Standard interfaces for Design for Removal

Estefanía Padilla on behalf of Clean Space

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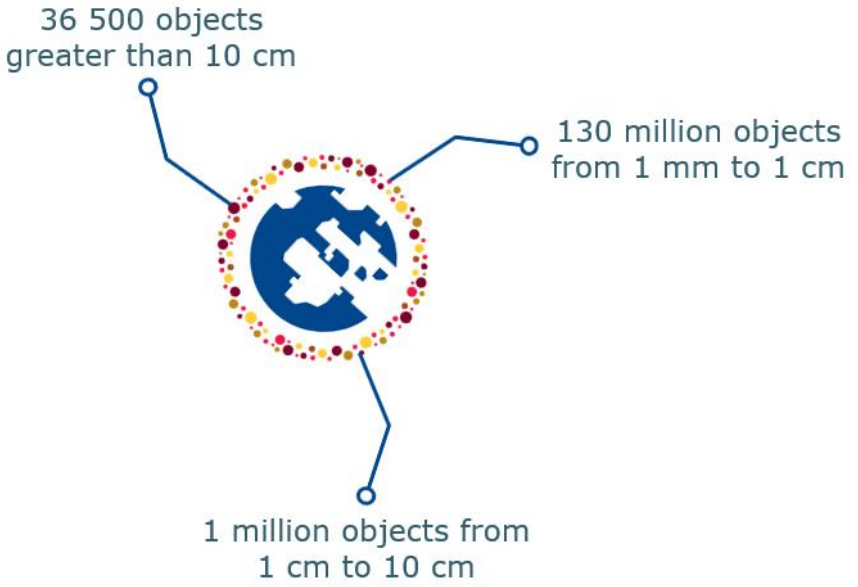
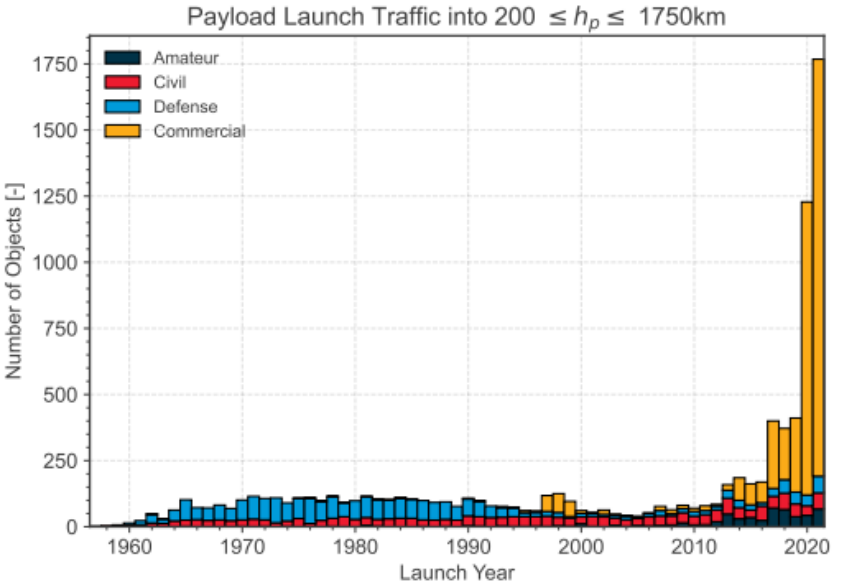
Agenda

- Introduction
- Why?
- What?
- How?
- Next steps
- Conclusion

Introduction





Space Debris objects already in orbit

A 1 cm object can strike a satellite with the force of an exploding hand grenade

Payload launch traffic in LEO

More satellites to be launched in the next 3 years than in the past 60 years

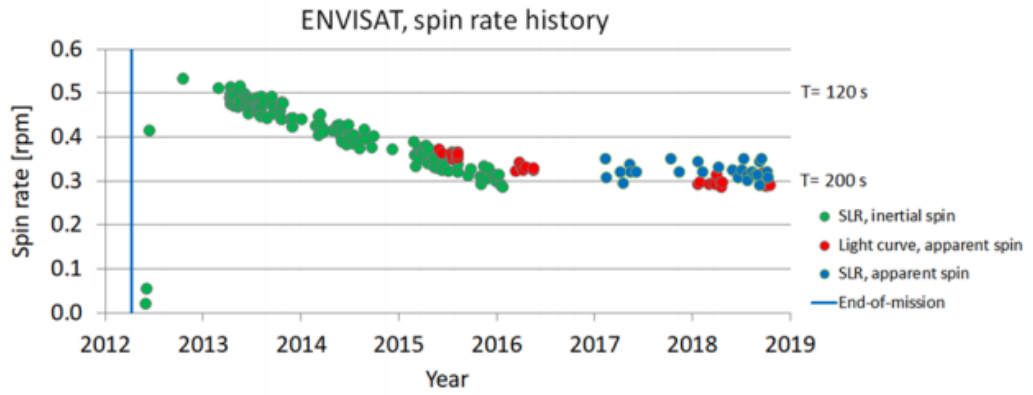
Need for improving EOL management

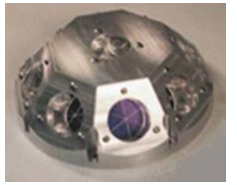
“In ESA we are implementing a policy that by 2030, we have a ‘net zero pollution’ strategy for objects in space, by consistently and reliably removing them from valuable orbits around Earth immediately after they cease operations. We need to lead by example here.”

