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# TeSeR – Technology for Self- Removal of Spacecraft

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# TeSeR – At a glance

- Challenge
  - Mitigate the risk of new space debris from future spacecraft
- Goal of TeSeR (Technology for Self-Removal of Spacecraft)
  - develop concepts for a standardized Post-Mission-Disposal (PMD) module which:
    - shall be attached to any future spacecraft **on ground** – NO in orbit delivery
    - shall perform PMD for any future spacecraft after end of operation in a reliable and cost-efficient manner
  - Major outcome: evaluated concepts and on-ground prototype



TeSeR

# Challenge

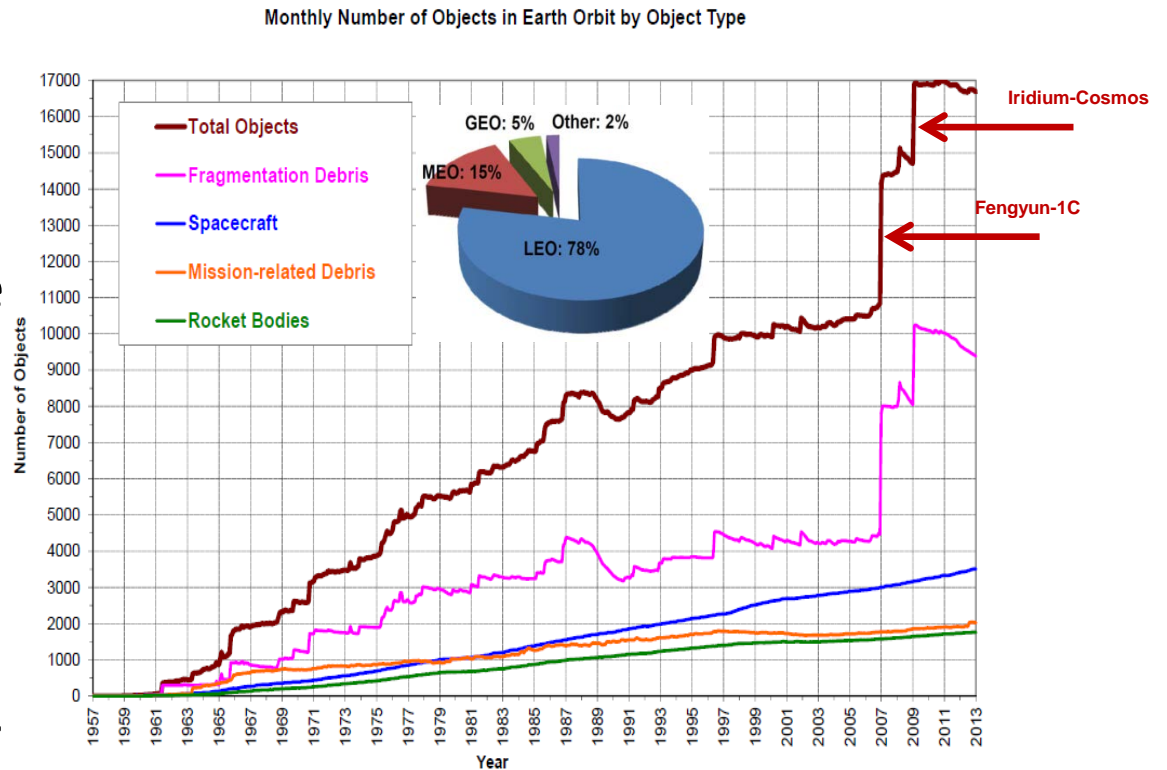
# The Space Debris Problem





# TeSeR – The Space Debris Problem

- Destruction of dead spacecraft (S/C) in orbit is a major source of new space debris
- Task: Ensure that future S/C do not remain in orbit after end of operation





# TeSeR – The PMD Gap

- Situation today: only 50% - 60% of S/C perform PMD
- PMD is required since a few years but:
  1. PMD has significant impact on S/C design (e.g. MetopSG requires several hundreds of kg additional fuel and extra thruster only for PMD)
    - a driver for design and costs due to individual designed solutions for each S/C
  2. Loss of communication/control
    - PMD not possible
  3. PMD not attractive for S/C owner
    - fuel is preferably used for increase of lifetime to increase benefit



# TeSeR

# Concept



# TeSeR – Goal and Solution

- Goal: remove any future S/C from space after end of operation in a reliable and cost efficient way → **close the PMD gap**
- Solution: develop a Post-Mission-Disposal (PMD) module which:
  - shall be attached to any future spacecraft **on ground** – NO in orbit delivery
  - shall remove\* any future spacecraft after end of operation from its orbit in a reliable and cost-efficient manner

