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ADOPTING MODULAR OPEN SYSTEMS APPROACHES TO ENSURE INTEROPERABILITY FOR
LUNAR EXPLORATION

Abstract

To ensure a sustainable and interoperable lunar ecosystem for all, we propose adopting a Modular Open Systems Approach (MOSA) as the framework for lunar architecture development. MOSA consists of programmatic and engineering design requirements that ensure interoperable systems. Importantly, MOSA does not indicate specific requirements or standards themselves, but rather it requires that critical interfaces are designed to be open and components are modular. Since there is flexibility about what constitutes a critical interface, the movement towards interoperability can begin with interfaces which are widely agreed upon as critical.

MOSA facilitates increased interoperability, accelerated innovation, robust competition, and most critically, life-saving repairability and interoperability, while yielding schedule and cost reductions, and opportunities for technical upgrades. Examples of MOSA include the Universal Serial Bus and Peripheral Component Interconnect Express, standards that have enabled rapid development within the computer industry world-wide. Recently, MOSA became required by United States Code for all major acquisition programs for the United States Department of Defense.

As more nations and companies seek to participate in the lunar ecosystem, the MOSA framework enables an open lunar architecture which is built on modular components, and stops the practice of expensive one and done space programs. Indeed, various MOSA practices and governing bodies already exist in the space community including the *International Deep Space Interoperability Standards* and the *International Space Station's Multilateral Coordination Board* respectively. With the rapid growth of a commercial space sector and its evolving marketplace, questions arise on the enforcement and adoption of MOSA practices.

NASA's Lunar Surface Innovation Initiative program, which has the goal to "establish sustainable exploration with commercial and international partners," has established the Lunar Surface Innovation Consortium (LSIC) to facilitate coordination between the United States' government, industry, non-profit, and academic sectors, and encourages international participation. To address the growing interest from the consortium on standards, modularity, and interoperability, the LSIC has established a MOSA working group to determine how best MOSA could be adapted for lunar applications. This paper will present these findings and present a recommended roadmap for implementing MOSA.

The list of stakeholders in the lunar ecosystem is higher than ever. MOSA will ensure an open and interoperable lunar ecosystem that reduces the barrier for global organizations to participate. It's critical

that these discussions are not an afterthought, and that MOSA is used early in the process to ensure interoperability and *Space for @ll*.