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Space Systems Engineering - Methods, Processes and Tools (1) (4A)

Author: Dr. Roberta Fusaro
Politecnico di Torino, Italy, roberta.fusaro@polito.it

Prof. Nicole Viola
Politecnico di Torino, Italy, nicole.viola@polito.it
Mr. Davide Ferretto
Politecnico di Torino, Italy, davide.ferretto@polito.it
Dr. Francesco Santoro
Altec S.p.A., Italy, francesco.santoro@altecspace.it
Mr. Gabriele Ferrari
Politecnico di Torino, Italy, gabriele.ferrari@studenti.polito.it
Mr. Gabriele Ferrari
Politecnico di Torino, Italy, gabriele.ferrari@studenti.polito.it

GUIDELINES TO DESIGN MULTI-ROLE SUBORBITAL FLIGHT SYSTEMS.

Abstract

On December 18, 2017 at the annual Next Generation Suborbital Researchers Conference, Virgin Galactic and the Italian Space Agency (Agenzia Spaziale Italiana, ASI) announced the signature of a Letter of Intent under which ASI would secure a full suborbital flight on Virgin Galactic's SpaceShipTwo. This is only one of kind of the various initiatives that are taking place all over the world and strongly confirming the increasing interest in suborbital parabolic missions. From an industrial standpoint, this means that the transportation system should be flexible enough to offer a service to the highest number of stakeholders. Starting from these considerations, this paper aims at suggesting a proper methodology to translate these high-level and qualitative needs into specific design parameters, supporting in a rational way the design activities of a multi-purpose vehicle. The presented methodology will exploit a Model Based Systems Engineering (MBSE) approach guaranteeing lot of improvements and benefits with respect to the traditional design methodologies: a complete internal traceability among requirements belonging to different categories and hierarchical levels as well as an external traceability towards design elements and within the overall industrial process. Moreover, this approach guarantees shortening the design activities, exploiting a reduced number of required design iterations, and lowering economic risk related to unappropriated design solutions thanks to the increment in the confidence level of the high level estimations. A complete tool-chain consisting of systems engineering tools, requirements management tools and CAD modelling software will be suggested, guaranteeing a multidisciplinary design environment. Considering the intent of developing a multi-purpose suborbital transportation systems, i.e. a vehicle able to be easily reconfigured in order to support a certain range of missions, the major design efforts should be focused on the design of different cabin configurations, each one optimized for a specific purpose. Moreover, special attention will also be devoted to the design and sizing of the different subsystems supporting the payload and its operations. Taking advantage of the methodology feature of being applied to existing systems, a specific vehicle will be selected as reference, and cabin arrangements solutions for three different missions will be presented: routine touristic flight services, microgravity scientific experimentation services and test bed of enabling technologies for future hypersonic missions. Eventually, a comparison of the results, as well as a brief investigation of the ground infrastructures and provisions to support the mission of such a multi-purpose transportation system, will be provided.