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ANALYSIS OF A 3-BURN INJECTION METHOD THAT ENABLES EFFICIENT DEPARTURES FROM A LOW EARTH ORBIT PROPELLANT DEPOT TO ARBITRARY DEEP-SPACE DESTINATIONS

Abstract

This paper presents a 3-burn injection method that enables manned and robotic spacecraft to depart for interplanetary destinations from a Low-Earth Orbit propellant depot with only minor ΔV penalties. This injection method overcomes two of the key identified obstacles to utilizing LEO propellant depots for interplanetary missions—the low probability that the plane of the depot will be properly aligned with the desired departure asymptote during a short interplanetary departure window, and the inability to target a departure asymptote with a declination higher than the depot's orbital inclination. Both of these obstacles are particularly challenging for destinations like Near Earth Objects, which tend to have very short departure windows and can sometimes have very high departure declination angles.

In this paper, the authors will: 1) provide a literature review on related injection methodologies, 2) illustrate the underlying concept behind this three-burn injection method, 3) discuss implications of using this method, including potential mission safety benefits, and 4) present some details on estimates of the worst-case ΔV penalty for performing this sort of departure maneuver, compared with a traditional one-burn departure from a LEO parking orbit.

This paper will also include case studies of using a single LEO depot to support multiple subsequent missions to a variety of interplanetary destinations including Mars, and one or more Near Earth Objects. One of the specific Near Earth Objects that will be included in this analysis will be 2007 XB23, as an acid-test for this injection method, due to its very short departure window and a high departure declination (-70 degrees).