Exploring the Use of Miniaturized Electrodynamic Tethers to Enhance the Capabilities of Ultra-small Satellites

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The success of nanospacecraft (1-10 kg) and the evolution of the millimeter-scale wireless sensor network concept (i.e., "SmartDust") have generated interest in small, sub-kilogram scale, "smart-phone" sized spacecraft, either as stand-alone satellites or as elements in a maneuverable *fleet*. Distributed fleets of ultra-small satellites, sometimes called "ChipSats", would require a high level of coordination, and this is made more sophisticated and long-lived if maneuverability and propulsion is possible. We summarize trade studies that investigated the use of a very short (few meters, 1 to ~10 meters), semi-rigid electrodynamic tether (EDT) for femtosatellite propulsion. The system concept utilizes an insulated, short tether and a pair of nearly identical pico- or femtosatellites capable of harvesting solar energy, storing electrical power, and driving current through the tether while collecting and emitting electrons. The results reveal that an insulated tether, only a few meters long and tens of microns in diameter, can provide milligram to ~100 gram-level ChipSats with complete drag cancellation and even the ability to change orbit. Further, this same tether could also serve as a communication or scientific radio antenna, serve as a plasma diagnostics probe, and even serve as a boom for passive attitude stability along the local vertical. We will describe early ground-based experiments intended to characterize our performance models. Finally, we will summarize a proposed student designed flight experiment intended to validate our concept of using electrodynamic tether thrust for propulsion of ultra-small satellites.