonstrator is currently undergoing TVAC, Vibe, EMI/EMC, and radiation testing, and will be ready for integration with a CLPS lander as early as 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. COLD-MAPP will be mission-ready in early 2022.

HL-MAPP 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 provides up to 120kg of payload accommodation and 85W of peak payload power for an extended mission and can travel up to 35km away from the lander. Another potential benefit is direct to Earth communications systems. HL-MAPP fits into a payload bay of 1.5m x 1.3m x 1.3m and will be mission-ready in late 2022.

Payload Accomodations. The Lunar Outpost MAPP reserves significant interior volume for prospecting, scientific, and commercial payloads. These payloads may be mounted internally or externally to the body, depending on payload 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.