Leveraging the Commercial Space Sector for Lunar Science and Exploration

Submitted as a white paper to the NASA Transition Team

Commercial Advisory Board (CAB) of the NASA-chartered Lunar Exploration Analysis Group
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Summary: The capabilities of the commercial space sector are increasingly supporting and facilitating NASA's goals in planetary science and exploration. NASA is leveraging the commercial sector's capabilities through public-private partnerships across all directorates, most recently in support of lunar exploration. The CAB strongly supports the continuation and increased funding of these collaborations, particularly the Commercial Lunar Payload Services (CLPS) program, which will provide payload delivery and operations services to the Moon. Public-private partnerships such as CLPS and similar programs are kickstarting the establishment of a permanent human and robotic lunar presence facilitated by broad industrial and customer bases, all made possible by a robust workforce. Continued support of public-private partnerships between NASA and the commercial sector will fortify American leadership in science, technology development, and contract innovation.

Role of the Commercial Sector at NASA

Industry has always played a role in supporting NASA's pursuit of national priorities; the Apollo program involved over 20,000 contractors to send humans to the Moon. More recently, the last decade of public-private partnerships in NASA programs have demonstrated that fixed-price contracts can incentivize companies to meet NASA goals at lower costs to the taxpayer compared to traditional sole-sourced, cost-plus contracts. Unlike cost-plus contracts, competitively bid fixed-price contracts instill a sense of urgency and competition in commercial partners that keeps costs down to the benefit of NASA and taxpayers.

NASA's willingness to engage the commercial sector through fixed-price contracts has paid off, most spectacularly with the Commercial Resupply Services (CRS) and Commercial Crew Transportation Capability (CCtCap) and the restoration of our nation's ability to transport astronauts to the International Space Station through partnership with SpaceX. Similar procurement mechanisms are now being tested in the lunar environment through the programs Gateway Logistics Services (GLS), NextSTEP, NextSTEP-2 (which includes the Human Landing System and Gateway modules), and the Commercial Lunar Payload Services (CLPS). Below, we highlight CLPS as an example of how fixed-price contracting can help NASA achieve its goals in lunar science and exploration.

The CLPS Program

Managed by the Science Mission Directorate, CLPS includes 14 commercial providers, three of whom—Astrobotic, Intuitive Machines, and Masten Space Systems—have been selected to deliver payloads to the lunar surface at a fixed price in response to task orders. Deliveries beginning in 2021 will perform science experiments, test technologies, and demonstrate capabilities to help NASA explore the Moon and prepare for human missions. CLPS contracts are indefinite delivery, indefinite quantity contracts with a cumulative maximum contract value of $2.6 billion through 2028. NASA's budget profile for this program corresponds to ~2 surface missions per year, outpacing all previous lunar programs at a fraction of the price. NASA can expect the following successes with the continuation of CLPS:

- **New Lunar Surface and Solar System Science.** The last landed NASA mission to the lunar surface—human or robotic—was Apollo 17 in 1972. Since then, we have learned much about the Moon by US missions through lunar samples and orbital data, but only further surface missions can tackle key knowledge gaps regarding water and resource distribution, polar regolith properties, lava tube stratigraphy, and other outstanding Moon-centric questions. Lunar surface exploration also addresses Solar System science questions, such as the impact history of the inner Solar System and the evolution of the Sun. Instruments from NASA and its international partners onboard current and future CLPS landers will directly address these issues.
- **Paradigm Shift in Planetary Exploration**. The CLPS model incentivizes companies to develop true lander product lines that can be used for rapid, regular missions that change the paradigm and cadence of

space science. No longer is a planetary scientist afforded just one or two missions to deploy payloads during their career. The model of "payload delivery as a service" is a new approach for U.S. planetary exploration that tests future low-cost solar system exploration strategies beyond the Moon, including orbiters.

- **Rapid Technology Iteration.** Planetary mission opportunities are currently very limited, leading to a reliance on high-cost heritage technology. An increase in flight opportunities for technology demonstrations and the relatively low consequences of failure for low-cost missions will facilitate a faster rate of technical development and technology demonstrations while driving toward lower-cost technologies.
- **Lunar Infrastructure.** CLPS services set the stage for the delivery of follow-on commercial lunar infrastructure that could further reduce the cost and increase the cadence of planetary science and exploration. Lunar use applications like in-situ resource utilization of water ice are now within reach if NASA continues to make investments in surface and orbital infrastructure like power, communications, and mobility.

National Benefits of Public-Private Partnerships

Further NASA investment in programs such as CLPS, CRS, CCPtCap, GLS, and NextSTEP will reap the following benefits to the nation:

- **Development and Retention of Space Professionals.** Contract awards lead directly to job growth and therefore investment in the American aerospace workforce, which in turn benefits NASA. For example, polling of our membership shows that since 2017, 10 CAB members have added a total of 502 jobs to their companies as a direct result of NASA contract awards aligned with the current Moon-centric focus for our space program. We must continue to develop our lunar surface exploration capabilities in order to develop and retain a technical workforce that makes these challenging space missions possible.
- **Growing Customer Bases**. U.S. industry and more specifically, CLPS providers, have captured the majority of global market share for lunar payload delivery. Public-private partnerships such as CLPS help grow non-NASA participation in the cislunar economy. NASA has the opportunity for creating demand not only for transportation and delivery services, but also for in-situ resource utilization and infrastructure.
- **Maturation of Industrial Base.** As an anchor customer for commercial missions, NASA ensures through follow-on partnerships that the institutional knowledge needed for low-cost planetary exploration continues to benefit NASA and the nation. This includes broadening the industrial base to include manufacturing, mining, and construction—all critical for a permanent lunar presence.
- **Returning Americans to the Moon.** Commercial space companies have already assumed independent roles in returning humans to the lunar surface, a step that will save NASA time and money that would have been spent in early formulation work and prototype design. In addition, the private sector has been developing new engines and launch vehicles that can significantly decrease the operational costs of human missions and again, save time and money in early development phases. Continuing and encouraging this kind of partnership will return humans to the lunar surface faster and result in significant cost savings over what would be spent if NASA was doing this work on its own.
- **Synergy with Private Capital.** Over the past 14 years, public-private partnerships have been integral to the influx of private investment capital into U.S. commercial space companies. Such partnerships provide necessary market demand signals along with confidence to the investment community of NASA's and the U.S. government's long-term commitment to the growth of the burgeoning commercial space sector. Private investment capital in-turn creates a positive feedback loop of reduced dependence on public funding for space infrastructure and capabilities, lower-cost, permanent space capabilities for NASA and the USG, and further economic and job growth for the U.S.

Conclusion

Public-private partnerships between NASA and the commercial space sector are changing the paradigm of lunar and planetary exploration. We applaud NASA for its pioneering work in these programs and encourage their continued support and evolution as well as the creation of similar partnerships to advance solar system exploration. As Commercial Crew has so spectacularly demonstrated, the 21st century innovation NASA needs is not in launch vehicles but in contract vehicles.

About the CAB

The Lunar Exploration Analysis Group (LEAG) was established in 2004 to support NASA in providing analysis of scientific, technical, commercial, and operational issues in support of lunar exploration objectives and of their implications for lunar architecture planning and activity prioritization. The Commercial Advisory Board (CAB) was created within LEAG in 2015 to foster collaboration between commercial space companies and the broader lunar community. The CAB is led by Chair Dr. Elizabeth Frank (First Mode), Vice Chair Rafael Spears (The Aerospace Corp., retired), and Executive Secretary Sarah Deitrick (Jacobs Technology/NASA Johnson Space Center).

Co-signers

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