\*remove: de-orbit or re-orbit, depending on S/C and orbit





# TeSeR – PMD back-up, or...

Remove S/C also in case of malfunction (PMD back-up), which requires

- Certain level of autonomy
  - Detection that S/C has to be removed
- vs
  - Ensure no removal by accident
- Independency from the S/C at least w.r.t.
  - Power
  - Communication
- Passivation of the S/C



# TeSeR – ...first standard PMD subsystem

- Optimize platform for operational mission
- Buy PMD module as standard product and attach it to the S/C via a standardized interface **on ground**
- Requires the same autonomy and independency like the back-up solution



# TeSeR – Remove any S/C

Closing the PMD gap requires a module which can remove **any** future S/C. That requires

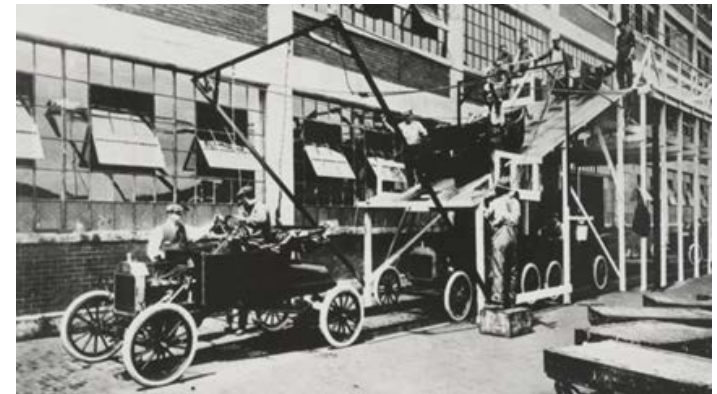
- Scalability
- Modularity
- Versatility



Source: Lego

PMD module shall be cheaper than classical approach (individual propulsion system)

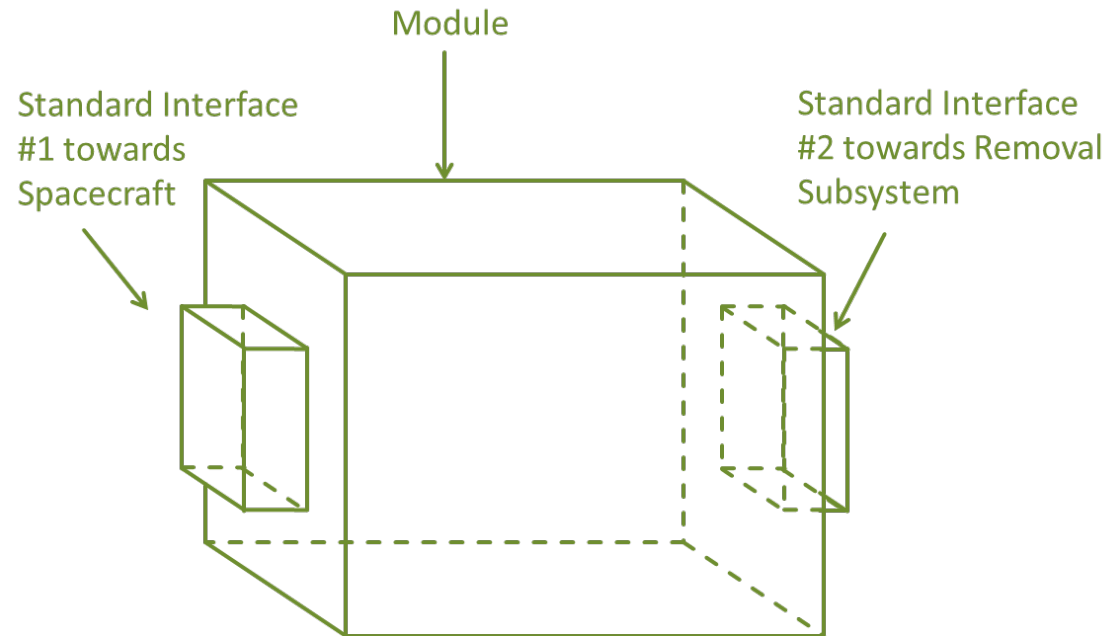
- Simple design
- Standardized
- Suited for industrial production





