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Author: Mr. Timothy Cichan
Lockheed Martin Corporation, United States

Mr. Luis Carrio
Lockheed Martin Corporation, United States
Dr. Christie Iacomini
Lockheed Martin Corporation, United States
Mr. Adam Marcinkowski
Lockheed Martin Space Systems Company, United States

A WATER-BASED, NUCLEAR-ENABLED LUNAR ARCHITECTURE

Abstract

Artemis is taking what the world has learned from Apollo and decades of living and working in Low Earth Orbit to return humanity to the Moon and build a sustainable presence there, thereby enabling us to move on to Mars and beyond. Achieving this requires infrastructure. There is an inherent complexity in designing infrastructure that is expected to persist for years, to be used by many diverse actors, and for those systems to evolve over time. At Lockheed Martin, we have formulated a vision for how this future could play out – an "existence proof" or "reference vision" for how today's technologies, companies, and agencies around the globe could combine to enable tomorrow's goals for the Moon and Mars. Our vision is characterized by a nuclear-enabled, water-based Earth/Moon/Mars ecosystem.

The Moon will serve as the center of the resultant Earth-Moon-Mars ecosystem, with trade routes leaving from the Moon to supply goods and resources to Earth-orbit factories and stations, and with routes headed to Mars to extend our human exploration further than ever before. The infrastructure systems expected to have the greatest impact in facilitating a nuclear-enabled, water-based Earth/Moon/Mars ecosystem include those associated with mobility, power, and in-situ resource utilization (ISRU) commodity production. Mobility is critical to deploying and growing any infrastructure, including both power and ISRU commodities. Power enables independence from Earth, infrastructure persistence through lunar nights, and system level improvements for the economic and exploration functions. The paper will show how fission surface power is key to the scale needed for production and continuous operation. These in turn enable ISRU-based commodity production that improves the overall sustainability of the lunar economy by minimizing Earth reliance and lowering the cost burden for both mission execution and operational replenishment. Water ISRU for propellant can enable both chemical propulsion and nuclear thermal propulsion (NTP) systems. With propellant sourced from the Moon, and both the efficiency and high thrust of NTP, multiple use cases will be shown for cislunar transportation and for Mars transportation. The development of fission power systems can also be applied to nuclear electric propulsion for higher efficiency movement of cargo on slower timescales.

As this international, interconnected, collaborative ecosystem grows, it will support many objectives, including manufacturing in Earth orbit, global-scale lunar science, and the crewed exploration of Mars.