

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Going To and Beyond the Earth-Moon System: Human Missions to Mars, Libration Points and NEO's  
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NEXT STEPS IN THE EVOLVABLE PATH TO MARS

**Abstract**

NASA is currently underway developing the Space Launch System (SLS) to carry crew and cargo beyond low Earth orbit (LEO). The heavy lift capabilities of the SLS will enable spacecraft and mission architecture flexibility not achievable with current or proposed alternative, medium and heavy lift launch vehicles. The SLS is being designed in an evolutionary approach to provide increased performance as NASA's Exploration program advances. This approach will see the SLS grow from an initial configuration (Block 1) capable of lifting more than 70mT to LEO to an intermediate configuration (Block 1B) capable of 105mT to LEO, and ultimately evolving to a configuration (Block 2B) capable of 130mT to LEO. The next steps of human exploration in space will depend on the development of deep space exploration capabilities needed to support extensive missions in hostile environments in preparation for a human mission to Mars. Recent work in Europe and the US has established the need for more data on the combined effects of microgravity and radiation on crew members. Also, architecture studies have established the need for improved in-space transportation of non-time critical cargo. In fact, it may be possible to reduce the costs of a human campaign of Mars expeditions by as much as 60% over the previously estimated cost targets. This will provide an affordable and sustainable approach that will allow the US and its international partners to begin preparing now by developing the required elements.

As we move forward into missions that prepare the way for Mars, a Deep Space Habitat and a Solar Electric Propulsion (SEP)-based transfer stage may represent the next logical capabilities that should be developed according to an incremental build-up logic. Together with SLS and Orion, these new capabilities would allow a number of exciting interim missions to be executed in the cis-lunar environment and demonstrate critical capabilities that will be employed for eventual human Mars missions in the 2030's. This paper will describe one such concept that can utilize heritage from the ISS as the basis for the habitat

and leverage the efficient transportation capabilities of a SEP transfer stage to position it in a lunar orbit.