# TeSeR – Versatile/Scalable/Modular

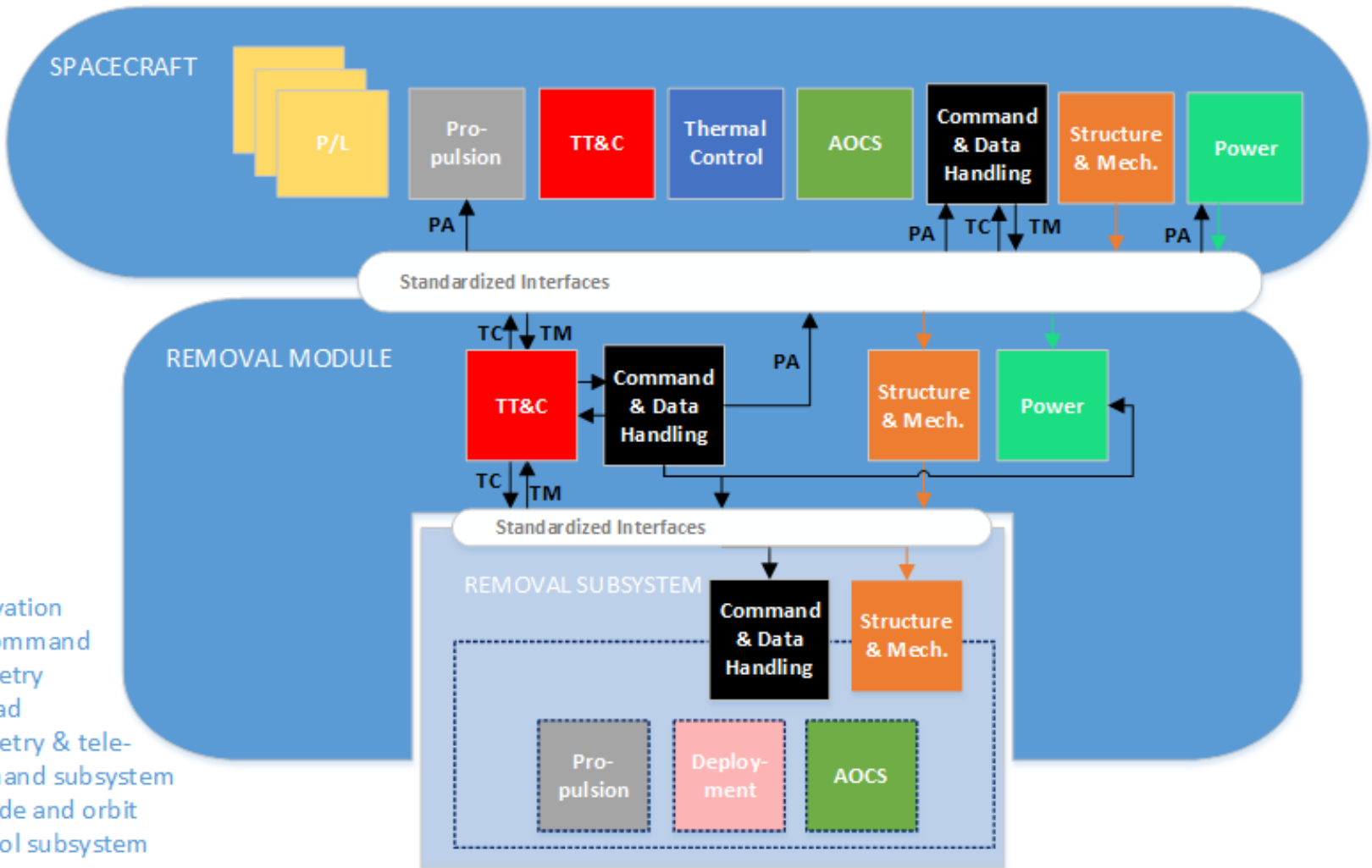
- 2 standard interfaces
  - standard interface #1 to attach module to any S/C **on ground**
  - standard interface #2 to attach different removal technologies to module



- Select the removal technology appropriate for S/C and orbit  
e.g. propulsion system for controlled de-orbit from any orbit or drag augmentation device for uncontrolled de-orbit <800 km altitude



# TeSeR – Functional Architecture



Draft of a concept of a functional architecture of the PMD module (provided by Universität der Bundeswehr München)



# TeSeR – Simple/Standardized/Industrialized

- Most subsystems for module already available
  - Structure/Mechanism/Thermal
  - Power supply
  - Communication
  - Attitude control
  - Command and data handling

- Already in development
  - Removal technologies (within TeSeR)
- To be developed
  - Standardized interfaces



