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THE VALUE OF ENHANCED DELTA V CAPACITY: A EUROPA CLIPPER CASE STUDY

Abstract

Interplanetary missions often take years because of the vast distances spacecraft cross before reaching their mission area. While it is physically possible for the spacecraft to have faster transfer orbits, they are often designed with rockets that cannot provide the velocity change required for the faster orbits. Designing launch vehicles and in-space propulsion technologies to surpass these limitations can be expensive and there is reluctance to depend on such new technologies with uncertain costs and availability when flight proven alternatives can enable missions. When it is in our best interest to design with such new capabilities in mind?

Europa Clipper is a NASA flagship mission to study Jupiter's moon Europa and provides an opportunity to gain insight into the value of new spaceflight capabilities. While much of its design revolves around its orbits in the Jovian system for its science mission, there is an open question about the best approach for the interplanetary transfer from Earth to Jupiter: Venus-Earth-Earth-Gravity-Assist (VEEGA) or direct. The VEEGA has been used to access the outer planets previously and allows use of an Atlas V rocket, whereas the direct transfer would require NASA's new SLS rocket. Both options are capable of placing about the same mass of spacecraft in Jovian orbit.

The direct trajectory can reduce the transfer time by years and not require close passage to the sun, but cost and availability of the SLS for Europa Clipper is still unknown. The direct transfer also eases requirements on the Europa Clipper, reducing required spacecraft lifetime and not requiring thermal management for close Sun/Venus passage. This could be leveraged to simplify the Europa Clipper spacecraft or reallocate mass dedicated to these requirements to enhance other spacecraft properties such as carrying additional maneuvering propellant, increasing the spacecraft's tolerance for the Jovian radiation environment, or adding additional scientific instruments to expand its mission.

Our research uses Europa Clipper as a case to study the value of enhancing change in velocity (delta v) capacity for deep space missions. A value model will be utilized to compare VEEGA and direct transfer Europa Clipper missions. The model will consider the impact of the different transfer times as well as design options enabled by the two transfer architectures using Net Present Value of the mission architectures.