Building an Economical and Sustainable Lunar Infrastructure To Enable Lunar Science and Space Commerce. A. F. Zuniga,[1] M. F. Turner[1] and D. J. Rasky[1], [1]NASA Ames Research Center, 555 McCord Ave., Moffett Field, CA (allison.f.zuniga@nasa.gov).

Introduction: A new concept study was initiated to examine the framework needed to gradually develop an economical and sustainable lunar infrastructure using a public/private partnerships approach. This approach would establish partnership agreements between NASA and industry teams to develop cis-lunar and surface capabilities for mutual benefit while sharing cost and risk in the development phase and then allowing for transfer of operation of these infrastructure services back to its industry owners in the execution phase. These infrastructure services may include but are not limited to the following: lunar cargo transportation, power stations, energy storage devices, communication relay satellites, local communication towers, and surface mobility operations.

The public/private partnerships approach for this plan leverages best practices from NASA's Commercial Orbital Transportation Services (COTS) [1] program which introduced a new affordable and economical approach to partnering with industry to develop commercial cargo services to the International Space Station. Similarly, this concept study, named Lunar COTS (Commercial Operations and Transport), aims to: 1) demonstrate commercial and affordable cis-lunar and surface capabilities and services; 2) encourage creation of new space markets to share cost and risk with industry; and 3) enable development of a sustainable and economical lunar infrastructure to support lunar science and new commercial ventures.

The primary goal of the lunar infrastructure development is to extend the life, functionality and distance traveled of surface mobility missions and to reduce cost, complexity, mass and volume of all surface missions. Presently, surface mobility or rover missions are heavily constrained by power demands, battery life, direct line-of-sight communications with Earth, extreme thermal conditions, traverse distances, landing conditions and 14 lunar day/night cycles. To date, there have not been any US surface mission that have survived a full 14 lunar day/night cycle primarily due to the extreme cold temperatures that exist during the lunar night (approx -250C). Therefore, the mission life of lunar surface missions is typically limited to less than 14 lunar days. The traverse distances are also severely limited primarily due to batteries not surviving the extreme cold temperatures in dark craters and throughout the 14-day lunar night.

A lunar infrastructure system with power, communication and navigation elements as well as a self-contained mobility system designed properly will have the capability to extend mission life to several years by providing power generation, storage, recharge and thermal control functions to the surface mobility system(s) and other payloads. In addition the communication tower will be able to increase communication links to the rover systems and not be limited to direct-line-of-sight to Earth communications. The local navigation aids located on the top of the communication tower will also aid the rover systems to navigate in dark areas, such as craters, where visibility is limited. A mobile infrastructure system will also have the added capability to extend the traverse distances of the mission to hundreds of kilometers. Therefore this new infrastructure system together with surface mobility systems have the potential to provide valuable and extensive scientific data over several years and cover numerous lunar sites over hundreds of kilometers. By partnering with industry to develop and own the infrastructure services using the COTS model, this plan will also result in significant cost savings and increased reliability and mission probability of success

A phased-development approach is also planned under this concept to allow for incremental development and demonstration of capabilities gradually over time. During the initial phase, a small-scale infrastructure is planned together with small mobility systems to collect ground truth data to identify valuable resources and assess its composition, distribution and accessibility. These data will be important not only to the science community but also the commercial space community for future planning of potential lunar industries.

This presentation will describe the Lunar COTS concept goals, objectives and approach for developing an economical and sustainable lunar infrastructure. It will also describe the technical challenges and advantages of each infrastructure element towards supporting future lunar science missions and lunar industrialization, such as lunar mining and space manufacturing. Finally, the presentation will also look forward to the potential of a robust lunar commercial economy supporting science missions and lunar industries and its potential effect on the next 50 years of space exploration

References:

[1] "A New Era in Spaceflight," NASA Commercial Operations and Transportation Services Program, U.S. Government Printing Office, Washington, DC, Feb 2014.