Scientific Objective and Infrastructure of Space Exploration (1)
Scientific Objective and Infrastructure of Space Exploration (2)

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GENERAL ARCHITECTURE AND KEY ENABLING TECHNOLOGIES FOR A CISLUNAR HABITAT

Abstract

Cislunar space is considered the next step in exploration: an international cooperation is envisioned by space agencies for the possible realization of a human infrastructure in Cislunar space as a sort of 'staging post' from where missions to other destinations can originate. Thales Alenia Space-Italia (TAS-I), by leveraging its significant know-how developed in the frame of ISS pressurized modules, recently supported the European Space Agency in the definition of an overall architecture of the Cislunar infrastructure, with specific focus on the configuration of the pressurized elements (Habitats) and the identification of the key technologies required to cope with the major critical design aspects. According to the first outcomes of TAS-I feasibility study, the Cislunar infrastructure Habitats are configured similarly to the ISS Nodes and share the same overall configuration and outfit, differing through specific functionalities to be implemented as Kits, according to a so-called "Common Module" approach, which is deemed promising in terms of greater flexibility in launch order packaging, advantageous mass per volume ratio, optimization of the development and verification process, increased opportunities for international partners contributions. In addition, the introduction of Kits allows an effective implementation of on-orbit outfitting, beneficial in terms of reduction of the mass at launch and along the approach of enforcing standard interfaces ("plug and play" of some equipment). To cope with challenging constraints on mass at launch, an exercise of identifying potential optimization in the design of the Habitats was performed by TAS-I, in particular for the following aspects:

- a global re-thinking of the thermo-mechanical configuration considering the peculiarities of a Cislunar scenario wrt the LEO environment, the adoption of specific interfaces (e.g. launch with SLS, IDSS-compatible docking system) and the optimization of the module dimensions and the number of docking ports;
- a careful failure tolerance approach implementation;
- an effective management of the on-orbit water cycle, to allow significant savings on the overall mass and volume to be transferred in orbit, in particular through the recovery of condensate water from cabin atmosphere and the adoption of flexible storage systems for potable and waste water aimed also at providing local radiation shielding capabilities.

Besides the considerations about mass, the optimization of the internal packaging and the configuration of the habitable spaces in the module is considered one of the key aspects for the design of the Cislunar Habitats.