OPERATIONS COST REDUCTION FOR A JOVIAN SCIENCE MISSION USING CUBESATS. A. C. Faler[1] and A. Rajguru[2], [1]Department of Astronautical Engineering, University of Southern California, Los Angeles, CA 90089.

Introduction: With NASA's renewed interest in exploring Jupiter and its moons, specifically Europa, cost reduction is on the forefront of concern. Concurrently, the surge in successful CubeSat launches to NEO, has spawned interest in examining their use for deep space applications. By means of an in-depth trajectory and communication optimization, we aim to drastically reduce the operations cost of a science mission to the Jovian system using CubeSats.

In recent years there have been various proposals for a science mission to the Jovian system. Those that have made it past the proposal stage, such as NASA's JIMO, resulted in cancellation due to its $10 billion budget. Current proposals include the NASA/JPL Europa Clipper and ESA's Laplace and JUICE proposals each estimated at $2, $4.7 and $1.1 billion dollars respectively. Using CubeSats to reduce hardware, launch and operations cost, we propose that missions similar to those formerly mentioned could be accomplished for under $500 million dollars.

Approach: In order to drastically reduce operations cost our main focus will be on the communication link budget, which has been designed specifically in regards to the ground operations of the DSN's 34 m HEF Antennas. We are looking to minimize ground operation usage of the DSN to 15-30 minutes on specific days over the entire mission duration. In addition, the Jovian moons exist in a harsh radiation environment, therefore it is critical to reduce mission duration and high-pulsed data transfer will be utilized to achieve this goal. Most importantly, the CubeSats will meet all the science requirements mentioned in the decadal survey proposed by NASA for the Jovian moons in consideration.

In order to optimize communication operations, the mission is designed to have a three tier bend pipe communication architecture, consisting of a mothership carrying multiple units of 6U CubeSats, which will be deployed around the Jovian moons. Currently, we are targeting the three moons - Callisto, Europa and Ganymede.

The trajectory optimization is performed and tested using Evolutionary Mission Trajectory Generator (EMTG), which is a new trajectory generator software implemented by NASA Goddard Space Flight Center. In addition, a trade analysis of launch vehicle selection to reduce operations cost and mass is performed.

Concept: The main objective of the mothership is to be the link between the DSN and the orbiter. The data from the lander is uplinked to the orbiter and the orbiter transfers this data along with uplinking it's own science data to the mothership, which in turn transmits it to the DSN. The paper's primary focus is on the operation of this bend pipe communication architecture in conjunction with the ground operations of the DSN.

The trajectory analysis also involves the operation of using high-powered pulsed discharge through the propulsion system on a duty cycle at optimal points. The high power pulse discharge system is required for deep space communication to transmit large amount of data. To address concerns regarding a sufficient power supply, a Radioisotope Thermophotovoltaic (RTPV) coupled with batteries and super capacitors will be used to implement the acyclic high power bursts. The secondary focus is the intelligent dual-mode operation of this system for both propulsion and communication.

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