TPP20110004

INTERNATIONAL SPACE UNIVERSITY
TEAM PROJECT PROPOSAL FORM

Project Title: Debris Removal

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One-paragraph description: Long-term simulations of the Low-Earth-Orbit (LEO) environment has shown that the critical density of objects is reached and that collisions between space debris and satellites or rocket stages will produce more new objects than air-drag can remove. A collision cascading will start in 20-50 years if we do not start to remove objects from LEO. To guarantee a self-sustaining environment and access to space, active debris removal needs to be started!

Background rationale: The critical density is already reached at 800 km altitude. The anti-satellite test in 2007 created 2500 fragments and the collision in 2009 between Kosmos 2251 and Iridium 33 added another 1500 fragments. Therefore there is a high probability that one of the big satellites or rocket upper stages in this altitude will be hit within the next 5-10 years and destroyed creating another debris cloud. A NASA study has shown that the environment can be stabilized by removing annually just a few objects with large cross-section areas at the most critical altitudes.

Main issue(s) to be addressed: Technologies how to remove objects; the legal framework to remove objects; How is the debris removal organized and financed?

Main tasks to be accomplished:

1) **Literature review to prove the necessity of debris removal (there are recent studies on this subject)**
2) **Review of debris removal technologies**
3) **Detailed description of the most promising debris removal concept(s)**
4) **Definition of the structure of the organization which is in charge of debris removal**
5) **Establishment of a business plan or financial planning of the endeavor**
6) **Establishment of a legal framework for debris removal**

International/Intercultural Scope of the Project: It is not possible for a single nation to solve the debris problem. The debris was created by all nations and has to be cleaned up by all nations. There is also a different understanding of pollution in different countries, e.g. in GEO. Whereas the US, Europe and Japan move their GEO spacecraft into a graveyard orbit at end-of-life, the Russian and Chinese spacecraft operators often use the last drops of the fuel and leave their satellites in GEO. The importance of a "clean" space is seen differently in different countries.

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Interdisciplinary Scope
Expected level of involvement by disciplinary area:

	Business Management	Life Science	Policy & Law	Physical Science	Satellite Applications	Systems Engineering	Space & Society
Major	x	☐	x	☐	x	x	x
Minor	☐	x	☐	x	☐	☐	☐

Brief explanation of expected involvement by discipline:

Space Business & Management: A business plan how to implement debris removal is required. An organisational structure needs to be proposed

Space Life Sciences: The space station relies on a safe environment; the debris removal might be done with astronauts on board (to better grab the objects)

Space Policy & Law: A legal regime has to be defined for debris removal (can you de-orbit a foreign object?) A world-wide consensus on which objects to remove is required. Developing debris removal capabilities is identical to developing capabilities to "kidnap" foreign satellites (dual-use technology)

Space Physical Sciences: It is important to move objects from 800 km altitude to about 600 km altitude such that they will decay within 25 years (the new debris mitigation guidelines). The lifetime of a satellite ultimately depends on the solar activity. The survivability during this time on the debris and meteoroid environment.

Satellite Applications: The most critical density is at 800 km where most of the Sun-synchronous satellites are. Nearly 100 % of the objects to be removed are application satellites.

Space Systems Engineering: New technologies for debris removal have to be studied: tether, laser, docking-and-rendezvous vehicle,

Space & Society: Don't we have the obligation for the next generations to stop a collision cascading in orbit which would render space unusable (after me the deluge)? Don't we have the moral obligation to remove in space what we brought there?

Proposed ISU program (MSS, SSP, other): SSP

Window of opportunity in terms of potential relevance of and interest in the project topic: ASAP

Potential external interest in or sponsorship of the TP topic: ESA

Prospective impact of the TP: There was the first "debris removal" conference in 2010. Presentations of the TP results will further promote the idea of active debris removal. It is like in many environmental issues, the common understanding is there, but the nations are hesitating because any measure costs quite some money. Hence more public pressure is needed to progress …

Additional comments: none