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DESIGN AND PROGRAMMATIC OPPORTUNITIES FOR SMALL SATELLITE MISSIONS CONSIDERING RECENT TRENDS IN LAUNCH VEHICLE MARKET

Abstract

Spacecraft (S/C) design is often constrained by mass and size because of the resulting launch costs. However, launch costs have been decreasing significantly in the last years, especially for small satellite missions. Recent announcements and most notably SpaceX' current prominent ridesharing offers are changing the small satellite market even more. What does that mean for the design and engineering of (new) concepts and missions?

A lowered launch price per kg obviously allows reduced mission cost for the same mass. Another option is increased spacecraft mass for the same price. Relaxing the mass budget could increase payload (P/L) performance and thus the actual purpose of the mission. In addition to that, being less constrained by mass would allow simpler and faster engineering due to less and maybe unnecessary 'mass-optimization'. One of the results could be the reduction of equipment costs as development of highly specialized components or miniaturization can be substituted by suitable, less optimal commercial off-the-shelf (COTS) components instead. Development can also be faster by using COTS units and reduced effort to fit everything into the S/C under the mass requirement constraints. Lead time for procurement and implementation might be improved and thus further reduce the overall cost of a mission. On the other hand, the launch cost savings could be used to introduce better equipment on P/L or S/C side, depending on the financial annual budgets available.

Ultimately this opens questions such as "Can smarter design allow more (science) missions?", "Why are satellites still design driven mostly by mass?" and help to vitally challenge the status quo of spacecraft engineering.

The aim of this paper is to analyze opportunities for institutional, scientific and commercial small satellites based on the launch market evolution/ launch cost reduction and the impact on spacecraft requirements, design and eventually costs. It discusses the trade space for possible design decisions and describes the interdependencies amongst e.g. launch cost, equipment selection approach, engineering effort, development time, risks, redundancies, use or reduction of total cost budget... Historical data of past and current missions are analyzed and trends for future missions based on a case study for exemplary missions are identified. In conclusion it provides technical and programmatic recommendations for different S/C classes and extends to possible re-evaluation of previously discarded missions which may now become feasible.