CLEAN SPACE INDUSTRIAL DAYS

DESIGN FOR REMOVAL

AIRBUS DEFENCE & SPACE

gmv INNOVATING SOLUTIONS

INDEX

D4R
OVERVIEW

OBJECTIVE

- To increase the feasibility and reliability of an ADR mission (both in terms of cost and technically) by **identifying concepts that could be hosted on board a spacecraft to facilitate such future ADR mission**
- The concepts to be identified within the study shall support the ADR mission in at least the following:
  - Aids to **support tracking and state estimation of the debris** (from ground and on-orbit), since it is essential to have first good knowledge of orbital position and tumbling state of the debris
  - **Space systems attitude stabilization**, as a tumbling debris can impose strong requirements on the capture, stabilization and disposal of the debris
  - **Aids to facilitate capture**, which would be needed in capturing and disposing the debris

DEFINITIONS

- **SDRS**: **S**ituational awareness, active **D**ebris **R**emoval and on-orbit **S**ervicing
- **SDRS Segment**: Different segments that can be considered in an ADR mission, e.g. Situational Awareness segment, Rendezvous segment, Capture segment
- **SDRS Technologies**: Methods, systems, devices or techniques that are used to fulfil the requirements of the different phases of an ADR mission
- **SDRS Aiding Concepts**: Systems or devices that could be hosted on-board a spacecraft to facilitate an ADR mission in case it becomes non-functional

WORK LOGIC

- SDRS Supporting Technologies
  - Identification of the SDRS aiding concepts for D4R
- SDRS Case Study Selection and Preliminary Assessment
  - Target selection
  - Definition of the evaluation criteria
  - Preliminary assessment of the identified SDRS aiding concepts
- D4R Concept System Trade-off
  - Trade-off for situational awareness aiding concepts
  - Trade-off for RdV aiding concepts
  - Trade-off for passive stabilisation concepts
  - Trade-off for structural fixture concepts
- D4R Roadmap

D4R
CURRENT ACTIVITIES

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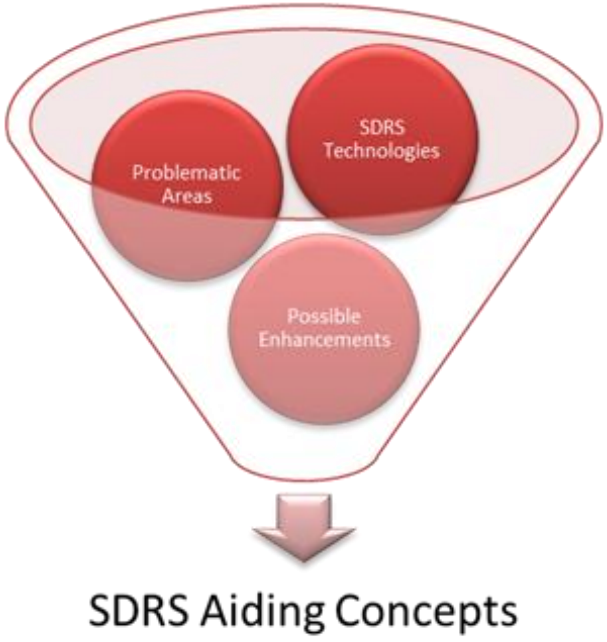
IDENTIFICATION APPROACH

- Review the SDRS technologies based on:
  - Literature review
  - Running Clean Space branch 4 activities
  - Consortium internal expertise
  - Advice and guideline from ESA
- Identification and analysis of the problematic areas to derive possible enhancements for the technologies
- Definition of SDRS aiding concepts based on the identified enhancements



