

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Future Space Transportation Systems (4)

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COMPARISON BETWEEN VTOL AND HOTOL HYPERSONIC TRANSPORTATION SYSTEM  
AIMED AT SUBORBITAL FLIGHTS: IMPACT ON SYSTEM ARCHITECTURE, SIZING AND  
PERFORMANCE**Abstract**

This paper deals with a comparative analysis of two different configurations for hypersonic transportation systems aimed at suborbital flights. The two architectures differ from each other for the required and implemented take-off strategy. Indeed, the way in which the take-off will be performed deeply affects not only the external layout of the transportation system but also its subsystems architecture as well as its performances. In this context, it is important to notice that the ability of performing trans-atmospheric flights is a very demanding goal with a very high level of complexity that also depends on the relationships between the flight segment and the other elements of the System of Systems. Moreover, the additional capability of carrying out a vertical take-off increases the complexity of the technical solutions but can have very positive impacts on operations. Starting from the mission statement and a preliminary list of mission requirements, the conceptual design of the two different architectures have been developed, following the typical steps of a systems engineering methodology. Once the external layout has been defined and the impact of the requirements that stem out from the take-off strategy has been highlighted, the main subsystems are analysed, designed and sized in terms of mass, volume and power budget. To support this iterative and recursive methodology, a proper tool-chain, consisting of both commercial software and ad-hoc built-in tools, has been built and applied. In particular, due to the high level of complexity of the systems, simulations have played a fundamental role in the design process. Indeed, the use of modelling and simulation techniques since conceptual design is required to diminish the level of uncertainties of important design parameters, such as the take off gross mass, the propellant mass, the thrust or the overall time required to carry out the mission. A comparative analysis has been carried out to figure out main advantages and drawbacks in terms of ground operations, logistics, maintainability, safety and costs for both VTOL and HOTOL hypersonic transportation systems. The analyses confirm the expectations highlighting penalties in terms of mass, complexity and additional costs for the VTOL configuration. Notwithstanding, trade-off analyses clearly show advantages in terms of operations and flexibility of similar transportation systems with respect to a conventional one. Eventually, a comparison between Single Stage To Orbit and Two Stage To Orbit configuration is presented and discussed.