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: maria.e.banks@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. A total of 9 task orders (TOs) have been awarded via a competitive process among a pool of 14 companies that will result in lunar landings at widely distributed sites across the surface of the Moon, including the south polar region and the farside.

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. Many CLPS landers will carry a 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 carrying additional commercial payloads that are operated independently from the NASA payload suites.

TO2-IM: Awarded to Intuitive Machines using their Nova-C lunar lander and scheduled to land near the South Pole in 2023. The Intuitive Machines Mission 1 (IM1) will carry payloads that will focus on plume-surface interactions (Stereo Cameras for Lunar Plume-Surface Studies, SCALPSS), space weather/lunar surface interactions and radio astronomy (ROLSES), precision landing technologies through doppler lidar (NDL), a communication and navigation node for future autonomous navigation technologies (Lunar Node 1), and a laser retroreflector (LRA). 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 Sinus Viscositatis, a newly named region of mare that embays the Gruithuisen Domes, in 2023 using their Peregrine lunar lander. This landing site was selected to allow an early CLPS delivery to explore the mare material surrounding the domes and conduct complementary science for TO CP-11 (see below). The Peregrine 1 mission is currently carrying 9 NASA payloads that will conduct a wide range of investigations on the lunar surface. The lunar exosphere and gases released by regolith with be explored by 3 instruments: Surface and Exosphere Alterations by Landers (SEAL), and the Mass Spectrometer observing lunar operations (Msolo). The thermal properties of the lunar regolith with be examined by the Near-Infrared Volatile Spectrometer System (NIRVSS) and the hydrogen content of the near subsurface will be examined by the Neutron Spectrometer System (NSS) and the Neutron Measurements at the Lunar Surface (NMLS). Magnetic fields will be measured by the Fluxgate Magnetometer (MAG) and radiation environment will be measured by the Linear Energy Transfer Spectrometer (LETS). Advanced solar arrays will also be tested at the surface by the Photovoltaic Investigation on Lunar Surface (PILS) instrument.

TO PRIME-1: Awarded to Intuitive Machines and scheduled to land near the South Pole in 2023. This will be the second landing of the IM NovaC lander in the vendor-named Intuitive Machines Mission 2 (IM2). The Polar Resources Ice Mining Experiment-1 (PRIME-1) is an in-situ resource utilization demonstration on the Moon. PRIME-1 comprises The Regolith and Ice Drill for Exploring New Terrain (TRIDENT) and MSolo to measure volatile content of subsurface materials to 1-meter depth (see also VIPER/MSolo and TRIDENT). This delivery will also include a LRA and a μ-hopper demonstration that will hop to a handful of locations enroute to hopping into (and out of) a permanently shadowed region. The hopper will take images and Lunar RADiometer (LRAD) thermal IR measurements to determine surface brightness temperature, mm to cm-scale surface roughness, and thermal inertia.

TO 19C: Awarded to Masten Space Systems who filed bankruptcy in 2022. The payloads will be re-manifested on other TOs.

TO 19D: Awarded to Firefly Aerospace and scheduled to land in Mare Crisium [3] in 2024 using their Blue Ghost lander. The Blue Ghost 1 (BG1) mission will deliver payloads [4] that investigate the heat flow of the lunar interior (Lunar Instrumentation for Subsurface Thermal Exploration with Rapidity-LISTER), plume-surface interactions (SCALPSS), and will test regolith sampling technologies (Lunar PlanetVac-LPV). Payloads will also acquire X-ray images of Earth's magnetosphere (Lunar Environment heliospheric X-Ray Imager-LEXI) and constrain the temperature structure and thermal evolution of the Moon by studying crustal electric and magnetic fields

(Lunar Magnetotelluric Sounder-LMS). Additional payloads will look at dust adherence on different materials (Regolith Adherence Characterization-RAC), investigate the first use of GNSS (Global Navigation Satellite System) in transit to the Moon and on the lunar surface (Lunar GNSS Receiver Experiment-LuGRE), test a radiation tolerant computer system (Radiation Tolerant Computer System-RadPC), perform dust mitigation experiments using electrodynamic fields (Electrodynamic Dust Shield-EDS), and reflect very short laser pulses from Earth-based lunar laser ranging observatories (Next Generation Lunar Retroreflector, NGLR).

