IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
In-Space Transportation Solutions and Space Logistics (8)

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REFUELING IS FUNDAMENTAL TO IN-SPACE TRANSPORTATION SOLUTIONS AND SPACE LOGISTICS

Abstract

In-Space Servicing, Assembly, and Manufacturing (ISAM) promises more sustainable space operations and can enable activities not economically feasible with expendable approaches. An in-space transportation and logistics infrastructure supports spacecraft refueling, repair, and upgrade and assembly and resupply of new space platforms and habitats. It will deliver raw materials and components for manufacturing and assembly in space and on the Moon and transport finished space products to destinations in space, on the Moon, or back to Earth.

Many elements and capabilities are needed to develop sustainable in-space transportation solutions and space logistics infrastructure including new technologies, designs, and systems and regulations, policies, and norms of behavior. However, refueling is a fundamental capability for the remaining logistics sustainability efforts. The United States Space Force (USSF) is pursuing refueling for their own maneuverability needs, but commercial and civil entities also need refueling for sustainable logistics capabilities. Whether for 'space tugs' to move spacecraft, commodities, or material or servicers for repair and upgrade or manufacturing and assembly, they all need fuel to continue operations. Without refueling, each of these efforts is no different than the single-use spacecraft we have today with their lifetime set by a single propellant load.

This paper explores refueling benefits for a sustainable space ecosystem from spacecraft and servicing infrastructure to impacts on the launch and ground systems.

Refueling allows spacecraft to use smaller propellant tanks since mission life is no longer tied to the initial propellant load. This results in smaller spacecraft for the same mission, which reduces production time and cost, and likely reduces launch cost. Smaller vehicles are more delta-V efficient. They have the same stationkeeping and maneuver capability as a larger vehicle with less delta-V, or conversely, they have greater stationkeeping and maneuver capability given the same delta-V expenditure.

Smaller client spacecraft increase space tugs and servicing vehicle efficiency. Space tugs need less delta-V and propellant to transfer them, and servicers can carry less refueling propellant. This results in smaller space tugs and servicers with similar reduction in production time and cost and lower launch cost.

Smaller spacecraft, space tugs, and servicers improve ground and launch operations. A reduced propellant load improves safety with hazardous commodities, like hydrazine, and reduces ground processing time. They allow smaller launch vehicles or launch vehicle configurations, or, alternatively, it increases launch vehicle capability margin. Increased launch margin can expand launch windows and increase winds aloft capability, thereby improving launch responsiveness.