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FAMILY OF LAUNCHERS APPROACH VS. "BIG-SIZE-FITS-ALL"

Abstract

The recent rapid development in the field of international space transportation systems requires an updated and refined European strategy with a new generation of modern, high-performance launchers in the medium to longerterm with partial reusability probably being the most promising approach.

One of the concept options could be a family of launchers supporting a wide range of payload performance as proposed in ESA's 2021 program NESTS [1]. The idea bases upon using "building blocks" of common stages or main propulsion rocket engines and applying them in a modular way with up to four different launcher classes from micro, through intermediate, heavy and "super heavy" types.

SpaceX is following a somehow contrarious approach. A single TSTO launch vehicle should serve all kinds of missions and should be economical even for those which have payload mass requirements far below the design capacity. This tactic is already followed today with small satellite missions transported on the Falcon9 but will become even more explicit in the future with the StarshipSuperHeavy combination.

The key question can be formulated: What is the best approach for Europe and its space transportation needs? Huge and heavy single payloads are still required to be transported into orbit while constellation deployment, smaller Earth-observation satellites or even human space transportation [2] could be part of the portfolio mix.

The technical investigations described in this paper evaluate the two antipodal design approaches of either establishing a launcher family consisting of modular building blocks or choosing a full-size launcher serving all missions with minimal adaptations with upper- and kick-stage or customizing propellant filling.

RLV configurations all based on sustainable liquid fuels like hydrogen and methane are considered. A systematic assessment on stage-arrangement and different return and recovery modes, as well as propulsion options is carried out. Reference 2 has demonstrated that a payload beyond 14 tons GTO-class with multiple payload capability can be achieved at relatively compact size. An improved version of this concept is baseline for the full-size reference launcher and the largest member of the family.

The paper summarizes major results of the preliminary technical design process. Critical design constraints related to ascent controllability issues due to stiffness or partial propellant loading are highlighted and assessed.

[1] ESA STS PB: Outcome of Studies for New European Space Transportation Solutions (NESTS), ESA/PB-STS(2021)37

[2] Sippel, M. et al A viable and sustainable European path into space – for cargo and astronauts, IAC-21-D2.4.4