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RLV APPLICATIONS: CHALLENGES AND BENEFITS OF NOVEL TECHNOLOGIES FOR SUSTAINABLE MAIN STAGES

Abstract

Within the scope of the European Green Deal, the aerospace industry is currently staking on sustainability. To fulfill the objectives and in order to ensure Europe's independent and cost-effective space access capabilities, the ASCenSIon (Advancing Space Access Capabilities - Reusability and Multiple Satellite Injection) project, funded by H2020, is connecting fifteen Early Stage Researchers (ESRs) and twenty-four partner organizations all across Europe. The pillar concept within the project is to adopt a Concurrent Research Network (CRN) methodology. Accordingly, different host institutions, each one with its main research program and vision, are connected to develop the design under a new perspective. This approach emphasises the cooperation between the fifteen ESRs, thus covering the design of a Reusable Launch Vehicle (RLV) in its overall complexity, facing the new challenges deriving from the required sustainability in a more efficient manner.

Corresponding to work package two (WP2) of ASCenSIon, this paper focuses on main stages for RLVs, and how the goal of sustainability affects their design. Therefore, many different interconnected

disciplines, such as propulsion system, structural design, fatigue-life analysis and Health Monitoring (HM) have to be taken into consideration. These different domains are represented by the individual research projects of the ESRs, supported by a collaborative environment which promotes the foreseen interactions. At first, this contribution gives a general State-Of-The-Art overview of the already mentioned topics. A preliminary trade-off on RLV architectures is established through multi-disciplinary design analysis and optimization methods based on propulsion modeling, optimal staging and structural sizing. These use performance and cost design metrics as objective functions, accounting for operability and maintainability factors. This investigation is then used to discuss the different Advanced Nozzle Concepts (ANCs) tailored on the system requirements and mission constraints. At this point, a one-dimensional performance analysis addresses the payload gain deriving from altitude-compensation properties of ANCs. Subsequently, the identification of a suitable green propellant will give the needed/accurate/required inputs to conduct a trade-off between engine cycles w.r.t. the fatigue-life of their most critical components. Consequently, fatigue-life analysis contributes to HM and sensing requirements for RLV systems. As a common approach between the ESRs, the data collection is organized in various Databases accessible within the network, which encourages their interconnections and collaborative research.

This paper provides a preliminary analysis of the above discussed topics and their interconnections within the framework of ASCenSIon aiming to develop novel technologies for future sustainable main stages.