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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Small Launchers: Concepts and Operations (7)

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CONCEPTUAL LAY-OUT OF SMALL LAUNCHER OF WHICH ITS REFERENCE MISSION IS 250KG OF PAYLOAD INTO A 700KM-CIRCULAR POLAR ORBIT

Abstract

Miniaturized satellites represent the current forefront of space technology. Indeed, the progress in the area of structure and electronics has led to smaller satellites and thereby reduced the size requirements of launch vehicle. The development of a small launcher will reduce the launch cost and allow time flexibility. Furthermore, the trend seen in small launcher augmentation is to develop a small launcher based on existing stage in order to use existing technologies and thereby to reduce the cost of a new production.

The objective of this paper is to present the conceptual layout of two small launchers: a three-stage launcher with two solid stages and one liquid upper stage, a two-stage launcher, both containing liquid fuel. The small launcher has to be able to put around 250kg of payload into a circular polar orbit with a radius of 700km. The launch pad is Kourou in French Guyana.

From studies on existing launcher, stages characteristics have been correlated to each other. The thrust, specific impulse and structural index have been represented as a function of the propellant mass in the stage. By using a performance tool written in MATLAB and especially developed for the purpose of this study, the optimal characteristics of the small launcher have been found. The Nelder-Mead algorithm has been used in order to find the optimum launcher. As the launcher characteristics are automatically defined with the propellant mass, by changing the amount of propellant in the different stages and the parameters of the gravity turn trajectory, tendency about the amount of propellant in the different stages has been seen. From this trend, the existing stages, which have their characteristics the closest ones from the optimum ones, have been chosen. The upper stages have been newly designed to fulfill the requirements for both launchers. This design includes propellant budgets, helium budget, structural mass calculations and total mass breakdown. A final performance assessment has been done on the two launchers.

The content of this paper is new and was hence not presented at previous conferences. Also the attendance of the author in Naples, Italy to deliver the paper is assured.