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

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# SMALL LOW-COST LAUNCH VEHICLES: ENGINEERING AND BUSINESS BROAD ANALYSIS

**Abstract**

The number of small satellites to be launched is increasing year after year and, due to the conditions (i.e. schedule, cost, orbit) under which those satellites have to be launched, the necessity of a specific launch service is today more obvious than ever. For this reason several companies and organizations have started to propose and develop different launch systems in order to fulfil the launch necessities of that specific market. One of those requirements is the price, which has to be low enough to be attractive in front of other market competitors, and secure the required flight rates to be a sustainable business. Until now most of the existing launch systems have been designed mainly from the performance point of view, being the cost a secondary parameter. However, many launch system concepts have been proposed aiming to be the lowest cost solution for this particular market: modular rockets, air launch systems, SSTO, reusable systems, etc. This paper analyses the space launch systems from the engineering and the economical point of view in order to determine which are the concepts and solutions most likely to be the optimal ones for a small satellite launch service. A broad study is presented; several launch systems concepts are proposed, studied, and compared between them in order to identify which are the elements of low-cost launch system. Additionally, the subject is analysed from the business side so as to recognize how the economic parameters can affect the launch service. Finally, it has been found that the optimal low-cost solution for a specific launch service for small satellites will be affected by several factors (i.e. experience of the team, political interferences, company's background, etc.). However the space launch systems concepts expected to be the most cost-effective solutions are the ones based on simple propulsion systems, equal staging and maintaining the number of elements in the minimum required.