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

Author: Mr. Steffen Callsen
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Space Systems, Germany, Steffen.Callsen@gmail.com

Mr. Jascha Wilken
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute of Space Systems, Germany, jascha.wilken@dlr.de
Mr. Sven Stappert
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, sven.stappert@dlr.de
Dr. Martin Sippel
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, Martin.Sippel@dlr.de

FEASIBLE OPTIONS FOR POINT-TO-POINT PASSENGER TRANSPORT WITH ROCKET PROPELLED REUSABLE LAUNCH VEHICLES

Abstract

For the first time in spaceflight history the flight of a fully reusable launch system with rocket propulsion appears possible within the next couple of years. Apart from the implications for the orbital launch market, a fully reusable system could also enable an entirely new class of commercial point-to-point transport on Earth.

Rocket propelled point-to-point systems promise the ability to transport passengers or cargo to any suitable landing site on Earth with extremely short travel times (typically less than 90 minutes). However, their mission profile and trajectory design are non-trivial, since a large number of constraints have to be respected during both ascent and descent of all stages. Such aspects include thermal and mechanical loads but also safety aspects with regard to populated areas. Depending on the reliability of the system in question, different levels of risk might be acceptable for the overflight of populated areas.

The number of potential commercial routes is limited by the expected noise during the ascent and descent of the systems as well as the safety considerations. Potential point-to-point connections of major global hubs are identified and the performance of two reference vehicles are evaluated.

The trajectory studies are performed using multi-objective trajectory optimization with evolutionary algorithms in order to identify the pareto-front with regard to multiple objectives, for example payload performance, minimal risk to populated areas, minimal heat load, minimal mechanical loads and others, while still respecting other constraints.

Within this paper, possible point-to-point missions and the associated performance for two reference vehicles are evaluated: DLR-SART's SpaceLiner 7 as well SpaceX's StarShip. For both cases the models on which the mission analysis is based are described. This includes mass budgets, aerodynamic and aerothermal databases as well the assessment of the structure and thermal protection systems. Where appropriate parametric studies are used to identify the impact of the various mission options on the design and mass of critical subsystems, such as the thermal protection system.

Based on these results potential configuration and design updates for the new SpaceLiner 8 are discussed.

In addition to the point-to-point missions, the orbital performance and the reentry profiles of both reference vehicles are shown and the differences assessed.

[1] Sippel, M.; Stappert, S.; Koch, A; Assessment of Multiple Mission Reusable Launch Vehicles. 69th International Astronautical Congress (IAC), 01.-05. October 2018, Bremen, Germany.