Small Launch Vehicle Design Approaches: Clustered Cores Compared with Multi-Stage Inline Concepts

Abstract

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In an effort to better define small launch vehicle design options two approaches were investigated from the small launch vehicle trade space. The primary focus was to evaluate a clustered common core design against a purpose built inline vehicle. Both designs focused on liquid oxygen (LOX) and rocket propellant grade kerosene (RP-1) stages with the terminal stage later evaluated as a LOX/methane (CH_4) stage. A series of performance optimization runs were done in order to minimize gross liftoff weight (GLOW) including alternative thrust levels, delivery altitude for payload, vehicle length to diameter ratio, alternative engine feed systems, re-evaluation of mass growth allowances, passive versus active guidance systems, and rail and tower launch methods. Additionally manufacturability, cost, and operations also play a large role in the benefits and detriments for each design.

Presented here is the Advanced Concepts Office's Earth to Orbit Launch Team methodology and high level discussion of the performance trades and trends of both small launch vehicle solutions along with design philosophies that shaped both concepts. Without putting forth a decree stating one approach is better than the other; this discussion is meant to educate the community at large and let the reader determine which architecture is truly the most economical; since each path has such a unique set of limitations and potential payoffs.