

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

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SMALL LAUNCHER ENABLED BY HYBRID ROCKET MOTOR TECHNOLOGY

Abstract

In this paper we present a small launcher for payloads ≥ 10 kg and orbits of 350-400 km. Currently there is an increasing demand for small launchers, demand that is increased especially by the nano-satellite expanding missions as well as a strategy shift to smaller and more efficient payloads. Advancements in electronics helped this direction by creating smaller and more powerful computers and communication equipments that can be fitted on smaller satellites with performances at least equal with the ones from the previous generation. We propose a three stage small launcher powered by solid-hybrid-hybrid combination. We investigate the full flight dynamics of the launcher including the technological solutions for each of the stages, stage separation systems as well as guidance and telemetry. We argument each choice using previous experience on launcher designs as well as technical and economical arguments. We present the solid rocket motor for the first stage and its dimensioning and technological solutions available for a low cost booster fabrication. We present the full internal ballistic computations with validated solutions. The relatively new proposal is to use hybrid rocket motor technology for the second and third stage due to its lower cost of manufacturing as well as simplicity compared to liquid rocket motors. At the same time the performance promise from hybrid rocket motors and their throtttable capabilities makes them ideal candidates for upper stage propulsion. Detailed discussion is performed related to the performance of hybrid rocket motors and its influence on launcher lift capability. We also show the preliminary design of such hybrid rocket motors as upper stage propulsion units and propose several fuel/oxidizer pairs based on both technical performances as well as cost parameters. The entire airframe is proposed to make heavy use of advanced aluminium alloys ensuring a lightweight overall structure. Next we present a full 6 DOF model for the flight of the launcher as well as simulation results for various flight scenarios ending with different payloads on different orbits. Detailed discussion is performed on guidance and control systems illustrating the main limitations and the option to use as many as possible COTS due to their availability and low design-production cycle. The paper ends with a discussion related to optimization procedures for a small launcher due to its importance on launcher performances and price of operation.