Paper ID: 66900
student

19th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

Author: Mr. Alexander Huschke
International Space University, France

Prof. Gongling Sun
International Space University, France

FEASIBILITY STUDY TO BUILD A DEPOT IN LOW EARTH ORBIT

Abstract

As commercial spaceflight, including space tourism, private space stations, crewed lunar missions, and eventual Mars missions, will develop into a sustainable and growing market, in-space depots for propellant and water will be key to space infrastructure.

This study assesses various possible architecture concepts and design configurations, weighs tradeoffs on systems and sub-systems levels and evaluates enabling technologies for a modularly extendable non-cryogenic propellant and water depot in low Earth orbit. The proposed architecture will focus on servicing space stations, such as the International Space Station (ISS), the Chinese space station or private space stations. Also, as a future application the depot could provide logistic support for crewed lunar exploration missions or serve storage needs for in-situ extracted water resources in the cis-lunar environment. As a secondary aim, the concept of in-space fluid depots is assessed according to its economic feasibility and affordability.

The design of a depot in low Earth orbit is presented through a top-down approach. After a high-level analysis, the sub-systems are analyzed and different design configurations are proposed. A risk assessment including Failure Modes and Effects Analysis is calculated and the technology readiness levels of the subsystems involved are estimated. The resulting configurations from this are compared and a tradeoff analysis is conducted. The final proposed system consists of a modular in-space depot and a transfer vehicle able to relocate fluid from the depot to a space station. Key capabilities for the in-space depot are short-term and long-term thermal control, power supply, attitude control and stabilization as well as robust interface design. Lastly, long-term storage poses an additional challenge that is addressed by means of adequate thermal insulation.