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CIS-LUNAR PROPULSION OPTION COMPARISON

Abstract

There are many potential architectures for moving supplies, propellants, and people in cis-lunar space. There are also a number of propulsion options.

This paper analyzes and compares nine trajectory elements: Low Earth Orbit (LEO) to the lunar surface, LEO to Low Lunar Orbit (LLO), LEO to the Gateway orbit, Gateway orbit to LLO, Gateway orbit to the lunar surface, LLO to the lunar surface, various vehicle Trans Lunar Insertion (TLI) capabilities to the lunar surface, various vehicle TLI capabilities to LLO, and various vehicle TLI capabilities to the Gateway orbit. Various cis-lunar architectures will use some subset of these trajectory elements.

For each of these trajectory elements five propulsion options are examined: solar electric propulsion (SEP) (except for those trajectory elements that go to the lunar surface – i.e., a deep gravity well), storable chemical propulsion, LOX/CH4 propulsion, LOX/H2 propulsion, and nuclear thermal propulsion (NTP).

For the trajectory elements that go from LEO, the Gateway orbit, or LLO to the lunar surface, three vehicles are developed: a lander that only goes down, an ascent vehicle that goes up, and a reusable lander that carries a payload (that may be an ascent vehicle) and lands and then returns. For the trajectory element that is deposited into a TLI orbit, a lander vehicle is developed.

For the other trajectory elements that are deposited into a TLI orbit, a one way transfer vehicle is developed.

For the LEO to Gateway orbit and the Gateway to LLO trajectory elements, reusable transfer vehicles are developed that deliver a payload and then return empty.

Lastly, for the LEO to LLO trajectory element, a transfer vehicle that delivers a payload is developed as is a reusable transfer vehicle that flies one way, delivers a payload and returns empty is developed.

For all these vehicles the vehicle mass versus payload is shown for the various propulsion options.