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SPARTAN: Scramjet Powered Accelerator for Reusable Technology AdvaNcement

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ABSTRACT

The global economic environment combined with the rapid pace of technology advancement is pushing for a change in how we access space. Importance is now placed on reducing the cost and increasing the responsiveness of access to space systems. This is in contrast to the old way of thinking where the availability of expendable large launch vehicles led to the development of large multi-purpose satellites with long lifespans to maximise the benefits from the high costs. Based on decades of practical experience with rocket-only launch vehicles, current technology is operated close to theoretical limits and only marginal further efficiency improvement is achievable. In order to further improve the efficiency of access-to-space vehicles, new propulsion systems will be required.

Airbreathing engines, and scramjets in particular, are considered the most promising alternative. Scramjets have an advantage over rocket propulsion in terms of a significantly higher specific impulse; other benefits of airbreathing propulsion for access-to-space are increased launch flexibility, such as shorter time to rendezvous with a target spacecraft, and increased launch window duration and number of opportunities. These benefits are obtained through propulsion throttling, and aerodynamic turning and pitch control available from a high *L*/*D* vehicle**.** This project investigates the use of a three-stage rocket-scramjet-rocket system for transporting payloads of approximately 500 kg to a Sun Synchronous Orbit (SSO). It is believed that this mission profile combined with a small launch capability focusing on rapid deployment, single mission only satellites with short lifespans of 2-4 years will meet the requirements of many missions, such as responsive surveillance of man-made and natural disasters and several earth science missions.

The first stage is being developed as an advanced academic programme in Australia, South Africa and France, and is named the **A**ustral **L**aunch **V**ehicle (ALV). The ALV is a re-usable liquid rocket stage used to accelerate the stack to the point of Scramjet ignition at Mach 6, after which it is recovered by flying back to the launch site. The reusable second stage named the **S**cramjet **P**owered **A**ccelerator for Reusable **T**echnology **A**dva**N**cement (SPARTAN), is based on a winged-cone vehicle initially developed for the US National Aerospace Plane program. It is powered by liquid hydrogen fuelled Scramjets and it is intended to provide acceleration until the net specific impulse drops below useful levels. The final stage is deployed upon scramjet shutdown, using a conventional expendable liquid-fuelled rocket motor to place the payload in the desired SSO. Preliminary analysis of the complete three-stage system indicates a better overall performance, in terms of the payload mass fraction to orbit, than current rocket-only systems of this scale. The project has advanced to the next phase of development which includes the design, manufacturing and testing of scaled down demonstrators of the ALV and SPARTAN vehicles. This project is a good example of what can be achieved through international collaboration to develop a cost-efficient space access vehicle as well as to educate and motivate the coming generation.