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ACTIVE SPACE DEBRIS REMOVAL - A SYSTEM ENGINEERING APPROACH

Abstract

Space debris mitigation guidelines have been issued in the past years by the United Nations and other international institutions, and were adopted by many of the space-faring nations. However, these guidelines alone are no longer sufficient to control debris growth and protect access to the desirable orbits. The current density of orbital debris is such that it will increase with time even if all launch activities are stopped. This will eventually lead to a collision cascade that will render some orbits unusable. The only way to tackle this problem is to actively reduce the quantity of debris in orbit. Many studies have demonstrated that removing ten to fifteen large objects per year from specific orbits would prevent the collisions from cascading and would guarantee safe access to space for future generations.

Following an analysis of the context, including an identification of the critical stakeholders, their needs and expectations, the current markets, the legal and regulatory framework, the available and proposed technologies, the authors have developed the concept of a company and a system for active space debris removal. Using available advanced robotic technology, the considered mission will target and remove selected debris to minimize the net risk of collisions and stabilize the debris population. The system, designed to be cost-effective and commercially viable, will remove large debris from the low earth orbits in which most catastrophic collisions are predicted to occur, and place them into lower re-entry orbits. A range of technologies were assessed and the final end-to-end design has been justified in terms of its validity, maturity, cost and risk. The space segment is conceived to approach, capture, control, and safely move targeted objects to identified re-entry orbits. The ground segment will provide the necessary operational control and full transparency to customers and stakeholders during all phases of operations.

The system is designed to operate within the current commercial, legal and regulatory framework with the lowest risk possible to third parties. The impacts of these current regulations and commercial environment on the system performance are assessed and the results are reported. Various options to further facilitate debris removal are also presented.