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SPACE RAPID TRANSIT M: A ROTATING DETONATION ENGINE ENABLED SPACEPLANE FOR SMALL PAYLOADS

Abstract

Many organizations have studied spaceplanes for horizontal launch and landing, and the potential benefits of such a configuration are well known. New breakthroughs in Rotating Detonation Engine (RDE) detonation initiation and a novel configuration with a turbopump for low-Mach operation may now enable an RDE first stage for a true spaceplane. An RDE provides better performance than a turbo-ramjet and enables a surprisingly small two-stage space plane. We call the spaceplane SRT-M.

This vehicle would lower launch costs for small satellites to LEO by at least an order of magnitude, driven largely by the ease of airline-like operations and full reusability. We project the cost to launch a single small satellite on the order of 30 kg could drop to the tens of thousands of dollars. The concept would allow any organization with access to a large airport to operate SRT-M.

SRT-M is composed of two stages: the first stage is called the "Ferry," and the second stage is the "Orbiter." A Rotating Detonation Engine (RDE) combustor in the first stage engine will allow the Ferry to reach nearly Mach 8, greatly reducing the delta-V required from the second stage. The RDE engine is a coaxial design with a turbopump and variable geometry inlet. The RDE engine is analyzed in this paper using analytical models for the combustion process.

The Orbiter, conceptually similar to the X-37b , would utilize a small LH2/LO2 engine and also land horizontally. The SRT-M design is supported by several other relatively recent advances: metallic thermal protection, green propellant Reaction Control Systems, and all-electric actuation. These advances eliminate toxic fluids and simplifies maintenance. SRT-M could be launched from any airfield and be fully reusable with rapid turnaround time. Operations can utilize commercial cranes and tanker trucks further lowering costs. The hydrogen and oxygen fuel need not be stored at the launch site.

The paper will present the latest results showing the first stage RDE engine performance. End-to-end simulations from takeoff roll to landing of both stages will be presented for an emergency ISS resupply mission. Stage separation simulation results will be given. The economics of SRT-M will be discussed.