SUMMARY OF THE CONTRACTED DELIVERIES OF NASA PAYLOADS TO THE MOON VIA COMMERCIAL LUNAR PAYLOAD SERVICES (CLPS). Commercial Lunar Payload Services (CLPS) Project Office[1] and Exploration Science Strategy and Integration Office (ESSIO)[1] [1]National Aeronautics and Space Administration (corresponding author: paul.b.niles@nasa.gov)

Introduction: NASA's Commercial Lunar Payload Services (CLPS) initiative allows rapid acquisition of lunar delivery services from US companies for payloads that advance capabilities for scientific, technological, or commercial development of the Moon [1]. In conjunction with instrument development efforts within NASA, academia, and international partners, a considerable variety of payloads have been delivered to CLPS vendors or are in the process of development.

Initially welcoming nine U.S. companies to its CLPS initiative in November 2018, NASA added five more vendors a year later, bringing the total number of eligible vendors to 14. A total of 7 task orders (TOs) have been awarded under this contract that will result in 7 lunar landings at sites ranging from the South Pole all the way to the far side (Figure 1). One more task order is nearly ready to be solicited while two additional payload suites have been solicited in the Payloads and Research Investigations on the Surface of the Moon-2 (PRISM-2) call.

Individual task order awards cover end-to-end commercial payload delivery services, including payload integration, mission operations, launch from Earth, and landing on the surface of the Moon. The NASA and international payloads scheduled for delivery have a wide range of applications, from lunar geology and geophysics to technology demonstrations critical to future space exploration efforts. All landers will carry a NASA provided laser retroreflector array payload to create a suite of fiducial markers on the lunar surface. In addition to delivering the NASA payloads, the CLPS vendors are encouraged to fill out their mission manifest with any additional payloads that don't interfere with requirements of the NASA payload suites.

TO2 IM: Awarded to Intuitive Machines using their Nova-C lunar lander and scheduled to land in Oceanus Procellarum in 2022. The IM1 mission will carry payloads that will focus on plume-surface interactions, space weather/lunar surface interactions, radio astronomy, precision landing technologies, and a communication and navigation node for future autonomous navigation technologies. As one of the first CLPS deliveries, a successful landing will help prove out the CLPS model for commercial payload deliveries to the lunar surface.

TO2 AB: Awarded to Astrobotic and scheduled to land in Lacus Mortis in 2022 using their Peregrine lunar lander. The Peregrine 1 mission will carry 9 NASA payloads that will investigate the lunar exosphere, thermal properties of the lunar regolith, hydrogen abundances in the soil at the landing site, magnetic fields, and conduct radiation environment monitoring. Advanced solar arrays will also be tested at the surface.

TO PRIME-1: Awarded to Intuitive Machines and scheduled to land at the south pole in 2022. This will be the first in-situ resource utilization demonstration on the Moon utilizing a drill and mass spectrometer to measure volatile content of subsurface materials. This delivery will also include a hopper demonstration that will land inside a permanently shadowed region and take images and temperature measurements.

TO 19C: Awarded to Masten Space Systems and scheduled to land in the South Pole region, near the rim of Haworth Crater in 2023 using their Xelene lunar lander (configuration XL-1). NASA payloads will investigate plume-surface interactions during landing [2], regolith geophysical properties using a robotic arm, the lunar radiation environment, regolith thermal properties and primary mineralogy of the polar surface, and the composition of the lunar exosphere, possibly including volatiles from ices in the regolith. This delivery will also carry a small rover equipped with a neutron spectrometer system capable of measuring hydrogen content of the near sub-surface and mapping the hydrogen around the landing site.

TO 19D: Awarded to Firefly Aerospace and scheduled to land in Mare Crisium [3] in 2023 using their Blue Ghost lunar lander. The Blue Ghost 1 mission will deliver payloads [4] that investigate the heat flow of the lunar interior, plume-surface interactions, and will test regolith sampling technologies. Payloads will also acquire X-ray images of Earth's magnetosphere and study the structure and composition of the Moon's mantle by studying crustal electric and magnetic fields. Technology demonstration payloads will look at regolith adherence on different materials, demonstrate the first GNSS fix on the lunar surface, test radiation tolerant computing, and perform a dust mitigation experiment using electrodynamic fields.

TO 20A (VIPER): Awarded to Astrobotic and scheduled to land at the South Pole in 2023 using their

Griffin lunar lander. VIPER is a solar and battery powered rover that will characterize the distribution and physical state of lunar polar water and other volatiles in cold traps in order to evaluate the potential for future in-situ resource utilization at the South Pole. VIPER will operate over multiple lunar days and will be capable of traversing into permanently shadowed terrain. Subsurface volatile sampling will be accomplished by a one-meter drill paired with a quadrupole mass spectrometer [5].

