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Strategies and Architectures to Establish a "Stepping Stone" Approach to our Future in Space (1)

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AN EVOLUTIONARY APPROACH TO A FLEXIBLE ARCHITECTURE FOR SPACE EXPLORATION

Abstract

Lessons learned from years of hard-won experience with the International Space Station (ISS) - in terms of docking operations, routinary module assembly, resupplying and refueling - are directly applicable to the design, development, operations and management of future exploration missions. Furthermore, many successful robotic missions and astronomic observatories have been launched with new technologies on-board aimed at expanding capabilities for future exploration.

Based on these remarkable achievements, during the last decade a number of designs have been assessed for much more ambitious targets such as human operations and long permanence beyond low Earth orbit (LEO). However, all these studies rely on the capability to transfer significant amounts of equipment to the final destination. To this end, the development of innovative propulsion technologies and the improvement of in-space assembly capability beyond LEO are essential steps.

In this frame and based on the successful experience of the European Automated Transfer Vehicle (ATV), Alta is proposing the design of a flexible architecture as stepping stone for future space exploration. Compliant with the NASA flexible path guidelines, main strategic objective of such an architecture is to improve servicing capabilities beyond LEO. This would allow next generation systems developed on ISS experience to be proved on a harsher environment. In fact, this architecture could serve for ISS resupplying and refuelling, testing of enabling technologies for future exploration activities, multi-purpose research laboratory beyond LEO and support of human and robotic survey missions. A second generation of vehicles properly powered by nuclear power could also serve as crew transportation system to the Moon and beyond.

Main elements of this architecture are a service module and inflatable structures. The service module is powered by a hybrid propulsion system that provides the vehicle with much more flexibility thus allowing a wider range of mission classes and objectives to be accomplished. The vehicle will be able to perform autonomous ISS rendezvous and docking for refuelling and - in a longer run – with fuel depots. This will extend the vehicle operational lifetime thus allowing many transfers between LEO and the target destinations. Expandable structures will be deployed after launch providing a significant volume to be equipped with cargoes and various experiments to be performed beyond LEO. Moreover, these inflatable modules could also serve as building blocks of a future space station beyond LEO.

In this study, main application scenarios and a proposed configuration of this architecture are presented.