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INNOVATIVE METHODOLOGY FOR THE PRELIMINARY DESIGN APPROACH FOR LOW EARTH ORBIT CONSTELLATIONS

Abstract

Traditional infrastructure design approaches are strictly sized and related to initial conditions and financial effort making use of optimization methods to design specific performances of the single spacecraft with a fixed market analysis and focusing on the design of a single spacecraft each time. This means that there is a lack of a holistic approach to the design of a constellation considering the whole mission from the stakeholders and customers need analysis to technical and economical constraints. The necessity to develop design tools able to reply to the above needs is significant inside the present industrial scenario where large Low Earth Orbit (LEO) constellations of small satellites are of increasing importance for Earth Observation and Telecommunication missions. This study aims to formulate an approach to carefully consider the customers demand in order to accomplish different needs and to arrive to a preliminary design of the constellation avoiding the previously lacks. The purpose of the methodology is to identify cost-effective architectures and deployment strategies for more detailed design studies and to propose utility parameters to fill the variety of requests from customers. It allows architects to start from user needs analysis and passing through the analysis of the metrics of interest (and consequently the performance of interest), to explore a trade space with alternative optimal architectural solutions for LEO constellations. Through different steps, the approach allows to find different Pareto optimized preliminary designs of constellations and according to customer needs, to be able to choose the most suitable alternatives. Therefore, it can evaluate low-cost alternatives or high-performance ones, or maybe balanced solutions and continue the study for the subsequent design. Moreover, an analysis of the deployment is performed with respect to the service development strategy. The case study of a multi-payload LEO constellation for Earth Observation purposes will be considered and deeply analyzed. The presented approach will provide an important tool for the preliminary design of a satellite infrastructure considering cost uncertainties during all the course of the simulation and proving effectiveness, scalability and attention for demand.