60th International Astronautical Congress 2009 Paper ID: 3753

SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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A SOLAR ELECTRIC PROPULSION TUG WITH STRETCHED LENS ARRAY FOR LUNAR CARGO DELIVERY

Abstract

The present architecture for delivering cargo to the moon in NASA's Mission to the Moon, envisions an all-chemical approach that lands 22 MT of cargo on a lander anywhere on the moon. This architecture requires a heavy-lift Ares V launch vehicle presently under development. This direct ascent to low lunar orbit has severe payload penalties and the vehicle is not resusable. Both factors lead to high costs. It is the purpose of this paper to explore the use of a reusable solar electric propelled (SEP) spacecraft that can deliver the same cargo to the lunar surface annually. Reusability is a key cost saving measure that requires durability of the solar array to the effects of the earth's radiation belts. In addition, there is the need to only launch the SEP vehicle once. Subsequently, only the new payloads and propellant for the next mission need be supplied to the reusable vehicle which has returned to low earth orbit (LEO) after delivering the cargo to the moon.

The critical element that enables this new spacecraft is the Stretched Lens Array (SLA) that offers an unprecedented portfolio of performance metrics: Areal Power Density = 300 W/m2; Specific Power = 300 – 500 W/kg; Stowed Power = 100 kW/m3 High-Voltage (600 V) Operation; Unexcelled Radiation Hardness at Low Mass Penalty 66

These attributes make SLA ideally suited for reusable Solar Electric Propulsion (SEP) space tugs, especially those which haul cargo from low earth orbit (LEO) to the Moon. We have analyzed SLA-SEP space tug solutions to this cargo delivery mission, and have concluded that SLA-SEP tugs offer multi-billion-dollar savings over conventional chemically fueled cargo delivery approaches. The paper will describe the SLA-SEP space tug approach, and present the assumptions, methods, and key results of our analysis of SLA-SEP space tugs for lunar cargo delivery.

The basis for the SLA was demonstrated by the successful 38 month flight of NASA's Deep Space 1 that performed a comet rendezvous. A demonstration segment of this lightweight array is shown in figure 1. The key conclusion of our study is that each reusable 600-kW-class SLA-SEP lunar cargo tug will provide savings of more than $3billioncomparedtoconventionalchemically-fueledcargotransportindelivering110MTtothelunarsu$