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SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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ECONOMIC BENEFITS FOR LEO TELECOM CONSTELLATIONS DUE TO MODULAR SPACECRAFT ARCHITECTURE

Abstract

The realization of future satellites based on the aggregation of modular units offers several advantages compared to the traditional approach, consisting of monolithic, highly customized spacecraft. In fact, the aggregation of multiple, standard, self-consistent units with the capability of cooperation would lead to the realization of platforms with equivalent performance compared to traditional satellites, but with increased fault tolerance and flexibility. Such approach would also lead to a significant increase of the platform lifespan by replacement of malfunctioning, damaged or obsolete units with spare or updated units. The major drawback of this concept is represented by the increase of inert mass of the single unit, which is inevitable in the process of fragmentation of the monolithic platform, leading to increase of costs. While this is certain for a single satellite, this may not apply if we consider a constellation based on dozens of satellites. If each spacecraft is fragmented in a cluster of modular, standard units, their amount becomes so large that economy of scale can be applied, causing decrease of both costs and production time of the single unit. In addition, the fragmentation approach makes it possible to deploy a reduced capability constellation in a short time simply by launching platforms composed by half of the total units; such initial constellation could be further, gradually expanded by launching additional units. In this work, the economic benefits deriving from the adoption of a modular design applied to LEO telecom constellations is analysed. The overall cost of constellations based on monolithic satellites and modular platforms with equivalent telecom capabilities and performance are compared, considering different constellation architectures and reference monolithic satellites. For each architecture, the mass of the monolithic satellite is determined exploiting historical data, as well as the mass of the modular units as a function of the number of units the monolithic satellite is fragmented. Then, the overall cost of the fragmented platforms is calculated using cost estimating relationships (CERs) and compared to the cost of the monolithic satellites. The analysis shows that in most of cases there is a fractioned configuration that significantly reduces the cost of the whole costellation.