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Abstract: "Small Orbital Debris Mitigation Mission Architecture"– (NASA/MSFC -Wiegmann, B. Kos, L.)

Small orbital debris in LEO (1-10 cm in size) presents a clear and present danger to operational LEO spacecraft. This debris field has dramatically increased (nearly doubled) in recent years following the Chinese ASAT Test in 2007 and the Iridium/Cosmos collision in 2009. Estimates of the number of small debris have grown to 500,000 objects after these two events; previously the population was 300,000 objects. These small, untracked debris objects (~500,000) outnumber the larger and tracked objects (~20,000) by a factor 25 to 1. Therefore, the risk of the small untracked debris objects to operational spacecraft is much greater than the risk posed by the larger and tracked LEO debris objects. A recent study by The Aerospace Corporation (Ailor, 2010) found that the debris environment will increase the costs of maintaining a constellation of government satellites by 5%, a constellation of large commercial satellites by 11%, and a constellation of factory built satellites by 26% from $7.6 billion to $9.57 billion.

Based upon these facts, the NASA Marshall Space Flight Center (MSFC) Advanced Concepts Office (ACO) performed an architecture study on Small Orbital Debris Active Removal (SODAR) using a space-based non-weapons-class laser satellite for LEO debris removal. The goal of the SODAR study was to determine the ability of a space-based laser system to remove the most pieces of debris (1 cm to 10 cm, locations unknown), in the shortest amount of time, with the fewest number of spacecraft. The ESA developed MASTER2005 orbital debris model was used to probabilistically classify the future debris environment including impact velocity, magnitude, and directionality. The study ground rules and assumptions placed the spacecraft into a high inclination Low Earth Orbit at 800 km as an initial reference point. The architecture study results found that a spacecraft with an integrated forward-firing laser is capable of reducing the small orbital debris flux within a 60 to 100 km orbital shell by a significant amount within the one spacecraft's operational lifetime. The technology developments required for such an architecture to be successfully employed are: 1) A pico-pulsed, space qualified laser and 2) The ability to detect and track a small LEO small debris object from a space based platform. Therefore, a conceptual design for a demonstration satellite to showcase the ability to detect and track small orbital debris was completed.