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

Author: Mr. Iñigo Alforja Ruiz
Politecnico di Milano, Italy

Ms. Lucía Ayala Fernández
Technische Universität Braunschweig, Germany
Mrs. Alice De Oliveira
Politecnico di Milano, Italy
Mr. Guillermo Joaquin Dominguez Calabuig
DLR (German Aerospace Center), Germany
Mr. Jacopo Guadagnini
Deimos Space SLU, Spain
Mrs. Melissa Lantelme
ONERA - The French Aerospace Lab, France
Dr. Nathalie BARTOLI
ONERA - The French Aerospace Lab, France
Mr. François Chedevergne
Office National d'Etudes et de Recherches Aérospatiales (ONERA), France
Mr. Gabriele De Zaiacomo
Deimos Space S.L., Spain
Dr. Sylvain Dubreuil
ONERA - The French Aerospace Lab, France
Prof. Michèle Lavagna
Politecnico di Milano, Italy
Dr. Ysolde Prevereaud
ONERA - The French Aerospace Lab, France
Prof. Enrico Stoll
TU Braunschweig, Institute of Space Systems, Germany

MISSION ANALYSIS, GNC AND ATD FOR REUSABLE LAUNCH VEHICLES WITHIN ASCENSION: MULTI-ORBIT MULTI-PAYLOAD INJECTION, RE-ENTRY AND SAFE DISPOSAL

Abstract

Reusable Launch Vehicles (RLVs) are not only key for an economically and ecologically sustainable space access but also represent a paramount innovation towards the increasing demand for smaller satellites and mega-constellations. In order to ensure Europe's independent space access capabilities, ASCenSIon (Advancing Space Access Capabilities - Reusability and Multiple Satellite Injection) is born as an innovative training network with fifteen Early Stage Researchers, ten beneficiaries, and fourteen partner organisations across Europe. This paper provides an overview of the mission, ranging from the ascent to the re-entry of the reusable stages and including the multi-orbit injection and the safe disposal. A special focus is put on the activities developed within ASCenSIon regarding Mission Analysis (MA), Guidance Navigation & Control (GNC) and Aerothermodynamics (ATD). Hence, the foreseen methods, approaches and goals of the project are presented.

These aforementioned topics require innovation within and a high level of collaboration due to their interconnection. The re-flight capability drives the necessity of a Mission Analysis and GNC missionization tool for re-entry solutions. Such a reliable and efficient tool will require the development of GNC algorithms for both the ascent and re-entry of the launcher. Additionally, specific challenges of trajectory optimization for RLVs are addressed, including integrated multi-disciplinary vehicle design and trajectory analysis, fast and reliable on-board methods, and optimization under uncertainty. The results from this study are then used to develop the controlled strategy to perform the novel multi-orbit multi-payload injection. This activity is followed by the development of a GNC architecture capable of optimally steering the vehicle towards a targeted landing site ensuring a pinpoint soft landing. Moreover, ATD affects the mission profile at multiple phases. Due to complexity and limited resources during the preliminary design phase, surrogate models with low response times are required to predict wall heat fluxes along the considered trajectories based on the pressure topology. The complete profile is wrapped up with the recommendations for the Post-Mission Disposal strategies to be used by the launchers, as well as considerations on the system design level that will benefit their reliability to comply with space debris mitigation guidelines. The paper provides a preliminary analysis of the discussed topics and their interconnections within the work-frame of ASCenSIon paving the way towards the development of novel cutting-edge technologies for RLVs.