

Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture that Leverages Commercial Space Capabilities and Public-Private-Partnerships. C. Miller (NexGen Space LLC, spacepolicy@me.com), A. Wilhite (Wilhite Consulting, Inc., awwilhite7@gmail.com), R. Kelso (rkelso54@gmail.com), D. Chevront (david chevront@gmail.com), H. McCurdy (American University, mcurdy@american.edu)

Introduction: NexGen Space LLC will present the top-level study results of an economic assessment, recently completed for and funded by NASA’s Office of the Chief Technologist Emerging Space office, which suggests a human return to the Moon could be as much as an order of magnitude lower cost than previously estimated using traditional methods.

NexGen assembled a team of former NASA executives and engineers who assessed the economic and technical viability of an “Evolvable Lunar Architecture” (ELA) that leverages commercial capabilities and services that are existing or likely to emerge in the near-term.

We evaluated an ELA concept that was designed as an incremental, low-cost and low-risk method for returning humans to the Moon in a manner that directly supports NASA’s long-term plan to send humans to Mars. The ELA strategic objective is commercial mining of propellant from lunar poles where it will be transported to lunar orbit to be used by NASA to send humans to Mars. The study assumed A) that the United States is willing to lead an international partnership of countries that leverages private industry capabilities, and B) public-private-partnership models proven in recent years by NASA and other government agencies.

Based on these assumptions, the our analysis concludes that:

- Based on the experience of recent NASA program innovations, such as the COTS program, a human return to the Moon may not be as expensive as previously thought.
- America could lead a return of humans to the surface of the Moon within a period of 5-7 years from authority to proceed at an estimated total cost of about \$10 Billion (+/- 30%) for two independent and competing commercial service providers, or about \$5 Billion for each provider, using partnership methods.
- America could lead the development of a permanent industrial base on the Moon of 4 private-sector astronauts in about 10-12 years after setting foot on the Moon that could provide 200 MT of propellant per year in lunar orbit for NASA for a total cost of about \$40 Billion (+/- 30%).
- Assuming NASA receives a flat budget, these results could potentially be achieved within NASA’s existing deep space human spaceflight budget.

- A commercial lunar base providing propellant in lunar orbit might substantially reduce the cost and risk NASA of sending humans to Mars. The ELA would reduce the number of required Space Launch System (SLS) launches from as many as 12 to a total of only 3, thereby reducing SLS operational risks, and increasing its affordability.
- An International Lunar Authority, modeled after CERN and traditional public infrastructure authorities, may be the most advantageous mechanism for managing the combined business and technical risks associated with affordable and sustainable lunar development and operations.
- A permanent commercial lunar base might substantially pay for its operations by exporting propellant to lunar orbit for sale to NASA and others to send humans to Mars, thus enabling the economic development of the Moon at a small marginal cost.
- To the extent that national decision-makers value the possibility of economical production of propellant at the lunar poles, it needs to be a priority to send robotic prospectors to the lunar poles to confirm that water (or hydrogen) is economically accessible near the surface inside the lunar craters at the poles.
- The public benefits of building an affordable commercial industrial base on the Moon include economic growth, national security, advances in select areas of technology and innovation, public inspiration, and a message to the world about American leadership and the long-term future of democracy and free markets.

An independent review team — led by Mr. Joe Rothenberg, former head of NASA human spaceflight — and composed of former NASA executives, former NASA astronauts, commercial space executives, and space policy experts — reviewed our analysis and concluded that “*Given the study scope, schedule and funding we believe the team has done an excellent job in developing a conceptual architecture that will provide a starting point for trade studies to evaluate the architectural and design choices.*”