

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Space Transportation Solutions for Deep Space Missions (8-A5.4)

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DESIGN AND OPTIMIZATION OF TRANSFER OF RESOURCES FROM THE LUNAR SURFACE  
TO LUNAR ORBIT**Abstract**

As envisioned in the Global Exploration Roadmap, permanent human presence on the Moon will be a reality in future years. In this frame, missions to Lunar surface and orbit will be of interest to both public and private entities, and they will envisage In-Situ Resource Utilization for generating resources (propellant, construction materials, water) for long term settlement. For these reasons, optimizing transfers between Lunar orbit and Lunar surface is of great interest and requires the detailed planning of operations, as well as the design of appropriate transfer vehicles and surface structures to support operations.

This paper discusses the optimization of the transfer of Moon resources from Lunar surface to Lunar orbit, both from an operational and a design standpoint. Possible concepts of operations with the related architecture elements have been conceived, and an overall mission scenario is presented. Logistics and traffic plans for multiple missions have been discussed, and a set of trade-off analyses have been performed to select the most suitable transfer method. The most important features of these analyses and their results are discussed in detail. Precursor robotic sample return missions have also been considered to validate reusable technologies in view of their application in large scale crewed and cargo missions. The paper also focuses on the definition of the building blocks of the system. A preliminary study of the transfer element has been performed up to the estimated mass and power budgets, considering both a cargo and a manned design with concerns on refueling capabilities. The surface spaceport structures and support equipment concepts have been analysed, with the purpose of allowing multiple landings/takeoffs on the

Moon's surface with high precision, reliability and safety. The issue of dust rising was also assessed in order to minimise damage and to prevent nearby equipment from being compromised. This paper is concluded by summarising the main takeouts on the selected operations plan and system building blocks, and possible future developments of the proposed systems are discussed.

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