ESA Director General, Josef Aschbacher

Active Debris Removal is Challenging…

Debris objects spin



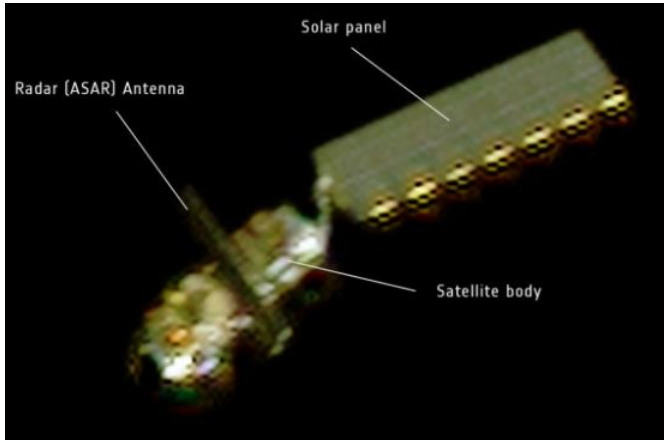


ENVISAT Retroreflector

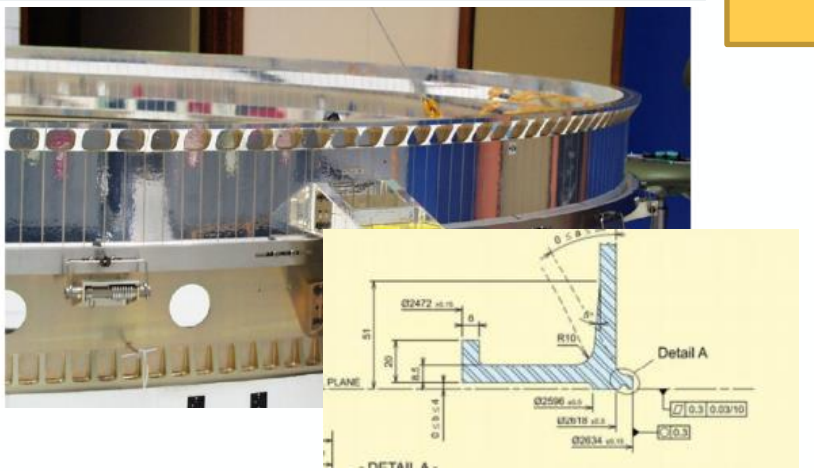
Why?

Without D4R, each satellite ADR solution would be different

Debris is not designed for capture



Capture interfaces



Ease removal by external servicer and decrease associated costs

What is a standard interface for D4R?

A D4R solution shall cover different aspects

What?

