ACTIVE DEBRIS REMOVAL

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01
INTRODUCTION
23 000+ orbital debris
(> 10 cm)
KESSLER SYNDROME
A self-sustaining cascading collision of space debris in LEO

Proposed in 1978 by a NASA scientist Don J. Kessler

Main events:
- 2007: Chinese anti-satellite missile test
- 2009: Cosmos/Iridium collision

A worrying trend:
Satellite constellations…

Monthly Number of Cataloged Objects in Earth Orbit by Object Type

- Total Objects
- Fragmentation Debris
- Spacecraft
- Mission-related Debris
- Rocket Bodies

Monthly Number of Cataloged Objects In Earth Orbit by Object Type: This chart displays a summary of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. “Fragmentation debris” includes satellite breakup debris and anomalous event debris, while “mission-related debris” includes all objects dispensed, separated, or released as part of the planned mission.
Mitigation vs. Remediation
MITIGATION

Internationally Recommended Disposal Guidelines

Issued by the Inter-Agency Space Debris Coordination Committee (including ESA, NASA, JAXA)

1. Placement in a disposal orbit with lifetime less than 25 years
2. Placement in a storage orbit above GEO
3. Placement in a storage orbit between LEO and GEO
REMEDIATION
02

CHALLENGES
TECHNOLOGICAL

[Taken from C. Bonnal, Active Debris Removal : Current Status of Activities at CNES, IAF Workshop on Space Debris Removal, Vienna, 2013]

1. Far-range rendezvous
2. Short-range rendezvous
3. Mechanical interfacing
4. Control, de-tumbling and orientation
5. De-orbitation
Financial & Legal

Financial

Rendezvous technologies are being developed for other applications

- Military
- Life-extension missions

New Space solutions are leading to an increase in space objects which make business cases more viable

Legal

France has adopted the French Space Act which enforces the Internationally Recommended Disposal Guidelines

Ongoing efforts to establish international legal framework
TECHNOLOGICAL

Lots of ideas!
Harpoon

The satellite can then be reeled back to the collection module and brought back in to the earth's atmosphere.
TECHNOLOGICAL

Robotic arm
TECHNOLOGICAL Net
TECHNOLOGICAL Tether
TECHNOLOGICAL

Dragsail
TECHNOLOGICAL

And many more...

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04

REMOVEDEBRIS
INTRODUCTION

Objective

Performing an in-orbit demonstration, in a low-cost manner, of active debris mitigation techniques using novel, realistic capture techniques

Low-cost

13 M€ (launch included)

Innovative

First of its kind

Raising Technology Readiness Levels (TRL) for:

- Dragsails
- Vision-Based Navigation
- Harpoons
- Nets
A EUROPEAN ENDEAVOUR

- Project management, Cubesats, Drag Sail
- Platform, AIT
- Ground Segment
- Harpoon
- System Engineering
- Vision-Based Navigation
- LiDAR algorithms

- Net, System support
- Cubesats Deployer
- LiDAR Hardware

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DEMONSTRATIONS

Concept of operations

https://youtu.be/7CEH9V9psKY

Mission Highlights

https://youtu.be/CwTHnglMVtg
THANK YOU FOR YOUR ATTENTION
REFERENCES


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