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# SMALLSAT AEROCAPTURE TECHNOLOGY DEVELOPMENT OBJECTIVES AND DEMONSTRATION OPPORTUNITIES

**Abstract**

With increasing interest in planetary science missions using small spacecraft, there are numerous technical challenges to address. Of particular importance is developing the ability for small satellite missions to slow down and enter orbit. Traditional methods of orbit insertion have utilized a chemical propulsion system, requiring large amounts of propellant mass to enact changes of velocity on a spacecraft. For any system, but especially a SmallSat, which is often volume and mass constrained, accommodating significant amounts of propellant can be prohibitive or impossible. Instead of a large propulsion system, aerocapture uses the drag of a single pass through the atmosphere to capture into orbit. Using drag modulation flight control, an aerocapture spacecraft adjusts its drag area during atmospheric flight, allowing it to target a particular orbit in the presence of navigational and atmospheric uncertainties.

A presentation at the 70th IAC in Washington, D.C. enumerated the benefits that aerocapture can bring to future missions, as well as discussed the key trades that have been assessed in defining the flight system configuration. This paper will detail the key technical challenges that must be addressed, as well as a technology maturation plan to develop and demonstrate the technology for infusion into near-term planetary small satellite missions. The aerocapure maneuver can be broken up into three main phases: cruise and approach targeting, atmospheric deceleration, and post-aerocapture maneuvers, each of which bring unique technical challenges. The spacecraft must deploy a drag skirt prior to entering the atmosphere, then jettison the drag skirt at a precise time using onboard guidance. This deployment occurs at hypersonic velocities in excess of Mach 35, leading to complicated flow interactions between the two bodies that must be taken into account to ensure a clean separation without recontact. Once the spacecraft exits the atmosphere, it must autonomously detumble and perform a critical periapsis raise maneuver.

Development and demonstration of aerocapture technology will be a combination of analysis (such as computational fluid dynamics), ground based testing (such as wind tunnel and ballistic range), and flight testing, which could include a suborbital sounding rocket demonstration or an orbital flight test in Earth's atmosphere. This flight test would be the first ever execution of aerocapture and demonstrate all of the technologies in a relevant environment to planetary entry at destinations such as Venus and Mars, ushering in a future of planetary small satellite orbiters to perform incredible new science exploration at reduced cost.