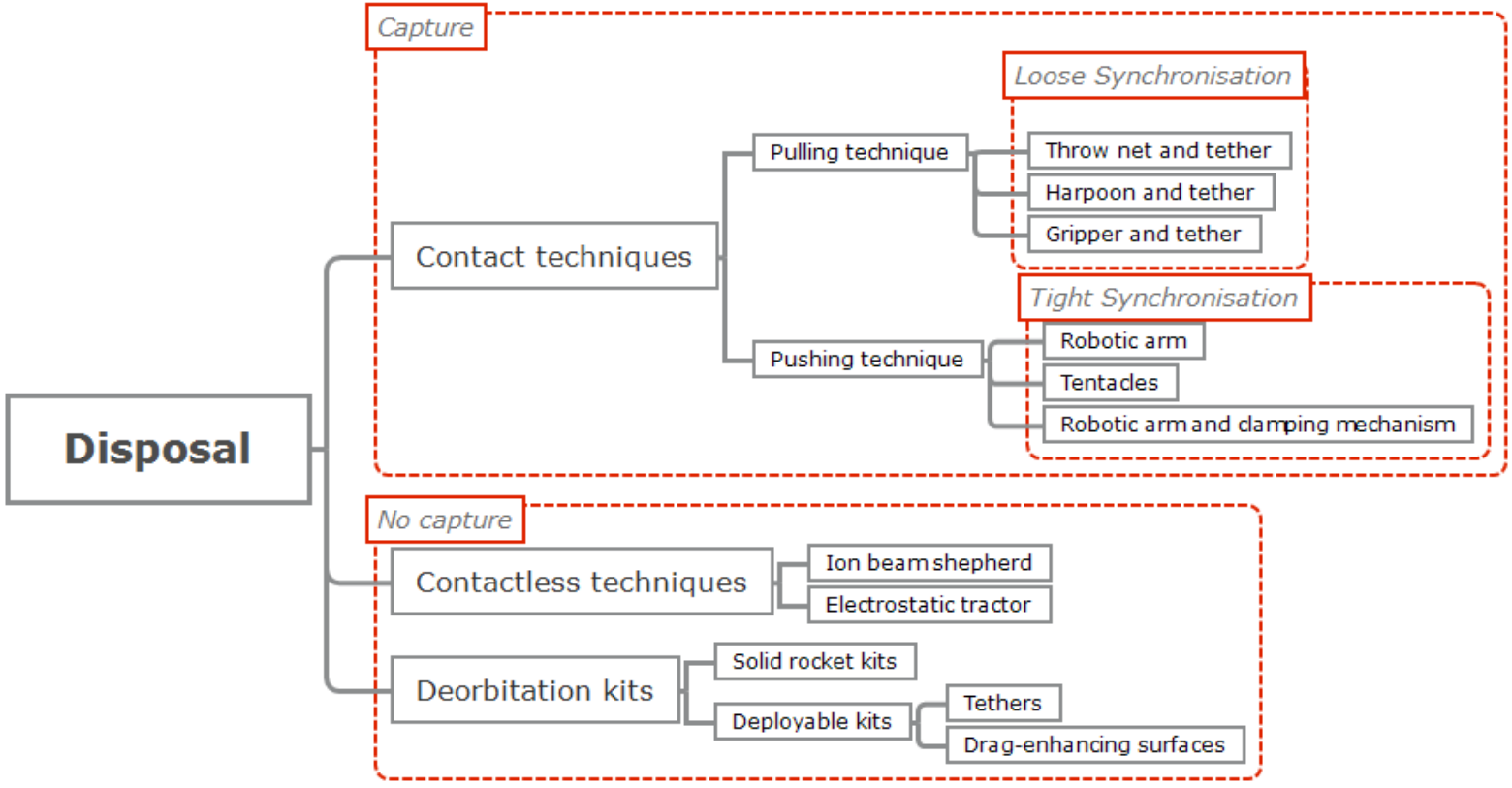
SST REVIEW

- Ability to detect and predict the movement of space debris in orbit around the Earth.
- The catalogue, the core of the SST, contains information on everything that has been detected in orbit.
  - Orbit Determination. Orbit reconstruction from sensor data
  - Object Correlation. Checking if the object is already available in the catalogue.
  - Catalogue Assessment. Monitoring of data in the catalogue so that tracking system can be tasked to update the information when needed.
- SST sensors:
  - Surveillance sensors. Catalogue build up.
  - Tracking sensors. Catalogue development and maintenance.
- Observations: SST technologies in the frame of D4R
  - Optical
  - Radar
  - Laser ranging

