Statement for the Record
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Leveraging Commercial Innovation for Lunar Exploration: A Review of NASA's CLPS Initiative

Chairman Haridopolos, Ranking Member Foushee, distinguished members of the Subcommittee, thank you for your support of lunar science and exploration, and for the opportunity today to provide my perspective on the Commercial Lunar Payload Services program.

My perspective is that of a lunar scientist committed to unlocking the transformational science the Moon holds. The Moon is our partner in space, and while the Earth's surface is constantly reshaped by plate tectonics and erosion from wind and water, the Moon holds a record of what was happening in our neighborhood of the Solar System during its earliest days. From the Moon we can understand how planets form and evolve, how impact bombardment affected the habitability of early Earth, and how water was delivered to the inner Solar System.

I also speak as someone who has worked on lunar orbital missions, upcoming human exploration with Artemis, and two suites of scientific instruments that will be delivered to the Moon by CLPS. Each of these modes of doing science has a critical part to play in the sustained exploration of the Moon.

Current status of science with CLPS

For the first set of CLPS missions, those that have already flown, the initial NASA science and technology payloads were largely simple instruments that were either already built or required no new development. Many in the scientific community were frustrated that, after more than 50 years,[1] the first U.S. robotic landers to return to the Moon would carry relatively ad hoc assemblages of instruments. However, the minimal investment in these science payloads was appropriate to the "shots on goal" risk posture for a new series of landers and a new way of operating. Of the four missions, one met all of its objectives and the data that was collected will provide new information about the Moon, and the new techniques for drilling and sample collection that were demonstrated can be used for future high-priority science investigations. Perhaps most importantly, NASA's investments in these first deliveries supported the development of new lunar landers and provided a new model for advancing science, but we must ensure that investment enables reliable delivery of future transformative science investigations.

The upcoming set of CLPS deliveries of new science payloads will be an evolution from the first. There are now five payloads awaiting launch or in development that were each selected as a

[1] Prior to CLPS, the last U.S.-led robotic lander on the Moon was Surveyor 7 in 1968.

suite of instruments designed to address a specific science investigation at a defined landing site and led by a single Principal Investigator through NASA's PRISM program[2]. These are still fairly modest science investigations by NASA SMD standards, but they will help address longstanding mysteries about the Moon or explore differing interpretations from recent orbital data, and ask questions that can only be answered by landing on the Moon.

I'll share two brief examples of these types of upcoming investigations you'll see delivered by CLPS. The first is Lunar Vertex, which is led by Dr. David Blewett at the Johns Hopkins Applied Physics Laboratory. It will go to a region of the Moon's nearside that has a strong magnetic signature. The Moon does not have a global magnetic field like the Earth, but in this small region we think the magnetic field shields the Moon's surface from some of the harsh radiation environment of space. Instruments hosted on the lander and a small rover will help us understand the magnetic field, how it got there, how it changes the way the Moon's surface evolves, and how much radiation actually reaches the surface in spite of the magnetic shielding. This mission will be delivered by Intuitive Machine's third lander.

The second is called Lunar-VISE and is led by Dr. Kerri Donaldson Hanna at the University of Central Florida. That investigation is benefiting from a rover being built by Honeybee Robotics that was provided as a CLPS mobility service, and will take place on the summit of a volcano over 5000 feet tall. A suite of instruments will determine how the Moon was able to produce a volcanic eruption of the type that, on the Earth, is usually found at a subduction zone where water is incorporated into the magma, indicating we don't really understand volcanism on single-plate bodies like the Moon. This mission is planned for 2028 and will be delivered by Firefly's Blue Ghost Mission 3.

Landing on the Moon is hard, and we probably should not expect every first attempt by new landers to succeed. You'll note that these science investigations are scheduled for the third lander from each of their CLPS providers, and to capitalize on the investment in, and experience gained from, their previous landers. However, there are other PRISM payloads that will be on the first lander from their CLPS provider.

What is Next for CLPS?

The next few years will be a critical period for CLPS to begin to prove out its promise of reliable, lower-cost deliveries to the lunar surface. At the same time, we need to start planning now for how to use NASA's investments in CLPS to deliver more ambitious investigations to do the kind of transformational science that the Moon offers. The Decadal Survey, for example, recommended a New Frontiers-class mission to deploy a network of geophysical stations at several locations distributed across the Moon. Seismometers would measure the signals from moonquakes and impact events to build a picture of how terrestrial planets solidify from oceans of magma into worlds with a crust, mantle, and core, and measurements of heat flow would show how much heat the Moon still retains from that process. Using CLPS to accomplish this high-priority science would take a commitment from NASA for the purchase of multiple landers and

[2] Each of the investigations selected as part of the Payloads and Research Investigations on the Surface of the Moon will take up only a portion available payload space on their CLPS lander; the landers will also carry many other unrelated investigations and demonstrations, including international partnerships.

direction from NASA to CLPS providers to develop the long-duration capabilities required for these measurements.

