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LAUNCHER OPTIONS FOR EUROPE IN A WORLD OF STARSHIP

Abstract

The progress made by SpaceX in flight testing its StarshipSuperHeavy launcher configuration is remarkable and could soon bring a fundamental shift to space transportation. Announced as a fully reusable rocket to LEO with unprecedented payload capacity, the global competitive landscape could be revolutionized with the realization of this super-heavy system.

These circumstances need to be well understood and therefore require, as a first step, a thorough technical analysis of Starship's actual capabilities in its early operational phase, based on the latest openly available data. Models used for new, updated, independent analyses in this paper are similar to those presented earlier [1].

The main part of the paper is dedicated to the technical evaluation of European options in serving a roughly similar payload class of above 50 Mg in single launch to LEO. Typical future applications which would require a significant number of missions per year are the deployment of mega-constellations, space solar power or deep-space human and large-scale robotic exploration. The small ESA-funded PROTEIN-study looked into some of the potential launcher design possibilities.

Annual payload delivery of several hundred tons is well-above the design capabilities of Ariane 64. Thus, either a major evolution of A6 or completely new launcher architectures are required. A launcher system analysis looks into such Ariane 6 evolution options and assesses the technical limits mostly based on the assumption of expendable stages.

However, a significantly better performance perspective can be achieved through a completely new architecture based on building blocks that already exist or are under development. Reusability with VTVL and VTHL are then viable options with impressive payload capacity [2]. TSTO-launchers are selected as the baseline, but the addition of a third or orbital transfer stage could be attractive for certain high-energy missions. In case of the new architecture launchers, all first stages are designed reusable and exclusively liquid cryogenic propellants are chosen.

The paper concludes with a comparative evaluation of main technical characteristics of launch vehicle options and indication of promising development roadmaps.

[1] Wilken, J.; et al: Critical Analysis of SpaceX's Next Generation Space Transportation System: Starship and Super Heavy, 2nd HiSST: International Conference on High-Speed Vehicle Science Technology, Bruges, September 2022

[2] Sippel, M.; Stappert, S.; Callsen, S.; Bergmann, K.; Dietlein, I.; Bussler, L.: Family of Launchers

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