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PRELIMINARY DESIGN OF A SATELLITE INFRASTRUCTURE FOR WIRELESS POWER SUPPLY OF EARTH SATELLITES

Abstract

As the Space Sector is striving towards more flexible and more efficient solutions, the power supply of space systems constitutes a bottleneck in this process. The ever-growing spacecraft's power demand represents in fact a limiting factor in the development of lighter and more flexible spacecraft.

In this framework we aim to investigate possible solutions for a satellite architecture capable of supporting future missions in Low Earth Orbit through Wireless Power Supply, as to propose sustainable alternatives to the current state of the art. The availability of such an infrastructure would revolutionize satellite design and operations. For example, it would enable to drastically reduce the satellite's Electric Power Subsystem (EPS) in terms of mass and volume. Also, it would allow supporting missions featuring very intense peak power requests. Or even it would open the possibility of recovering spacecraft facing an EPS failure.

The selected technology for the power transfer is that of lasers, which are excellent candidates in this application thanks to their high power density compared to other solutions.

Our research focused on the definition of an optimal orbital geometry for such a satellite infrastructure. For this purpose a multi-objective heuristic algorithm has been used to maximize the constellation performances, that is to minimize the number of satellites of the architecture while guaranteeing continuous coverage on the receiving satellite's altitude, and reducing the transmission losses. A pool of optimal geometries has been found, and a performance analysis has been carried out by evaluating the constellation's maintenance cost, deployment strategies, and operational constraints.

The study provided a preliminary analysis of the constellation design. But still, a technological limit does exist to its applicability and concerns the free-space transmission losses. Indeed, to ensure continuous coverage with a limited number of transmitting satellites, the orbital separation from the receivers results in transmission losses too large for the current laser technology.