

## SPACE EXPLORATION SYMPOSIUM (A3)

## Space Exploration Overview (1)

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COMPARISON OF LUNAR AND MARS IN-SITU RESOURCE UTILIZATION FOR FUTURE  
ROBOTIC AND HUMAN MISSIONS**Abstract**

While debate continues on whether the Moon or Mars should be the first or focal destination for re-sending humans beyond Low Earth Orbit (LEO), all agree that the human space exploration needs to be sustainable and affordable, and that new and innovative technologies and infrastructure are required. One approach NASA is developing that can significantly change how systems required for space transportation and sustained human presence are designed and integrated, as well as potentially breaks our reliance on Earth supplied logistics and enable space commercialization is In-Situ Resource Utilization (ISRU). ISRU, or “living off the land”, involves the identification, extraction, and processing of resources at the site of exploration into useful products and services. In particular, the ability to make propellants, life support consumables, fuel cell reagents, and radiation shielding can significantly reduce the cost, mass, and risk of sustained human activities beyond LEO. Also, the ability to modify planetary surface material for safer landings, lower maintenance of surface transportation, dust generation mitigation, and infrastructure protection, placement, and buildup are also extremely important for long-term planetary surface operations. At first glance, it appears that the resources available and the environmental conditions on the Moon and Mars are different enough that close synergism between lunar and Mars ISRU technologies and systems and how they are incorporated into mission scenarios is not possible. However, upon closer examination, it can be shown that there are significant synergisms in ISRU technologies, systems, and operations between the Moon and Mars. Incorporating ISRU capabilities into lunar missions and using the Moon as a test platform for future Mars missions may also significantly reduce the cost, mass, and risk for both human exploration destinations while providing a logical stepping stone approach to achieving sustainable and affordable human exploration. This paper will outline past and current technology and system development efforts by NASA and international space agencies for lunar and Mars ISRU, and how using the precursor missions to the Moon and Mars can reduce the cost and risk associated with human lunar and Mars exploration.