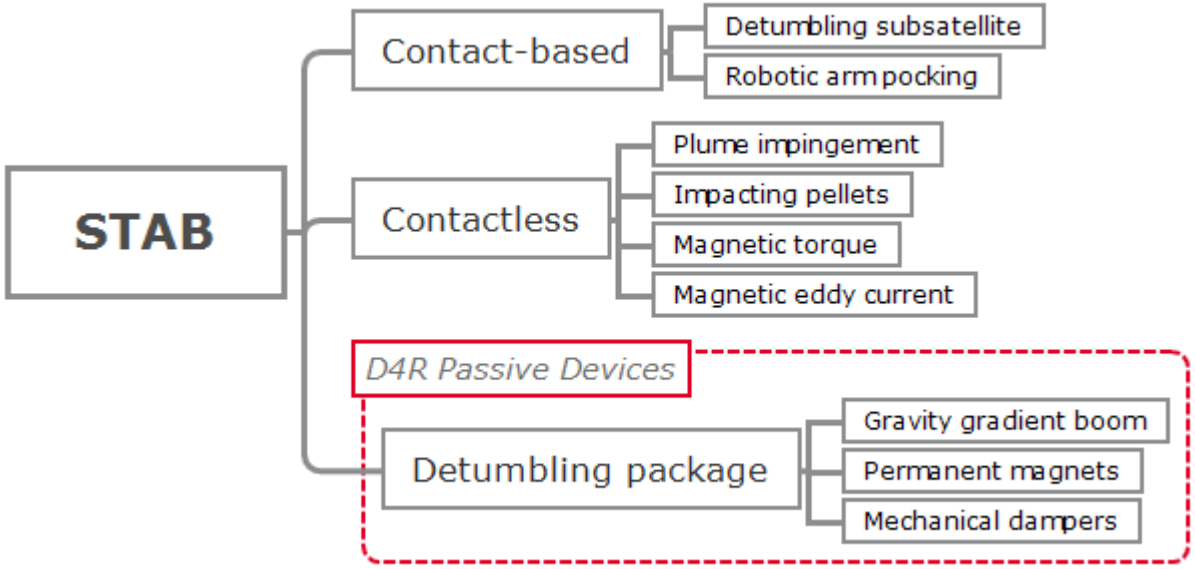
RdV REVIEW

- Operations to bring a chaser from thousand of km to station-keep with a target as a preliminary to mate with it.
- Different phases depending on GNC modes and/or sensors.
- RdV sensors
  - Optical camera.
  - Infrared camera.
  - LIDAR.
  - Imaging LIDAR.
- RdV technologies in the frame of D4R:
  - From non-cooperative RdV to a cooperative RdV at navigation level.
  - Passive navigation aids

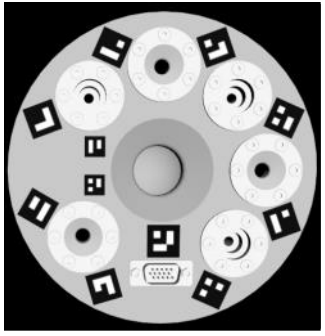
DISP & CAP REVIEW



STABILIZATION



SST – RdV SEGMENTS



Optical marker

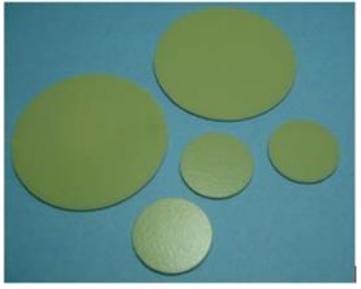
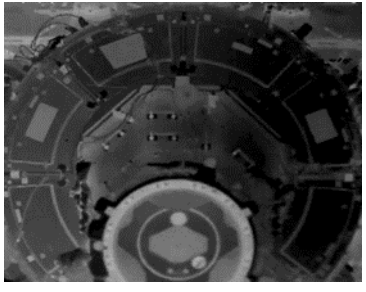


