

Aerospace Europe Conference 2023

Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX (to be filled by the organizers)

Preferred Topics: SUSTSP / NEWSPA

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Type: Oral

Status of corresponding author: Student (Master)

For student corresponding author: student member of one of the following:

Title

A Concurrent Methodology for Optimizing Constellation Deployment and Launcher Selection.

Authors

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Abstract

The popularity of constellations is on the rise, with 86% of SmallSats launched between 2012 and 2021 being owned by five operators, only in 2021, more than 70% of the SmallSats launched that weighed less than 600 kg were either a part of the Starlink or the OneWeb constellation [1]. Besides, the decreasing costs of launches and the increasing availability of commercial space components are fueling a revolution in Low Earth Orbit (LEO) systems, resulting in affordable constellations of small satellites. These developments have prompted a focus on propulsion systems, particularly electric [2], which can enhance the commercial or scientific yield of these satellites. Additionally, deployment strategies of launchers and other aspects of the broader "space mobility" issue have gained attention [3]. However, designing and deploying a constellation is a complex, multidisciplinary problem that requires collaborative optimization techniques. One of the most critical aspects of this process is selecting the right launcher, which can have a significant impact on the total cost of the system. As such, careful consideration of all the factors involved is necessary to ensure the success of a mission. Typically, each discipline is optimized independently, but a concurrent approach is necessary to find the best combinations of launchers, propulsion systems, and deployment strategies in terms of cost, timeliness, and performance. To address this challenge, we propose a methodology that relies on principles of concurrent engineering and applies metaheuristic, hierarchical, combinational, and dynamic optimization techniques to propose valid and efficient solutions, allowing for simultaneous analysis of all the involved parameters and facilitating the assessment of trade-offs. The approach aims to build robust optimization solutions using launch market uncertainty and to enable engineers to explore the design space efficiently, making smart decisions quickly.

References

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