18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Virtual Presentations - 18th IAA SYMPOSIUM ON SPACE DEBRIS (VP)

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PRELIMINARY MISSION ANALYSIS OF ACTIVE DEBRIS REMOVAL SERVICE FOR LARGE CONSTELLATIONS

Abstract

In the recent years, many large constellations have been announced to be deployed in low Earth orbits. The failed satellites from the large constellations, together with the existing space debris, will pose a severe safety threat to the space environment. Driven by the strong demand to remove the failed satellites, D-Orbit, a New Space company founded in 2011 and Politecnico di Milano, participate in a program as consortium to develop an Active Debris Removal (ADR) service for large constellations.

With such an objective, different mission architectures have been analysed to find the most cost-effective solution. This paper will present the preliminary mission analyses for the following three mission architectures.

1. *Mothership with chemical propulsion.* The mission is composed of two types of ADR servicers – "mothership" and "kit": one mothership hosts multiple kits. The mothership can approach one target at a time and attach one kit to the target, and then it will move to the next target. The kit and target will then de-orbit together. The number of targets serviceable is constrained by the mothership on-board propellant, mission lifetime, and number of kits.
2. *Chaser with chemical propulsion.* The mission is composed of one ADR servicer – "chaser" – that can capture and de-orbit one target at a time. The number of targets serviceable is constrained by the chaser on-board propellant and mission lifetime.
3. *Station and chaser with chemical propulsion.* The mission is composed of two types of ADR servicers – "chaser" and "station", where the chaser is same as the previous mission, and the station can transfer propellant to the chaser. The number of target serviceable is constrained by the station and chaser on-board propellant and mission lifetime.

The goal of this work is to maximise the number of serviceable targets, which is equivalent to minimising the cost per target, while compliant with the mission constraints. To achieve this goal, the designing

of transfer orbits, disposal orbits, capture sequences, etc., with Δv budget and mission time as the performance indexes, are to be conducted. Preliminary results have been obtained for the mothership mission, demonstrating that one mothership can retrieve at most 9 failures distributed in one or two planes, with a Δv budget less than 1 km/s and a mission time less than 3.3 years.