Resource Exploration and Exploitation in Near Earth Space
Satellite Salvage, Reservoir Crater Exploration and Asteroid Capture and Derotation

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Future proposed and funded low earth orbit (LEO) human and unmanned launch vehicle developments and deep space exploration initiatives will within ten years deliver advanced, fully reusable, vertically and horizontally launched dual fuel (hydrocarbon and hydrogen) heavy lift launch vehicles, for a wide variety of commercial and government funded national human and unmanned space flight programs.

- The Space Launch System (SLS) is essentially our dual fuel launch vehicle – writ large.
- Stratolaunching of hydrogen core stages now makes two stage orbital space planes feasible.
- Reusable staged and clustered hydrocarbon fueled heavy lift launch vehicles will fly routinely.

An alternative method of achieving the full reusability of launch vehicles, is the autonomous deep space flight of hydrogen powered ground started core stages flown directly to orbit.[1] Direct orbital insertions are enabled by engine clustering and sequential engine shutdowns. Hydrogen powered core stages with multiple clustered engines implicitly represent useful deep space infrastructure. Controlled assets placed in high earth orbits essentially exist as infrastructure forever. Deep space and geostationary orbits do not require any continuous reboost propulsion and fuel, and provide continuous illumination for their solar energy conversion systems, but they also require vast amounts of radiation shielding in order to be made habitable by humans. Large amounts of space based salvageable assets already exist in geosynchronous inventories, in locations far more accessible and useful than lunar polar surface operations and materials, and fully refined, manufactured and fabricated into products eminently useful for deep space operations.

Engine clustering in ground started hydrogen core stages will enable any large integrated spacecraft to reach high geosynchronous transfer and deep space orbits in a single burn, where they can drift within a continuously illuminated space littered with high value resources. Mission functionality must therefore be incorporated directly into these ground started hydrogen core stages, which can then be flown directly to high geostationary transfer orbits, subsequently enabling an ambitious near earth orbit extraterrestrial resource exploration architecture, consisting of large, complex and relatively mobile, autonomous deep space systems designed for capturing, derotating and salvaging old satellites. This approach allows for the near term testing of far more ambitious resource exploitation architectures, and also the simultaneous development of the infrastructure necessary to facilitate all future near earth material resource missions, including near term lunar polar surface operations and small (co) orbital asteroid capture and derotation.

- The continuously illuminated edges of dark lunar reservoir craters can provide unlimited regolith radiation shielding materials for a warm and energy rich surface, with nearby cold thermal traps containing as yet uncharacterized deposits of volatile enriched soils, hydrated minerals and ice.

- Small meter-sized asteroids are now predicted to routinely enter coorbital and earth synchronous trajectories and earth orbital resonances[2], bringing compositionally diverse materials into very close proximity to the Earth, where they may then be explored and exploited for raw materials.

What needs to be done to make a beyond low earth orbit space exploration architecture possible?

I have briefly outlined a deep space resource exploration architecture providing an ample framework for more advanced architectural studies, and unparalleled opportunities for the crowd sourcing of innovative concepts – all enabled by the expectation of future, dual fuel, heavy lift, fully reusable launch vehicles. This resource centric architecture is also compatible with recently proposed Lagrange point fuel depots. The enabling technology for this near earth space resource exploration and exploitation program is the availability of hydrogen upper and core stages with a sufficient Isp, weight, thrust and thrust to weight ratio to enable direct insertion into high geosynchronous orbits, which is readily achievable with the SLS as well as the numerous existing and proposed upper stages of conventional multistage launch vehicles.

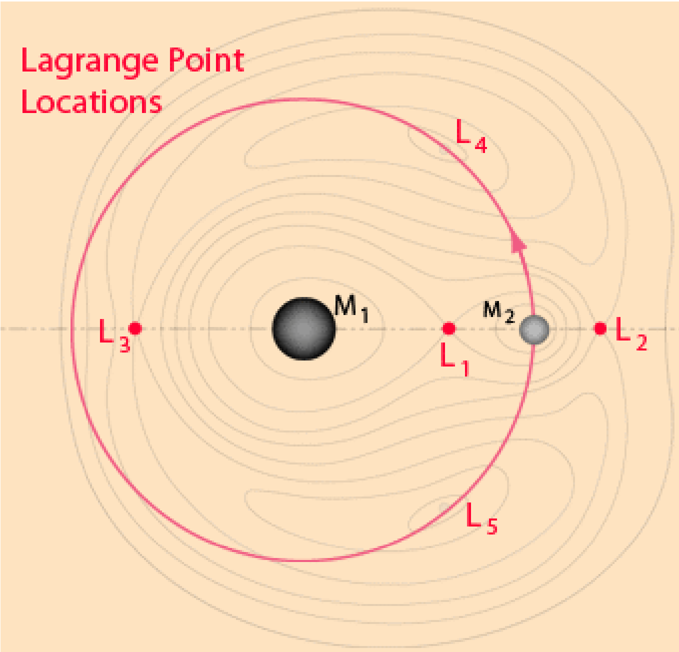
Space launch system (SLS) core stages must be redirected into high earth orbit instead of ocean reentry, and more importantly core stages must be designed for passive sun pointing and active attitude control, and outfitted with the equipment for the task of analyzing and approaching randomly rotating spacecraft. Modest vacuum rotation chambers can be flown in microgravity environments to test sub scale models of electromagnetic torquing methods, angular momentum transfers and propulsive damping of rotation. Experience with deployable sun shades, solar shields and solar cell arrays can also be readily obtained, and these subsystems can be incorporated or attached to the exterior of propulsive stages as payloads. In regards to the expendable SLS, the cost savings for complex infrastructure rich missions are self evident.

References

1. Reusable Space Launch Systems, Thomas Elifritz, NIAC Solicitation Number NNH11ZUA001N

2. The Population of Natural Earth Satellites, Mikael Granvik, Jeremie Vaubaillon, Robert Jedicke, http://arxiv.org/abs/1112.3781 (Accepted for Publication in Icarus – December 13, 2011)

Lagrange Point Locations - http://hyperphysics.phy-astr.gsu.edu/hbase/mechanics/lagpt.html



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