TO 20A (VIPER): Awarded to Astrobotic and scheduled to land near the South Pole in 2024 using their Griffin lunar lander in the vendor named Griffin Mission 1. The Volatiles Investigating Polar Exploration Rover (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 (TRIDENT) paired with a quadrupole mass spectrometer (Msolo) [5]. Hydrogen abundances in the near subsurface will be measured by the NSS and at the surface volatiles and mineralogy will be investigated using NIRVSS.

TO CP-11: Awarded to Intuitive Machines and scheduled to land at the Reiner Gamma swirl in 2024 using their Nova-C lunar lander. This will be the third landing of IM's Nova-C lander in the vendor-named Intuitive Machines Mission 3 (IM3). Payloads include the first Payloads and Research Investigations on the Surface of the Moon (PRISM) suite selections, the Lunar Vertex suite, containing a magnetometer, camera, and an electron and ion spectrometer on the lander, along with a small rover with a second magnetometer and a multispectral microscope. Lunar Vertex will study the properties of the Reiner Gamma swirl and its mini-magnetosphere [6]. The delivery also includes a technology demonstration of swarm robotics with the deployment of three small autonomous rovers each instrumented with ground penetrating radar (CADRE, JPL). Two international payloads will investigate the near-surface radiation environment (a high-energy particle detector from the Korea Astronomy and Space Science Institute (KASI) and funded by the Ministry of Science and ICT of Korea (MSIT) [7], and MPAc (MoonLIGHT Pointing Actuator), a laser retroreflector developed by the National Institute for Nuclear Physics (INFN-LNF) and funded by the European Space Agency that will make high resolution Earth-Moon distance measurements.

TO CP-12: Awarded to a team led by Draper and scheduled to land in the outer ring of Schrödinger Basin on the lunar far side in 2025. PRISM suites include long-lived seismometers in the Farside Seismic Suite (FSS) to study tectonic activity within the deep lunar interior and micrometeorite impact flux, a drill to measure heat flow and electrical conductivity probes investigating the near sub-surface (Lunar Interior Temperature and Materials Suite-LITMS). Additionally, CP-12 will carry a payload that will take measurements of the electromagnetic and electrostatic environment of the lunar surface (Lunar Surface Electromagnetics Experiment-LuSEE).

TO CP-21: Landing site will be the Gruithuisen Domes to investigate their composition and origin. The Lunar Vulkan Imaging and Spectroscopy Explorer (Lunar-VISE) investigation, selected as part of the second PRISM solicitation, consists of a suite of five instruments with some mounted on a mobile rover to be provided by the CLPS vendor. Landing is currently scheduled in 2026 and vendor will be competed in 2023.

TO CP-22: Landing site is the south polar region in 2026. The NASA payload suite in this TO includes: the Lunar Explorer Instrument for space biology Applications (LEIA) science suite, selected via PRISM2, which will study the biological response of yeast to the lunar environment; the Package for Resource Observation and in-situ Prospecting for Exploration, commercial exploitation and Transportation (PROSPECT), sponsored by ESA to assess the potential for use of resources for human exploration at a given location; the Lunar Compact Infrared Imaging System (L-CIRiS) a multispectral imaging radiometer designed to measure mineralogical and thermophysical measurements on the lunar surface; and the Laser Ablation Ionization Mass Spectrometer (LIMS) which will analyze the chemical composition of lunar regolith.

TO CS-3 (announced): The LuSEE at night experiment is planning to land at the farside mid-latitudes in 2025. Low-frequency radio astronomy with standalone operations through the night will be performed. This task order will also include the deployment of the Lunar Pathfinder orbiter built by Surrey Satellite Technology Ltd. sponsored by ESA.

References: [1] Bussey, B. et al. (2019) *AGU Fall Meeting*. PA54B-11. [2] Yingst, R. A., et al. (2020) *LPSC LI,* 1439. [3] Nagihara, S. et al. (2022) *LPSC LIII*, Abstract #1390. [4] Banks, M. E. et al. (2022) *LPSC LIII*. [5] Colaprete, A., D. et al. (2019) *AGU Fall Meeting*, P34B-03. [6] Blewett, D. et al. (2022) *LPSC LIII*. [7] Sim, C.K. et al. (2021) *LPSC LI.*