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Introduction: The Cislunar Logistics Center (CLC) is a multifunctional, modular, robotic spacecraft to be deployed in a halo orbit around Earth-Moon Lagrange Point 1 (EML-1). CLC will initially serve as a hosted payload platform for commercial and defense payloads at EML-1, which is a strategically and commercially valuable location due to its central position between the Earth and the Moon and the low energy requirements to access both Earth and lunar orbits. As additional CLC modules are launched and integrated with the initial spacecraft, new capabilities will be brought online. These capabilities include propellant storage and distribution, depot level spacecraft servicing, propellant processing, material handling and parts fabrication, on-demand power capabilities, and pre-staging of materials and vehicles for human spaceflight contingency and rescue operations. The modularity embedded in CLC's design allows for time-distributed cost and risk reduction. New capabilities can be added ad hoc as new markets emerge and develop.

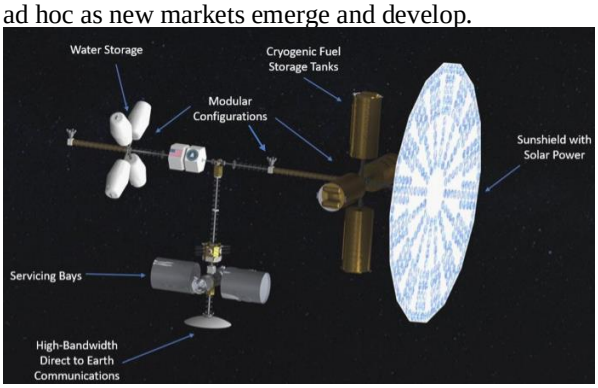

Fig 1. The Cislunar Logistics Center

Problem: One of the great discoveries in planetary science in recent decades is that water is ubiquitous in the inner solar system. Water exists at the poles of Mercury and is chemically bound in hydrated minerals within C-type asteroids includingnear-Earth objects (NEOs). Water is abundant on Mars, but most importantly, water exists in permanently shadowed regions (PSRs) near the poles of the Moon. The existence of water on Earth's nearest celestial neighbor is of paramount importance for space exploration, space commerce, and defense. Water has many uses in the context of space exploration and development. It is essential for human life and agriculture. Oxygen, one of its constituents, is a necessary component of breathing air. It is one of the most effective substances for radiation shielding on a per mass basis. But perhaps its most valuable use is as rocket propellant. It can be used directly in the form of steam or plasma for low to medium thrust applications. When split into hydrogen and oxygen and liquefied, it produces LO2 and LH2, the most efficient chemical propellant combination known. Water is the oil of space.

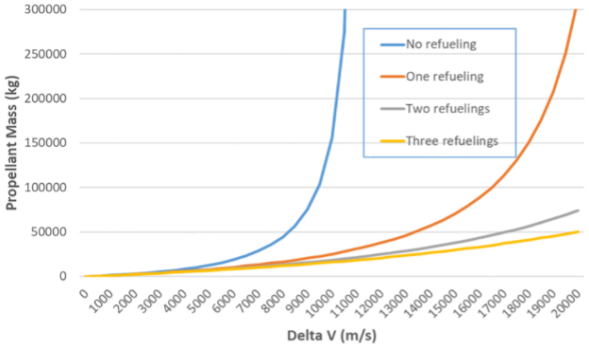

Fig 2. Breaking the Tyranny of the Rocket Equation

Space travel and exploration is limited by the mass of propellant required for the journey. This leads to high cost missions and restricted capabilities. All beyond LEO missions and space activities could benefit from lunar propellant via refueling. Figure 2 shows the relationship between required propellant mass at a given Delta V with no refueling incorporated into the mission up to three refuelings. A necessary prerequisite for the propellant market is a refuellable transportation architecture. The reductions in the cost of space travel are shown in Figure 3 for different locations in cislunar space with different sources of propellant.