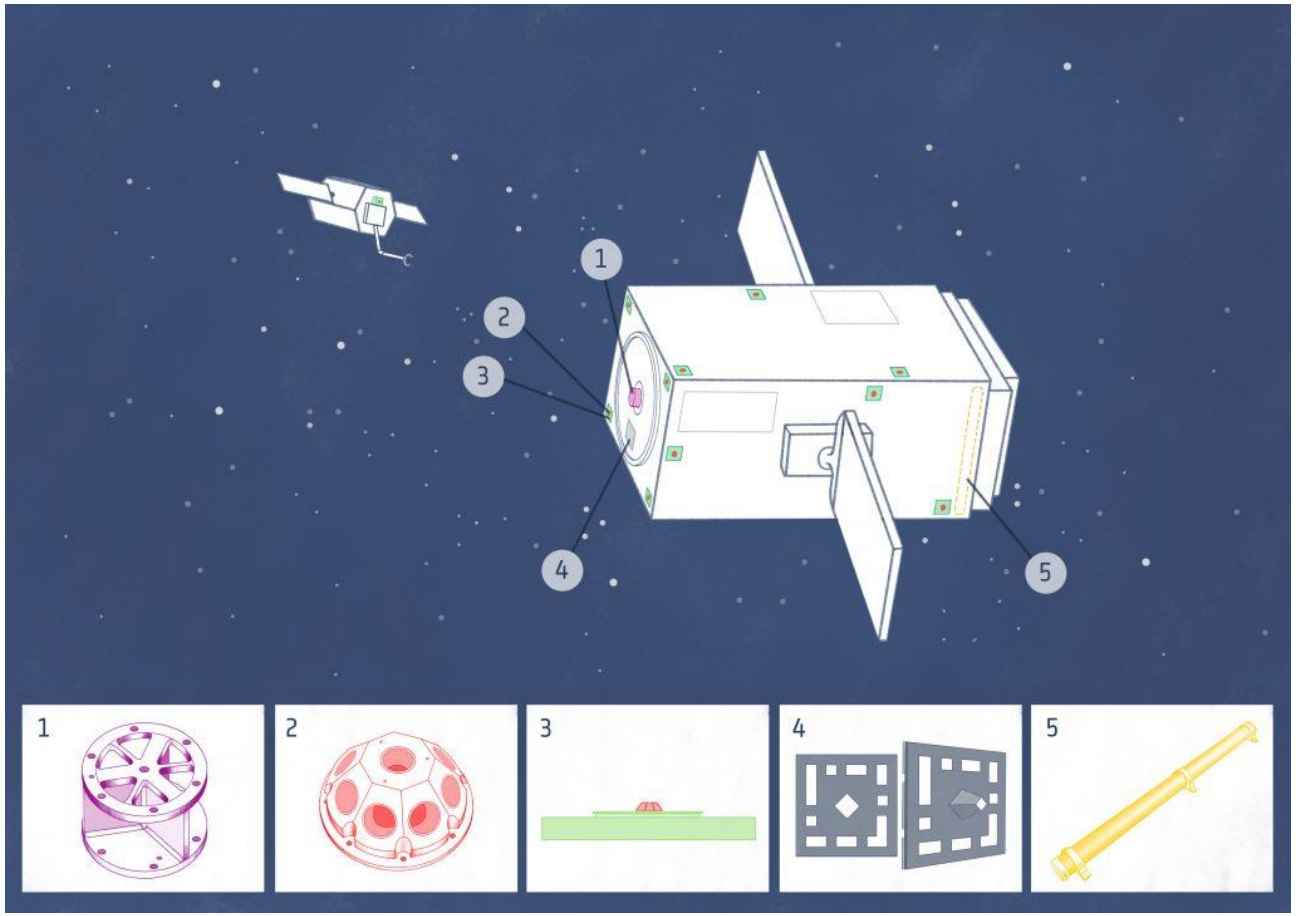
Capture

Relative navigation for rendezvous

Attitude reconstruction from ground

Detumbling

ESA solution for controlled re-entry



How?

1. Mechanical Interface for Capture
2. Retroreflectors to support attitude determination from ground
3. 2D Markers to support rendezvous
4. 3D marker to support the final metres of rendezvous and the visual servoing of the capture system
5. Detumbling through short-circuited magnetorquers

ESA has developed an **Interface Requirements Document** as interface with the system

Interface Requirements Document

D4R-U-001. The Spacecraft shall be able to auto… allow passive rate damping after power voltage… Agency.

Note 1: The shortcircuiting of the magnetorq… ***up to 3 degs./sec down to 0.75 deg/sec*** *that can be achieved wi… adapting the magneto… precession and nutati… vector shall also be co…*

…tically "short circuit" the Magnetorquers to …ld to be agreed with the

D4R-G-013. The Spacecraft shall include 2D navigation aids on the LAR face that ensure the support of the Chaser's relative navigation.

Note: By navigation aids it is understood passive devices to support and improve the chaser relative navigation, in all illumination conditions (including eclipse).

Rationale: Navigation aids aim at increasing the robustness of relative navigation using cameras in all phases of the approach, reducing the risk and simplifying the chaser design.

D4R-G-014.3. T… blocking the visibility of the 2D navigation aids on the LAR face (as specified in D4R-G-014.1) with an angular clearance of at least 30 deg (+/- 15 deg).

…appendages in the deployed configuration are

D4R-G-024. The mechanical capture interface mounting misalignment with respect to the Spacecraft body frame shall be lower than 1 mm and 0.25 deg at End-of-Life in orbit.

