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MEO TETHERS ENABLING LOW-COST ORBITAL ACCESS

Abstract

A space-faring civilization will require low-cost access to space and return to Earth. The issue with space access is that despite their promise, barring a breakthrough in propulsion, fully reusable launch systems are a refractory technology, and are likely to be anything other than low cost. A notable example is the now-retired Space Shuttle, which was 1.5 stages to orbit, but was enormously complex and expensive. There are two fundamental problems with fully reusable, single stage to orbit vehicles: propulsion (primarily specific impulse), and thermal protection. With LOX-Hydrogen propulsion, the maximum effective specific impulse from surface to orbit is 440 s. This allows vehicle planners to speculate that they may be tantalizingly close to a SSTO vehicle; nevertheless, the realities of materials and propulsion leave the unassisted SSTO systems unrealizable. Reentry from Earth orbit is similarly onerous issues with thermal management. Present reentry conditions require expensive and fragile ceramics. The MEO tether option reduces the required ΔV from 9 km/s to ¡7 km/s; furthermore, it reduces the reentry velocity similarly. These reductions make an SSTO feasible, indeed, the thermal management requirements are sufficiently reduced that it is possible that metallic TPS could be feasible. The reduced ΔV requirements tend to raise the payload and structure fraction from a mere 11

This tether system is phenomenologically distinct from space elevators and rotovators and other concepts using MEO or LEO tethers to reduce launch ΔV. This tether system has the potential to reduce navigation hazards to existing satellites to a negligible level. This makes it reasonable to contemplate this architecture as a follow-on to existing expendable launch systems. Considerable effort has been expended in developing models and performance characteristics, stability issues and other important parameters of the tether system. The authors have defined a plausible architecture and concept of operations for such a system. Based on our analysis to date, we project that in-volume launch costs could be reduced to as low as 180/$kg.Theauthorswillreportonfindingstodate,includingdynamicsandstability,aswellasimplicationsfordesignofanSS$