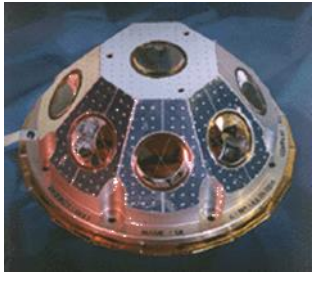
Photo-luminescent marker

GNSS Rx

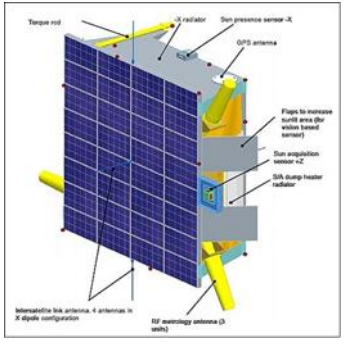
RF



Thermal marker



Retroreflector

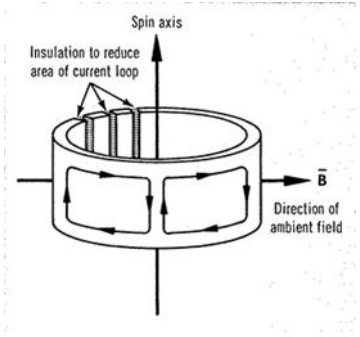


LEDs

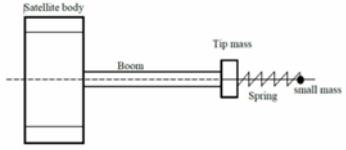
Passive Devices

Active Devices

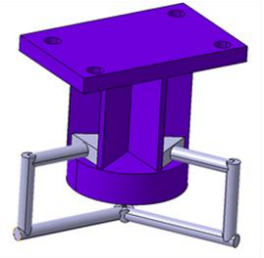
STAB - CAP SEGMENTS



Coils and resistors

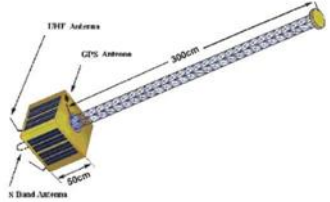


Mechanical vibration damper

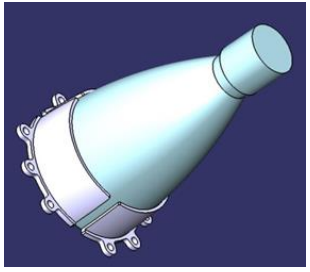


Robotic arm grappling fixture

Clamping mechanism interface



Gravity gradient boom



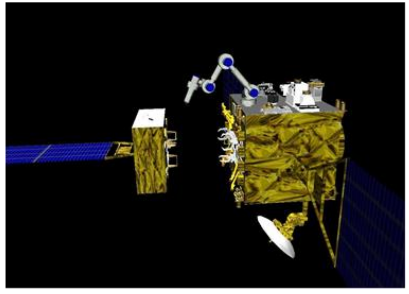
Grasping mechanism for apogee nozzle

Stabilization Aiding Devices

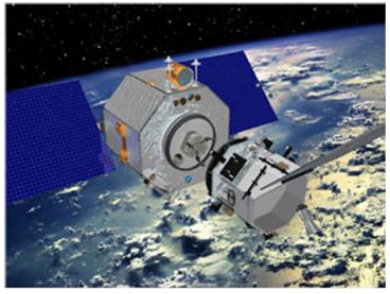
Capture Aiding Devices

DESIGN RULES

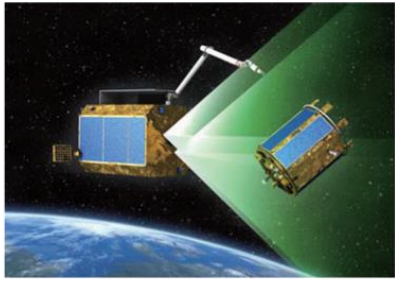
- Reduction of vibrations. Vibration modes not excited during capture
- Inertia matrix constraints. Aiding gravity gradient stabilization
- Flat zone around COM. Aiding shepherd stabilization techniques.
- Access to disposal devices. Possibility to activate disposal devices externally.
- Dedicated zone for disposal kit installation.
- Reinforce structural hard points. Improve the force and torque transmission for the contact-based capture technologies.
- Detailed spacecraft documentation to support the ADR mission design.



