

22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)

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INTERPLANETARY LOGISTICS: A LUNAR NEXUS AS A CRUCIAL HUB FOR FACILITATING MARS EXPLORATION AND BEYOND

Abstract

In the ambitious pursuit of sending astronauts to Mars, the Moon emerges as a pivotal launchpad and a ground base, assuming a crucial role in mission planning and design. This paper explores the implications of multiple missions to the Moon, envisioning its lunar surface not just as a point of departure but as a strategic platform for resource supply and cutting-edge experiments conducted in unique environmental conditions. The coordination of these missions becomes paramount, with challenges in managing diverse payloads and optimizing launch windows. Efficient traffic management and trajectory validation emerge as critical components in ensuring fuel optimization and mission success. The study emphasizes meticulous planning to facilitate a seamless flow of resources, exploiting the integration of reusable elements to enhance efficiency and cost-effectiveness. Financial implications are thoroughly analysed, providing a detailed comparison between moon-based launches and direct launches from Earth to Mars. Furthermore, the paper undertakes a comprehensive analysis of various launch systems, including an evaluation of future European launchers, to identify the most suitable options for frequent departures. A re-evaluation of launch vectors is also explored, recognizing that the transition towards routine lunar travel necessitates a paradigm shift in planning and the introduction of ad-hoc technical requirements. In conclusion, this paper highlights the Earth-to-Moon-to-Mars architecture as an essential strategic technological hub to adapt and refine technologies for Mars exploration and beyond, marking a significant leap in the future of interplanetary endeavours. This study is carried out in the framework of the II Level Master's programme SEEDS (Space Exploration and Development Systems), a project born from the collaboration between the Politecnico di Torino (PoliTo), the Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) and the University of Leicester, with the participation of Agenzia Spaziale Italiana (ASI), Centre National D'Etudes Spatiales (CNES), European Space Agency (ESA), Thales Alenia Space and Altec.