## Two removal technologies foreseen for TeSeR

**Left:** Self-deployable deorbiting space structure from Aalborg University (survived a failed launch in 2014 and is still working)

**Right:** Decommissioning device, solid propulsion from D-Orbit



# TeSeR

# Project



# TeSeR – Basics

## TeSeR (Technology for Self-Removal of Spacecraft)

- Major outcome: evaluated concepts and on-ground prototype
- R&D Project, funded with 2.8 Mio € by EC in H2020 frame under grant agreement number 687295
- +300 k€ by Airbus DS
- Start: 02/16
- End: 01/19





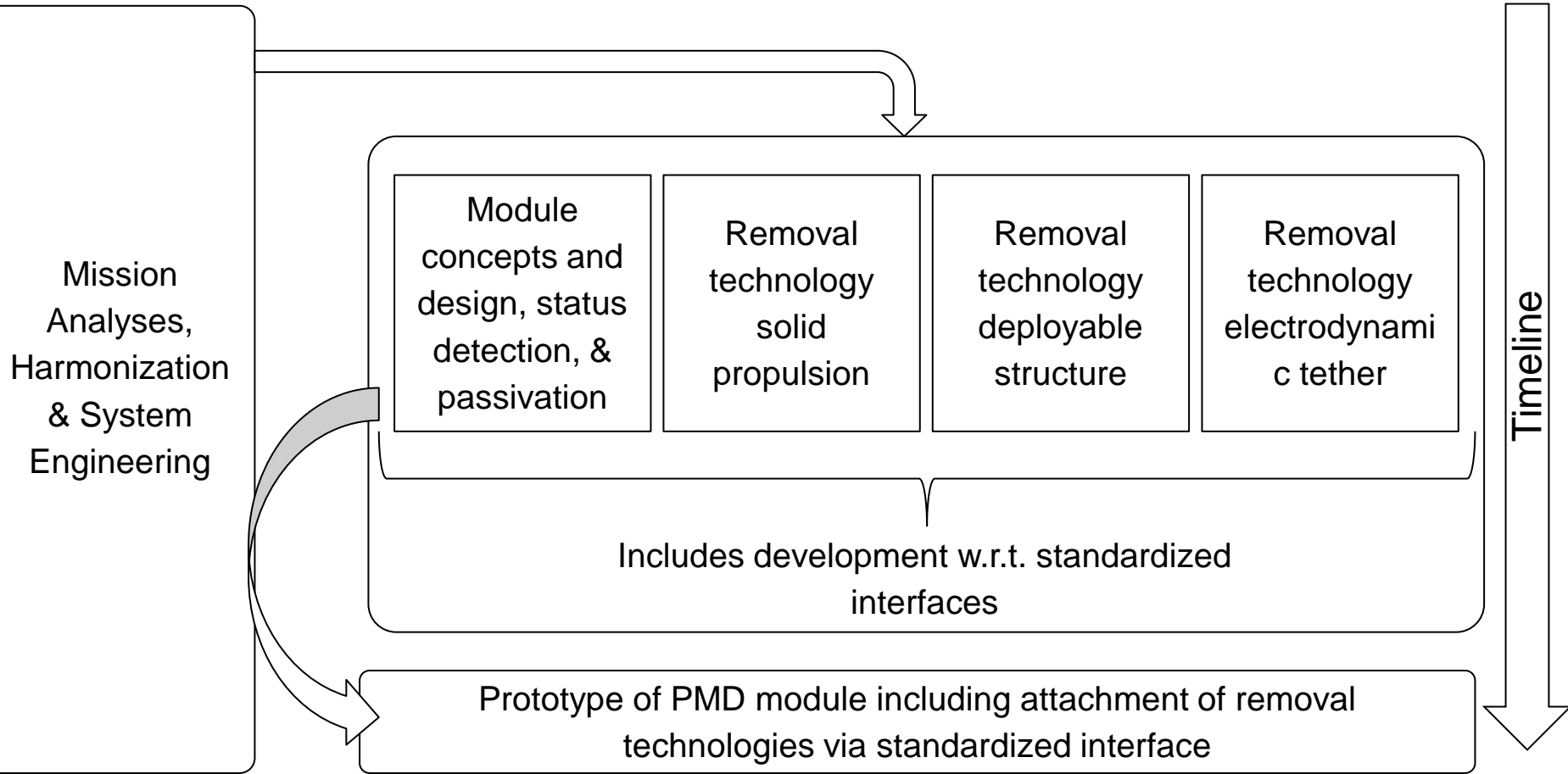


# TeSeR – Consortium

- Airbus Defence and Space (Coordinator)
- Aalborg University
- Beazley Furlonge Ltd
- D-Orbit SRL
- GomSpace ApS
- Hyperschall Technologie Göttingen GmbH (HTG)
- PHS Space Ltd
- University of Surrey
- Universität der Bundeswehr München
- University of Strathclyde
- Weber-Steinhaus & Smith



