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MISSION TO MARS USING SPACE-SOURCED PROPELLANT

Abstract

Current on-going efforts to source materials in space for their use in space will enable more cost-efficient and more versatile missions. It is consensus that the first application to this end will be to use propellant stored or even produced in space. We study the impact and potential of sourcing propellant at two different locations, that is, from depots in a lunar orbit and the farther Sun-Earth-Lagrangian point 2 (SEL2). To this end, we conduct a high-fidelity analysis for a mission to Mars using the General Mission Analysis Tool (GMAT) modelling all major mission arcs and propulsive events. We started with a pilot study where we compared our method to the 2003 MarsExpress mission, which serves us as reference. Then, we simulate missions for the 2026, 2028, 2030 departure windows. We compare the propellant consumption of the direct mission with the missions employing refuelling in lunar orbit or at the SEL2. We find that, even if considering a mass reservation for refuelling equipment, the payload mass can be increased and, in addition, a smaller, hence more cost-efficient launcher can be employed for both scenarios. Less refill-propellant is needed if the depot is stationed at the SEL2, which is advantageous from a mission perspective. However, the overall engineering and economic challenge to place a depot at the remote location is greater. This will likely increase the price of the propellant. This requires further overall cost analysis for concluding on the overall viability.