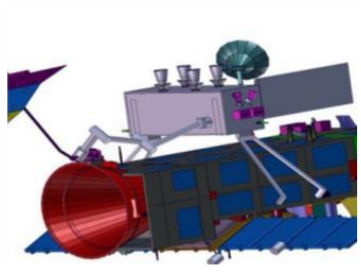
ETS-VII (NASDA/JAXA)



Orbital Express (DARPA)



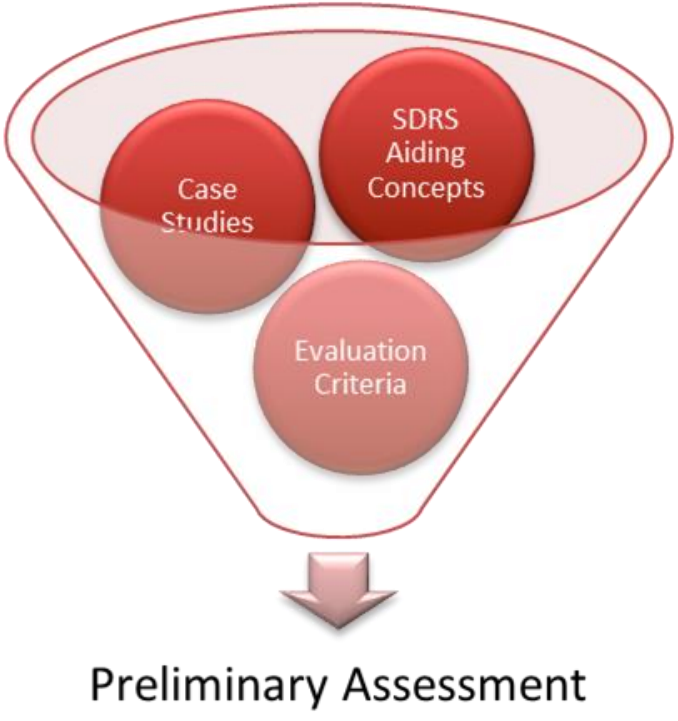
DEOS



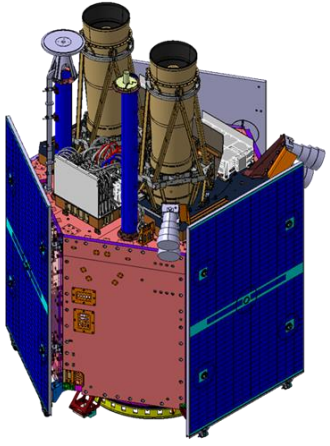
eDeorbit concept from ESA CDF study

PRELIMINARY ASSESSMENT

- Selection and definition of case studies
  - LEO satellite
  - Multiple payload dispenser platform
  - GEO satellite
  - Mega-constellation satellite
- Definition of evaluation criteria
  - Performance criteria
  - Technical criteria
  - Programmatic criteria
- Preliminary assessment of SDRS aiding concepts

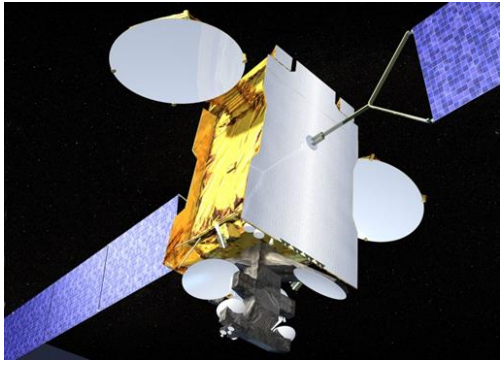


SELECTED CASE STUDIES



SEOSAT/Ingenio for LEO S/C

SYLDA Ariane 5 Multiple Payload Dispenser



Eurostar E3000 for GEO S/C

OneWeb platform for Mega-constellation

www.gmv.com

THANK YOU

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