RemoveDEBRIS - Mission Analysis for a Low Cost Active Debris Removal Demonstration in 2016

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ABSTRACT

All the major space agencies, including NASA and ESA, have acknowledged the need for an active space debris remediation policy in the years to come. In a 2009 joint study, they have showed that mitigation strategies and the sole deorbiting of future launcher upper stages and satellites after their operational life would be unsufficient to prevent an unremitting increase of the space debris population, thus leaving no other solution than Active Debris Removal (ADR).
In addition to the commercial, legal and many other non-technical issues raised by ADR, it brings new riveting challenges to the space industry: if the ability to perform an entirely automated rendezvous in space has been demonstrated several times over the past ten years, none has ever launched a spacecraft to reach and dispose of a passive and unprepared orbiting object. Grappling and anchoring to non-cooperative objects has been identified as one of the top technical challenges in the 2010 NASA Robotics, Tele-Robotics and Autonomous Systems Roadmap. Recent events, including the loss of contact with the largest European Earth observation civilian satellite and the explosion of a weather satellite in Low Earth Orbit, pertain to the growing hazard to functional satellites, which will bring forward the necessity to address the space debris issue in a near future.

In this context, a consortium led by the Surrey Space Center, and contracted by the European Commission in the frame of the EU's Seventh Framework Programme for Research (FP7), has been working since 2013 towards the design of a low cost in-orbit demonstration called RemoveDEBRIS. With a targeted launch date in the second quarter of 2016, the RemoveDEBRIS mission aims at demonstrating key ADR technologies, including capture means (net and harpoon firing on a distant target), relative navigation techniques (vision-based navigation sensors and associated algorithms), and deorbiting technologies (drag sail deployment after the mission followed by an uncontrolled reentry). In order to achieve these objectives, a micro satellite test-bed will be launched into a Low Earth Orbit, where it will deploy its own dedicated targets and CubeSats to complete each demonstration.

As part of its System Engineering role, Airbus Defence and Space has been conducting the Mission Analysis studies for this unprecedented mission. After a brief description of the RemoveDEBRIS demonstration objectives and scenario, the paper will present in detail some specific mission related analyses and trade-offs that have driven the mission design.
The impact of the launch strategy, with the main platform being injected either as a piggyback payload in a Sun Synchronous Orbit or jettisoned from the International Space Station, the CubeSats deployment strategies, the expectable lighting conditions for the various demonstrations, the drag effects on the relative motion and the safety issues will be addressed, along with some considerations regarding the concept of operations and the orbit lifetime.
Finally, parametric studies have been carried out in order to derive mission opportunities and an overall timeline when considering all these constraints jointly. These will be presented as well to support the definition of the baseline mission scenario one year before launch.