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The Rocketplane XS-1 Suborbital Satellite Launch Spaceplane and its Applications for Exploration Missions

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The US Defense Advanced Research Projects Agency (DARPA) has begun the Phase I preliminary design competition for a breakthrough in reusable launch vehicle technology intended to lower the cost of launch for small (1-2 ton) LEO payloads by an order of magnitude. The DARPA XS-1 program intends to achieve this disruptive reduction in launch costs by developing a reusable first stage spaceplane with aircraft-like operational characteristics while using a low cost expendable upper stage to reach orbit. The XS-1 spaceplane requirement is to fly at least to a Mach 10 velocity in a suborbital trajectory and be able to fly 10 times in 10 days.

Rocketplane Global, LLC (RGL) has submitted a proposal to DARPA for its Mach 12 spaceplane design, based on a 20 year legacy of systems engineering for a variety of high Mach suborbital spaceplanes. The Rocketplane XS-1 spaceplane is a winged horizontal takeoff and landing configuration using military turbofans for takeoff and landing and a LOX / kerosene rocket engine for the main propulsion on the zoom climb to a Mach 12 140km apogee. Once the rocket engine shuts down and the vehicle is on a ballistic coast the payload bay doors are opened and the satellite payload and upper stage stack are released in a gentle exo-atmospheric mechanical separation. The upper stage is then ignited, taking the payload on its insertion trajectory. The spaceplane closes the payload bay doors and orients for reentry. Once the vehicle has completed the reentry deceleration maneuver and is in a subsonic glide the jet engines are restarted for a powered landing – either at the original spaceport or at a downrange recovery runway.

A key enabling technology for this system is the use of a KDC-10 tanker aircraft to transfer the majority of the propellant load to the spaceplane once the vehicle is in the air and flying at normal subsonic jet speed. The tanker carries the 64,000 kg of LOX plus additional kerosene to replace the fuel used by the turbofans during takeoff and the tanking maneuver. By taking off "light" with only a fraction of the fuel and oxidizer required and then transferring this propellant load in flight, the vehicle dry mass fraction challenges are greatly reduced. This in turn reduces vehicle development and operations cost, and enables the disruptive reduction in launch price to less than $10 million for a 2 ton LEO satellite.

The ability to reduce the cost of launch for 2 tons to LEO by an order of magnitude has many applications to the global exploration agenda. Micro and nano class satellites are gaining in capability at a fast pace and some are already being tasked with deep space exploration missions. Small robotic landers for lunar and asteroid applications can also be launched into deep space with this class of launch vehicle. In addition, the rapid response time inherent in a new generation reusable vehicle will provide rapid mission planning and launch cycles, which can change the landscape for global exploration activities and provide more data for less money.