LUNAR COTS: USING THE MOON’S RESOURCES TO ENABLE AN ECONOMICAL AND SUSTAINABLE PATHWAY TO MARS AND BEYOND. A. F. Zuniga¹ and D. J. Rasky¹, R. B. Pittman²
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Introduction: To support NASA’s goal of sending humans to Mars, a new plan was constructed to develop and demonstrate cislunar capabilities and services in partnership with commercial industry using the well-proven Commercial Orbital Transportation Services (COTS) Program acquisition model. The NASA COTS Program was a very successful program that developed and demonstrated cost-effective commercial cargo transportation services to the International Space Station (ISS). As a result of NASA’s COTS program, two new launch vehicles and spacecraft were developed and have been successfully performing cargo transportation missions to the ISS since 2012. The COTS acquisition strategy utilized a new model than normally accepted in traditional procurement practices. This new model used Space Act Agreements where NASA entered into partnerships with industry to jointly share cost, development and operational risks to demonstrate new capabilities for mutual benefit. This model proved to be very beneficial to both NASA and its industry partners as NASA saved significantly in development and operational costs, as much as tenfold, while industry partners successfully expanded their market share of the global launch transportation business for significant economic benefit.

Using the COTS acquisition model as a basis, a new plan, notionally referred to as Lunar Commercial Orbital Transfer Services (or Lunar COTS), has been developed to determine the potential benefits and challenges of a new Lunar COTS plan[1]. The proposed plan includes low-cost, commercial-enabled missions to prospect for resources, determine the economic viability of extracting those resources and assess the value proposition of using these resources in future exploration architectures such as Mars. These missions would be accomplished in partnership with industry to meet these exploration goals but will also have the capability to carry payloads to meet science goals as well.

As noted in several references, there are a wide variety of lunar resources in the lunar regolith that can be useful to NASA’s long-term human exploration missions to Mars and beyond. One major example is water-ice concentrations in the permanently shadowed regions of the lunar poles. Several remote-sensing, lunar missions in the last two decades including DOD’s and NASA’s Clementine mission launched in 1994; NASA’s Lunar Prospector mission launched in 1998; NASA’s Lunar Reconnaissance Orbiter (LRO) [2] launched in 2009 and NASA’s Lunar Crater Observation and Sensing Satellite (LCROSS) [3] mission launched in 2009 have all indicated the presence of water-ice deposits at the lunar poles. Although these data are strong indications that the presence of water-ice is plentiful at the poles, ground truth data is needed to validate these results and determine the composition, distribution, depth and accessibility of these areas with high concentrations of lunar ice.

Several studies have also examined the In-Situ Resource Utilization (ISRU) processes and facilities necessary to extract and convert the lunar water into LO2 and LH2 propellants. These studies have also provided cost estimates for putting the infrastructure in place for creating the propellant and then delivering it to a cis-lunar propellant depot for use in a future Mars architecture. Although these studies have provided an excellent strategy and approach for creating propellant on the lunar surface, ground truth data from the Moon is needed to determine the exact methods, tools and machinery needed to extract the lunar ice and create the propellant for a more refined cost estimate. It is also best to obtain this ground truth data and develop extraction techniques in partnership with industry to share cost and risk as well as leverage on industry’s capabilities and innovativeness in a competitive environment employing the COTS acquisition model.

Over the past few decades, several architectures for the Moon and Mars have been proposed and studied but ultimately halted or not even started due to the projected costs significantly exceeding NASA’s budgets. Therefore a new strategy is needed that will fit within NASA’s projected budgets and takes advantage of commercial industry along with its creative and entrepreneurial attributes. The Lunar COTS plan presents a cost-effective approach to partner with industry to establish low-cost cislunar capabilities and services, such as, lunar transportation, lunar mining and lunar ISRU operations. These capabilities and services may enable development of an affordable and economical Exploration architecture for future missions to Mars and beyond. This paper will describe a plan for a proposed LCOTS program, its potential impact to an eventual Mars architecture and its many benefits to NASA, commercial space industry and the science community.

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