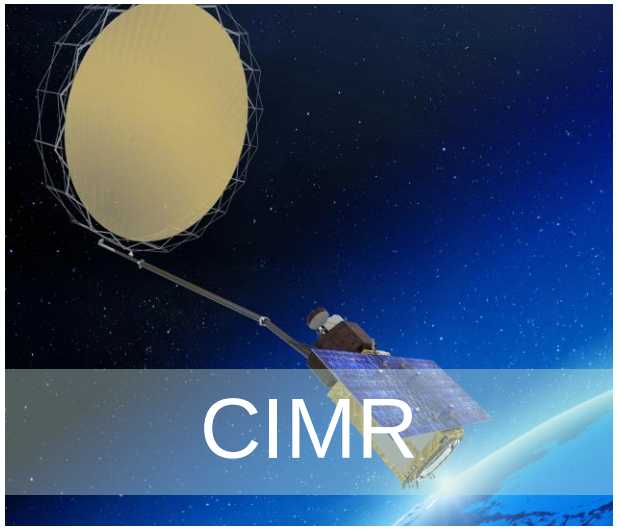
…d attitude rebuilt

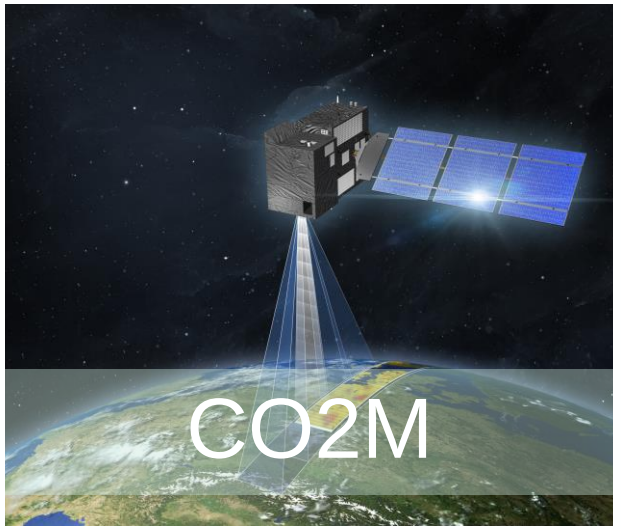
D4R-G-003. The Satell… from ground, close proximity operations … capture and removal).

D4R-G-012. The Spacecraft mechanical interfaces with the removal vehicle, i.e. passive mechanical capture interface and LAR, shall be free of thermal hardware susceptible to detach.

ESA solution for controlled re-entry

The developed standard interface is being integrated in the future Copernicus Expansion missions (EO missions)





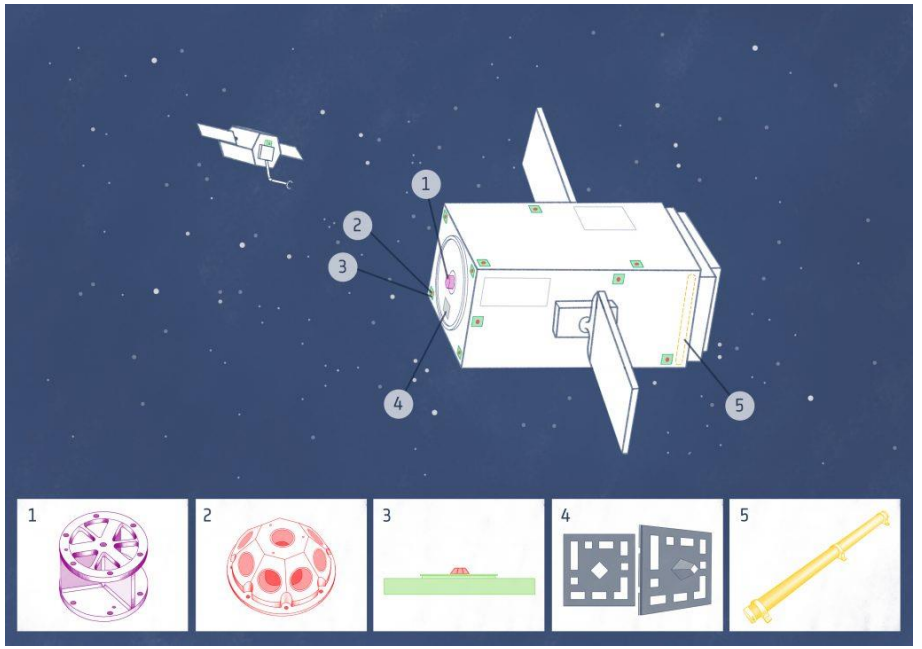
Next steps

- In Orbit Demonstration of the 1st generation D4R technologies
- Development and demonstration of the correspondent capture payload (e.g. CAT activity)
- 2nd generation D4R technologies
- Design for Removal for small platforms (for uncontrolled re-entry)
- Detumbling solutions for GEO/MEO satellites

European standard interfaces for D4R applicable to all platform classes in LEO, MEO and GEO

Conclusion

- ESA wants to lead by example by implementing Zero Debris approach by 2030
- D4R is an important part of **Zero Debris Approach**
- We need to **prepare for Removal** to ease removal by external servicer and decrease associated costs



- 1st generation standard interface optimised for controlled re-entry has been developed and implemented in 6 Earth Observation Missions
- Interface Requirements Document has been developed to gather the interface requirements with the system and is available under request
- Next steps:
  - Standard interfaces needed for small satellites and constellations (uncontrolled re-entry)
  - Standard interfaces needed for LEO, MEO and GEO

Thanks for your attention!