The Decadal Survey also recommended that once CLPS has demonstrated success, it should be used to land a long-duration rover called Endurance-A that would traverse hundreds of kilometers across the Moon's far side to collect samples and then deliver them to Artemis astronauts, in a synergy between robotic and human exploration. Endurance was recommended as the highest scientific priority for the Lunar Discovery and Exploration Program,[3] and a scientific definition team is currently evaluating its architecture and refining its requirements. This mission would result in an understanding of the Moon's ancient impact record and the cause of the big differences between the near and farside, science that has consistently been ranked, for decades, as the highest priority at the Moon, but not yet addressed by any U.S. mission. Moving forward, the success of CLPS should be judged on its capability to enable this kind of transformative science.

A note of concern for CLPS, however, is the uncertain fate of the VIPER mission. This fully built rover was to be delivered by CLPS to the Moon's south pole, where it would have performed the first in situ measurements of water ice in permanently shadowed regions. VIPER would have conducted some of the most important robotic science at the Moon this decade and would have been the first step in a much-needed resource prospecting campaign to learn whether lunar water can be used as a resource for future exploration. VIPER was also the most expensive scientific payload that NASA planned to fly thus far on CLPS. Its planned delivery on the first Griffin lander from Astrobotic was thus a risk posture that was out of alignment with that investment. However, rather than working to find a solution to ensure VIPER's success, in an enormous blow to science,[4] NASA chose to cancel the rover and suggested it be replaced by an inert mass simulator on Griffin 1.

NASA is now looking for industry or international partners interested in delivering VIPER to the Moon, but indicating that it will provide no funding to do so.[5] We should not expect that VIPER's science will be accomplished by hoping that someone will offer to fly and operate the rover on its own dime without NASA-provided support for operations and science analysis. Without urgent congressional action to restore VIPER, it is likely that China will make the first measurements of the abundance and composition of ice on the Moon with Chang'e 7.

The Urgency of a Strategic Set of Science Missions from CLPS

At the 56th Lunar and Planetary Science Conference last month, a meeting first organized to share the results from Apollo 11, scientists presented exciting new results from China's Chang'e 5 and 6 missions that returned samples from very well-chosen targets, including the first samples

[3] "Recommendation: Endurance-A should be implemented as a strategic medium-class mission as the highest priority of the Lunar Discovery and Exploration Program. Endurance-A would utilize CLPS to deliver the rover to the Moon, a long-range traverse to collect a substantial mass of high- value samples, and astronauts to return them to Earth." National Academies of Sciences, Engineering, and Medicine (2022) Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032.

[4] Nearly 5,000 people have signed a letter to congress urging action to restore the groundbreaking science of VIPER. The letter can be found here: https://planetary.s3.amazonaws.com/assets/pdfs/VIPER-community-letter-2024-10-02.pdf

[5] See https://science.nasa.gov/lunar-science/volatiles-partnership/

ever collected from the Moon's far side. China's strategic series of missions will result in the launch of Chang'e 7 next year, which will go to the south pole and include a rover and a hopper that will explore permanent shadows, as well as an orbiter with an important suite of instruments. Chang'e 8 will also target the south pole, and scientists shared that it will work to test extraction of resources and 3D printing of bricks from regolith. Crewed exploration will follow.

If we are to maintain U.S. leadership in space science, it is critical to lay out and then implement a strategic series of ambitious missions that address Decadal science priorities. Sustainable exploration is the key to long-term scientific success. Much as the commercial providers can build on their investments and iterate toward improved technical solutions, science can build toward better understanding through careful long-term planning that grows by incorporating new data and results along the way. But while selecting separate, focused PRISM investigations for CLPS landers was appropriate to a developing program, it is now time to lay out a multi-year series of investigations for the CLPS missions beyond those already planned. A path is also needed to make this program resilient to failures and to make sure important investigations are not lost forever given the risk-forward posture of CLPS. This will ensure we fully realize NASA's investments at the Moon to achieve the most important science laid out by the Decadal Survey, and enable CLPS providers to plan for meeting those needs. NASA should work with the scientific community to determine the path forward with unwavering focus.

Finding the Appropriate Balance for Science

The lunar science community hopes for the success of CLPS because of how this model can open up more routine access to the lunar surface, which will be enabling for so much of the science that awaits. But that science will require appropriate investments in ambitious and capable scientific payloads. Within SMD, the Exploration and Science Strategy Integration Office was tasked with both growing the lunar economy and infusing science into lunar exploration. Appropriate resources must be allocated to science payload development. Scientists are concerned, I am concerned, that at present ESSIO has not invested sufficiently in science given that the most important science yet planned for CLPS, VIPER, was cancelled, and there is not yet a plan to accomplish Decadal priorities.

Better alignment of budget authority and mission management responsibility and accountability within the Lunar Discovery and Exploration Program, as recommended by the Decadal Survey,[6] could improve focus on accomplishing lunar science priorities.

The Moon holds a rich history of our Solar System. We must ensure that we make the most of our current investments to explore the Moon and uphold science as a pillar of Artemis. Thank you for the honor of addressing the Subcommittee today, and I look forward to your questions.

[6] "Recommendation: PSD should execute a strategic program to accomplish planetary science objectives for the Moon, with an organizational structure that aligns responsibility, authority, and accountability." National Academies of Sciences, Engineering, and Medicine (2022) Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032.