TO CP-11 (CLPS PRISM 11): Awarded to Intuitive Machines and scheduled to land at the Reiner Gamma swirl in 2024 using their Nova-C lunar lander. Payloads include a magnetometer, camera, and an electron and ion spectrometer on the lander, and a small rover with a second magnetometer and a multispectral microscope. This payload suite will study the properties of the Reiner Gamma swirl and its mini-magnetosphere. The delivery also includes a technology demonstration of swarm robotics with deployment of 4 small autonomous rovers. Two international payloads will investigate the near-surface radiation environment (South Korea) and an actuated retroreflector provided by the European Space Agency that will make high resolution Earth-Moon distance measurements.

TO CP-12: Request for Proposals to lander vendors is scheduled for 2022. The landing site will be Schrödinger Basin on the lunar far side. Payloads include long-lived seismometers to study tectonic activity within the deep lunar interior and micrometeorite impact flux, and a drill to measure heat flow and electrical conductivity probes investigating the near sub-surface. Landing is currently expected to occur in early 2025.

TO CP-21 (announced): Landing site will be the Gruithuisen Domes. Payload suite proposals were solicited in the PRISM2 call at the end of 2021 and will be selected in 2022. Landing is currently expected to occur in 2025.

TO CP-22 (announced): Landing site is a South Polar region. Payload suite proposals were solicited in the PRISM2 call at the end of 2021 and will be selected in 2022 and will focus on either environmental monitoring or biological sciences, as outlined in the Artemis III Science Definition Team Report, Objective 7. Landing is currently expected to occur in 2025-2026.

References: [1] Bussey, B. et al. (2019) *AGU Fall Meeting*. PA54B-11. [2] Yingst, R. A., et al. (2020) *LPSC LI*, 1439. [3] S. Nagihara et al. (2022) *LPSC LIII*, Abstract #1390. [4] Banks, M. et al. (2022) *LPSC LIII*. [5] Colaprete, A., D. et al. (2019) *AGU Fall Meeting*, P34B-03.

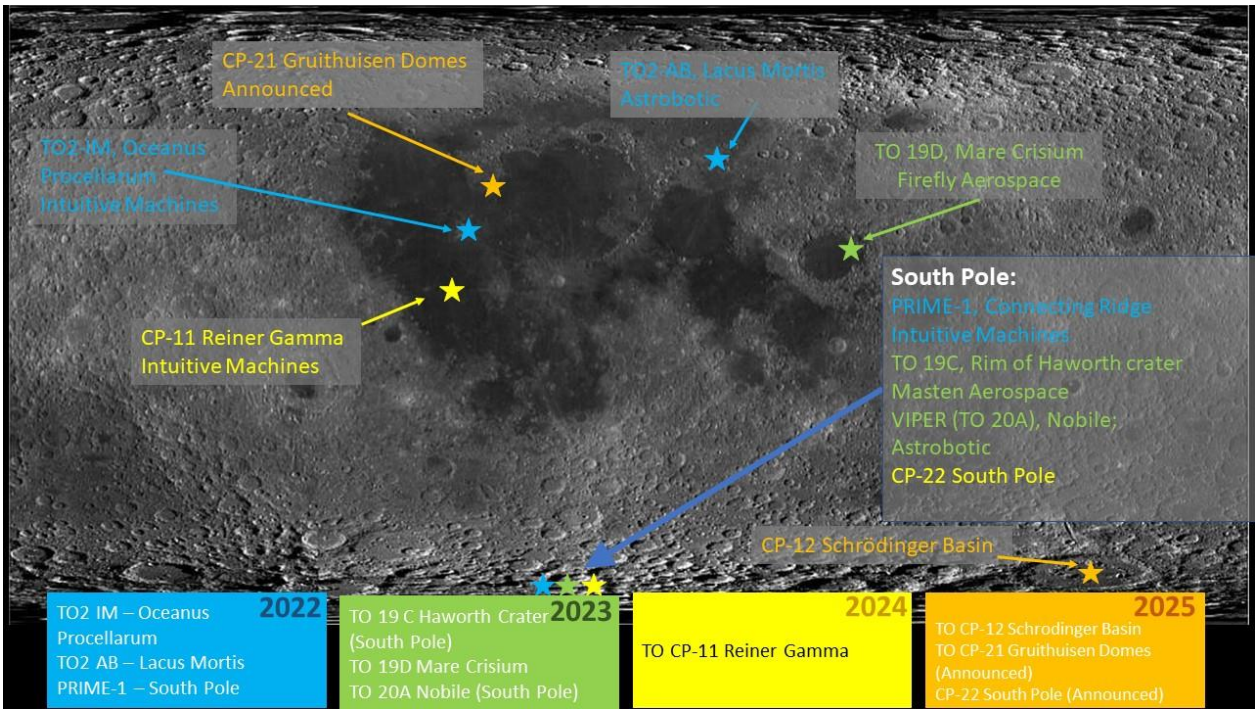

Figure 1. Map showing the landing site of the nine planned CLPS deliveries 2022 through 2025 [Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) global basemap centered on 0° lat, 0° lon].