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ECONOMIC BENEFITS OF REUSABLE LAUNCH VEHICLES FOR SPACE DEBRIS REMOVAL

Abstract

Cost is often cited as a significant barrier to Active Debris Removal (ADR) missions. Recent advances in space transportation, such as the SpaceX Falcon 9 booster recoveries, indicate that Reusable Launch Vehicles (RLVs) are approaching commercial viability. A key advantage of RLVs is their potential to significantly reduce the costs of space transportation. If sufficient cost reductions are attained, a wide range of space activities which are currently considered impractical from a cost perspective, such as ADR missions, can become feasible.

In this study, we perform an economic analysis of the potential impact of RLVs on ADR missions. Initially, this analysis canvasses several ADR mission concepts from previous studies, then establishes basic cost estimates for these missions. Such missions are categorized based on the size of debris, and the orbits in which they operate. These missions are then assessed to determine potential launch cost savings which can be achieved through the use of RLVs. The results are then used to determine the total cost reduction of ADR missions.

Previous studies indicate that a long-term program focused on debris removal would be required to stabilize the orbital debris population in the future. Using the mission-based cost estimates described above, our study projects the long-term cost savings achievable with RLVs in a large-scale ADR program. By considering this program as opposed to a single mission, this study establishes the broader economic impact of RLV cost reductions.

It is worth noting that expendable launch vehicle stages are also a major source of space debris. Expended upper stage boosters often remain in orbit following separation, thus adding to the debris environment. As RLV technology advances, it may become possible to reuse orbital upper stages. Upon reentry, reusable upper stages are removed from orbit, eliminating the need for removal by future ADR missions.Therefore, this study also investigates the long-term economic impact of a reduction in expended upper stages remaining in orbit.