TeSeR – Technology for Self-Removal of Spacecraft

Cornelius Vogt
Airbus Defence and Space
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Challenge:

- Mitigate the risk of new space debris from disused spacecraft

Goal of TeSeR (Technology for Self-Removal of Spacecraft):

- Develop concepts for a standardized Post Mission Disposal (PMD) module:
  - Shall be attached to any future spacecraft on ground – NO in orbit service
  - Shall perform PMD for any future spacecraft after end of operation in a reliable and cost-efficient manner

Main outcomes: evaluated concepts and on-ground prototypes
TeSeR – The PMD Gap

Status Quo: only 50% - 60% of spacecraft perform PMD

Goal: 90% PMD success rate

For a few years, PMD is required but:

1. PMD has significant impact on spacecraft design, e.g. MetOp-SG requires several hundreds of kg additional fuel and additional thruster only for PMD

   PMD becomes a design and cost driver if designed individually for each spacecraft (tailored design)

2. In case of loss of communication and control

   Conventional (integrated) PMD approach fails

3. PMD not attractive for spacecraft owners/operators

   Propellant is preferably used for lifetime extension
TeSeR – Remove Any Spacecraft

Closing the PMD gap requires a module which can remove any future spacecraft.

- Scalability
- Modularity
- Versatility

PMD module shall be cheaper than conventional approaches.

- Simple design
- Standardized
- Suited for industrialization
Two Standard Interfaces:

• Standard interface #1 to attach module to any spacecraft on ground

• Standard interface #2 to attach different removal technologies to module

• Select the removal technology appropriate for spacecraft and orbit, e.g. solid rocket motor for controlled de-orbit or dragsail for uncontrolled/semi-controlled de-orbit
Most subsystems for module are readily available

- Structure/Mechanism/Thermal
- Power supply
- Communication

TeSeR development

- Removal technologies

TeSeR development

- Standardized interfaces

• Attitude control
• Command and data handling

Two removal technologies pre-developments

*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
Functional block diagram of the PMD module, its subsystems and links, and its two standard interfaces
Bundeswehr University Munich
TeSeR – PMD Module

Prototype: 6U structure with platform avionics

PMD module prototype with three different removal subsystems: solid rocket motor, electro-dynamic system, dragsail
TeSeR – Solid Rocket Motor

Integration of solid rocket motor in 6U structure

Close-up of solid rocket motor
TeSeR – Dragsail

Shown here: Process of three times non-linear folding of the dragsail
Final achievement: nine times folding of the dragsail

Dragsail subsystem with the unfolded/deployed sail
TeSeR – Electro-Dynamic Hybrid System

Unfolded Rigid Boom Electro-Dynamic Drag Sail (RBEDDS)
TeSeR – Additional Results

Technical:
• Innovative passive AOCS concepts for long-time stabilization
• Re-entry simulations (semi-controlled)
• Multi-purpose concepts (shielding, impact detection...)

Non-technical:
• Norm evolution (ISO)
• Legal aspects (negligence, liability...)
• Insurance aspects (risks, insurability...)

Multi-purpose concepts

Semi-controlled re-entry
Project
TeSeR (Technology for Self-Removal of Spacecraft)

- Output: Evaluated concepts and on-ground prototype
- R&D project funded by the EC in H2020 framework (grant agreement number 687295)
- Kick-off: 02/16
- Completion: 01/19
TeSeR – Team

- Airbus Defence and Space (Coordinator)
- Aalborg University
- Beazley Group
- D-Orbit SpA
- GomSpace A/S
- HTG Hyperschall Technologie Göttingen GmbH

- PHS Space Ltd
- University of Surrey
- Bundeswehr University Munich
- University of Strathclyde
- Weber-Steinhaus & Smith
Summary
Challenge:
Close the PMD Gap

Solution:
Reliable and cost-efficient

PMD module
• Attachable to any future spacecraft 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
Cornelius Vogt
Airbus Defence and Space

cornelius.vogt@airbus.com