# TeSeR – Project Logic & Major Tasks

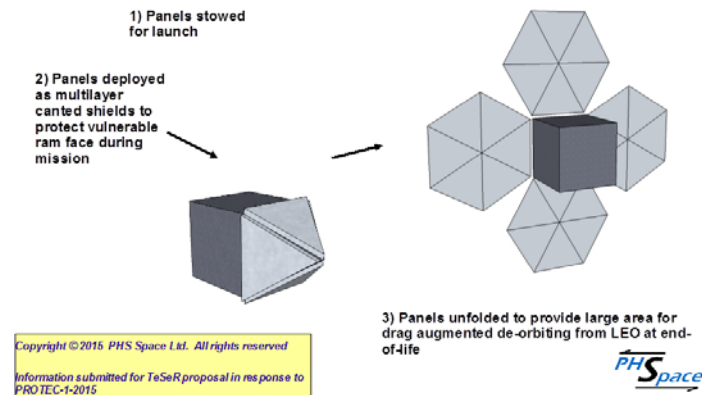




# TeSeR – Complementary Tasks

- Technical:
  - Innovative passive AOCS concepts for long-time stabilization
  - Re-entry simulations
  - Multi-purpose concepts (e.g. shielding)
- Non-technical
  - ISO norms
  - Legal aspects
  - Market & insurances

## An Example Application of the Multi-Purpose Concept



Example application of the multi-purpose concept  
(source: PHS Space)



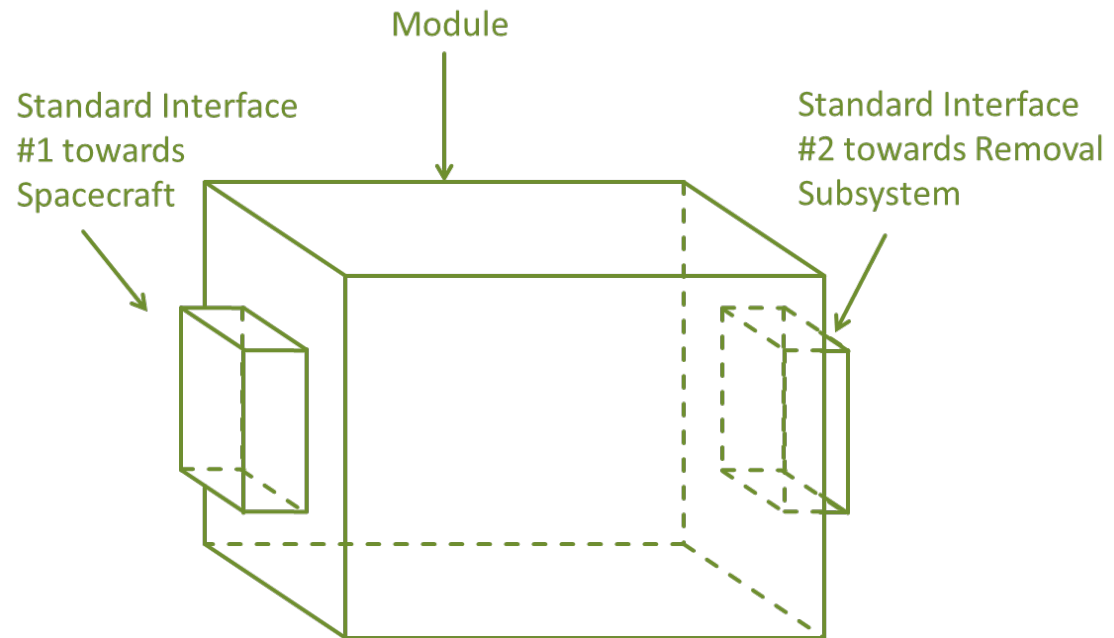
TeSeR

# Summary



# TeSeR – Summary

- Challenge: Close the PMD gap
- Solution: cost-efficient and reliable PMD module
  - attached to any future S/C on ground
  - scalable
  - modular
  - versatile
  - simple design
  - standardized
  - suited for industrial production



# TeSeR - Remove spacecraft before they become space debris...



...and ensure a sustainable space environment for future generations.



# TeSeR – Your Contact

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