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DESIGN OF A LOW-COST MICROSATELLITE FOR DATA-RELAY FROM THE DARK SIDE OF THE MOON

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ABSTRACT

The idea proposed in this work is to place a data-relay satellite in a halo orbit around the second collinear libration point of the Earth-Moon system. The design of the halo orbit is the result of an optimal compromise among cost of the manoeuvres to guarantee a periodic motion, cost of the slew manoeuvre required to point to the Earth and the Moon, the width of the view cone including both the primaries. This architecture allows to have always at least three ground stations in view. A perturbation analysis has been performed considering solar pressure, fourth body disturbance and oblateness of Moon and Earth, leading to a maintenance cost of $\Delta v = 88$ m/s per year. The satellite has been designed for low-cost piggyback launch on the Ariane-5 into GTO, but despite the mass and the reduced dimensions, it is endowed with a 650 W capable power plant thanks to two 3.2 m^2 of solar arrays. Such power mainly feeds the propulsion system during the transfer to the halo orbit. Once on the final orbit a grate part of the power is redirected to the telecom system when the spacecraft is not performing any correction manoeuvre. The selected main engine for the mission is the QinetiQ Ltd. T5 mkV Carbon Gridded Ion Thruster, while for the system of attitude control have been adopted some Hollw Cathod Thrusters (HCTs), also them produced by QinetiQ Ltd and now under testing. Limited volumes inside the bus required a toroidal tank designed for lodging about 13 kg of Xenon. The architecture of the communications system is based on the use of two steerable parabolas, one for the Earth link and another for the Far Side link, capable to sustain a maximum date-rate of about 500 kbps. The onboard computer&data handling system is designed in order to manage in completely autonomous way all the subsystems and in order to store a big quantity of data (memory mass storage capability of 1 GB), because of the consequent complexity of the software and the lack of link with the Ground Segment for long time during the transfer. The result of this feasibility mission study is a low cost system to support operations and activities on the far side of the Moon.