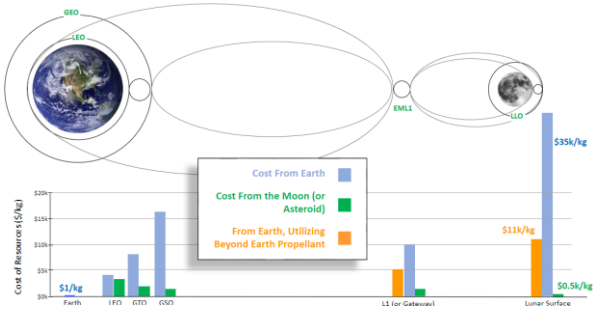

Fig 3. Costs of Propellant in Cislunar Space

Opportunity: Current American assets are not sufficient to ensure the upper hand in space nor protect commercial interests in cislunar space. This opportunity can be broken down into three main subsets. First,

the United States has little to no domain awareness in cislunar space or beyond GEO (XGEO), with limited domain awareness in GEO. Second, there is an increasing need for assets to maneuver without regret; due to factors like rapidly advancing ASAT capabilities, adversary spacecraft, and increasing space junk. Third, there are dozens of commercial, government, and adversary spacecraft being sent into XGEO over the next few years and the number of spacecraft operating in that domain continue to increase as the cislunar economy grows.

Solution: CLC will serve as a hub of the new cislunar economy. Initial development of a cislunar economy will rely on providing value to existing terrestrial customers; the first commercial customers for cislunar services will likely be existing spacecraft operators. Manufacturing and launching spacecraft is an expensive, risky endeavor for commercial operators, so there is a significant desire to extend the life of on-orbit satellites for as long as possible. Limited propellant, mechanism failure, and exhaustion of consumables severely limit the life of orbital spacecraft, creating a strong market demand for services that address those concerns. This can be addressed by a fleet of commercial servicing spacecraft that use CLC as a fuel depot and service station, before traveling to Earth orbits (LEO, MEO, GEO) to refuel, inspect, or repair commercial satellites. Commercial entities will deliver propellant, including hydrazine, water, and methane, to CLC for distribution to said servicing spacecraft. Advanced manufacturing capabilities will be added to CLC so parts and eventually whole spacecraft structures can be built in the microgravity of space rather than on Earth; commercial opportunities exist to fabricate and assemble the parts and resupply the manufacturing module. As the cislunar economy expands beyond Earth, CLC will serve as a delivery and distribution point for goods and materials made from space resources, including water and liquid hydrogen and oxygen propellants from the lunar poles, methane from asteroids, and metallic feedstock from lunar regolith. The customer base will also expand to include spacecraft traveling to lunar orbits or the lunar surface, asteroids, or Mars. Although CLC will not be a human-rated facility, it could be used to support crewed spaceflight activities by serving as a location to stage rescue spacecraft and materials for emergency use. CLC's servicing, inspection, and fueling capabilities can ensure that rescue spacecraft are in prime condition in case they are needed.

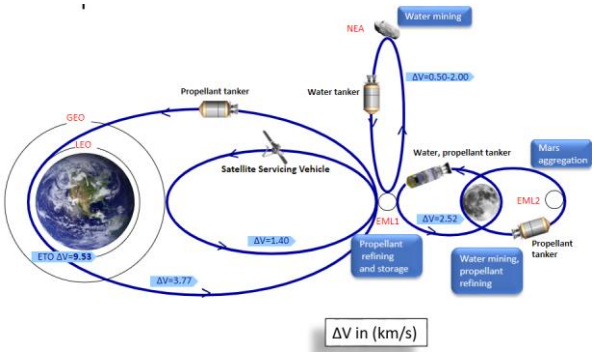

Fig 4. The Cislunar Propellant Distribution Network

There is currently no capability in space like that offered by CLC. Commercial spacecraft must currently launch with everything needed during the mission – propellant, consumables, et cetera – for their entire expected lifespan, with no expectation of refuel or servicing. No space capability like CLC has been sold, leased, or licensed to the public, nor has one been offered for sale, lease, or license.

Market research has been conducted on user adoption and the commercial potential for CLC. Based on the extensive commercial research performed it has been determined that there is a notable customer base for CLC. Additionally, there are strong complementary technologies that reduce technical risk towards implementation.

Additional Information: If you have any questions or need more information regarding the abstract, please contact Justin Cyrus at: justin@lunaroutpost.com.