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SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES, CONCEPTS AND TECHNOLOGIES (D3)
Infrastructures and Systems to Enable Ambitious Future Exploration and Utilization of Space (3)

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PRELIMINARY CONCEPT OF A CIS-LUNAR ORBITAL HANGAR TO SUPPORT EXPLORATION OF THE MOON, MARS AND BEYOND

Abstract

In the frame of the Third International Master SEEDS Project Work focused on a permanent habitable space station located in the Earth-Moon Lagrangian Point 1 (EML1), a concept for an orbital hangar has been devised with the following mission statement: to assemble, maintain and refuel exploration spacecraft in orbit.

A clear definition of the scenario in which such a system should be deployed has been a core part of the study. This long term space exploration scenario is centered on these main assumptions: a permanent base on the surface of the Moon with In-Situ Resources Utilization (ISRU) capabilities, a developed heavy launching system with sustained high lifting capabilities (crew/cargo) and an ongoing long term exploration program (human/robotic) towards the Moon, Mars and beyond.

Sitting on the edge of the Earth-Moon gravity well, the envisaged station would act as the local space transportation hub and provide key capabilities, including assembly, maintenance and refueling of vehicles.

The conceptual design and preliminary sizing of the hangar have been performed. The study firstly focused on the requirements assessment, then on the functional analysis of the system. Specific attention was devoted to the identification and selection of alternative designs for the physical configuration of such a large and innovative system. This effort led to the definition of the hangar building blocks and their interfaces.

Among these building blocks, the most innovative and critical ones have been selected for further investigation: the truss, the structure to which serviced vehicles are docked; the Mobile Pressurized Control Module (MPCM), a mobile habitable module which shifts along the truss and docks to serviced vehicles; the deck robotics, which manipulate visiting vehicles and their parts, support and perform maintenance activities; the refueling system, which stores and distributes cryogenic fuel.

The preliminary design of these elements is consolidated by detailed system budgets, the overall architecture being consistent with the resource allocation to all the elements of the hangar. Enabling technologies and other criticalities have been identified.

The work suggests that an orbital hangar, and the overall station, would provide significant benefits as part of a future space architecture for the exploration (and development) of the Earth-Moon system, of Mars and beyond. Presence of adequate amount of ice water on the Moon surface is critical for the viability of the project, and still hardly debated. Technological challenges, though significant, seem to be within reach in the envisaged time frame (2040+).