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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Small Launchers: Concepts and Operations (7)

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CONCEPTUAL DESIGN ANALYSIS FOR A TWO-STAGE-TO-ORBIT SEMI-REUSABLE LAUNCH SYSTEM FOR SMALL SATELLITES

Abstract

This paper will analyse the design drivers for the conceptual design of a two-stage to orbit, semi-reusable launch system for small satellites currently under development in the UK by Orbital Access. The aim of the system design is to develop a commercially viable launch system for near-term operation, thus emphasis is placed on the efficient use of high TRL technologies.

A previous study developed a market forecast leading to the selection of nominal and extended target missions, based on the OneWeb constellation, to deliver three 150 kg satellites to a circular 650 km polar orbit, with an extended target of one 150 kg satellite to a 1200 km orbit. A feasibility study evaluated a number of different design configuration concepts. The outcome was an integrated aerospace plane with multiple, parallel propellant tanks and a novel payload cartridge system that balanced technical requirements with operational flexibility which ties into the commercial business model. The vehicle has two rocket-powered stages. The first stage is a reusable, spaceplane configuration air-launched from a modified MD-11 carrier aircraft. Expendable second stage(s) are housed in an internal payload bay and ejected at the edge of the atmosphere at around 90 km. An optional third, upper stage can be mounted to the payload to perform an orbital transfer to the extended mission of a polar circular 1200 km orbit.

The work here is based on a follow-on ESA-funded study currently underway examining the design drivers in more detail, with emphasis on the unpowered descent trajectory, landing site analysis and thermal analysis. Computationally fast engineering models are being developed to allow the performance of the system to be optimised using a multi-disciplinary design optimisation approach. Different vehicle and mission design criteria were selected as inputs, with the models relating the impact of changes to those variables on the system. Specifically, the sizing of the lifting surfaces and choice of thermal protection system will be examined against the vehicle mass and descent range capabilities. A key system requirement is the ability to launch and land at different sites around the world, therefore an accurate assessment of the down- and cross-range capabilities is critical. In this study, different launch locations off the North/East coasts of the UK, with landing sites along the flight path such as Iceland or Norway will be examined, as will the option of powered orbit (once around) to return to a UK landing site.