



Design For Removal

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CleanSpace Industrial days

ThalesAlenia
a Thales / Leonardo company Space



PROPRIETARY INFORMATION

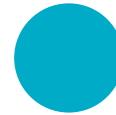
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TRL maturation



Study cases definition

Built-up



SDRS techniques

SSA + RDV + Stabilization + capture



System impact

SDRS technique implementation

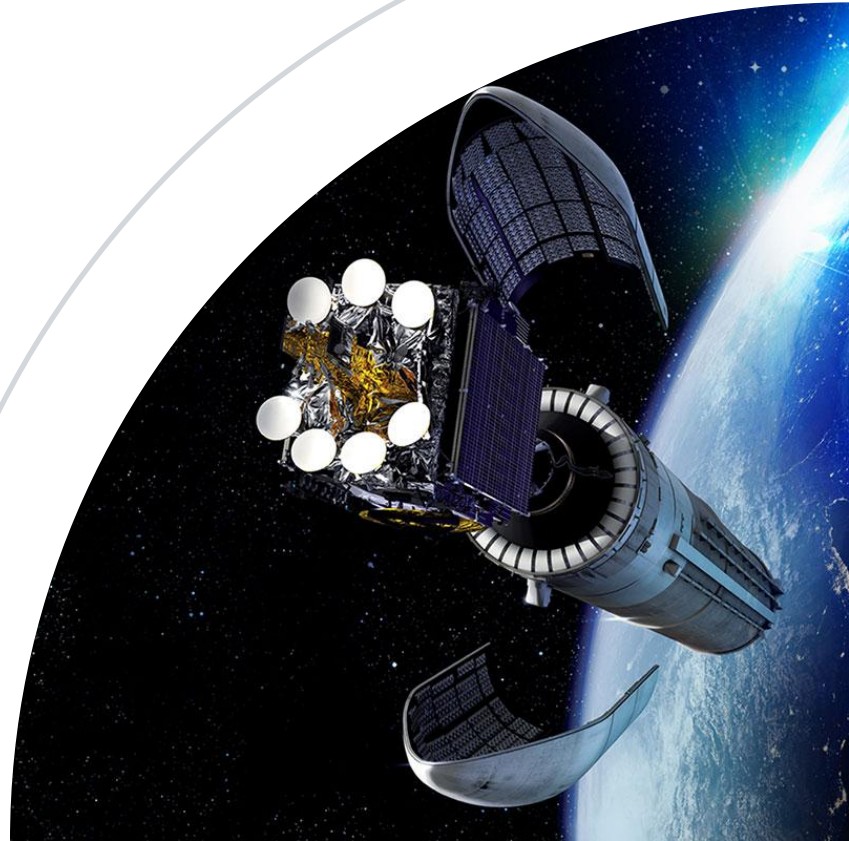
ESA Phase 0
Study managed
by
Andrew Wolahan



Objective

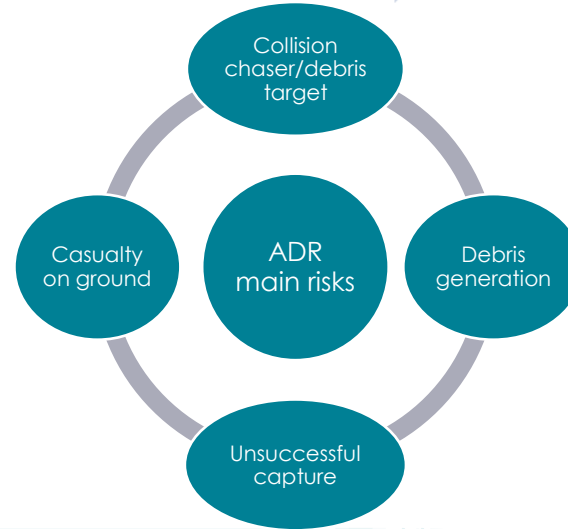
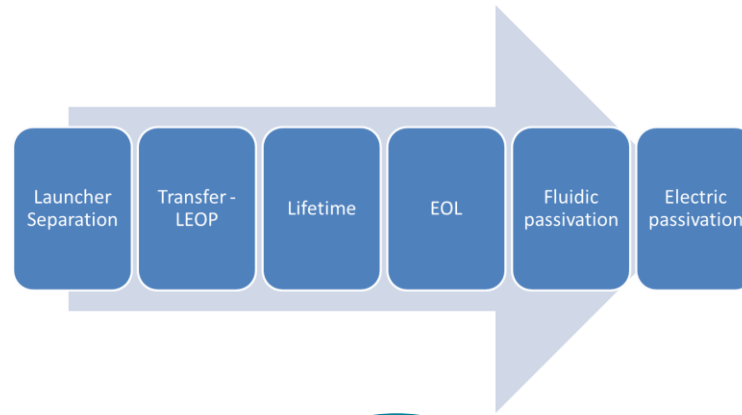
- 🚀 To keep space sustainability
 - 🚀 What can be done at Spacecraft level
- 🚀 To cover
 - 🚀 Non-functional during lifetime
 - 🚀 Non effective disposal
- 🚀 To improve
 - 🚀 Evaluation of satellite behaviour/ status
 - 🚀 SSA data
- 🚀 To support future services & evolutions
 - 🚀 On-orbit servicing
 - 🚀 Active Debris Removal

**D4R to reduce ADR
identified risks**



Satellite mission phase

- 🚀 Failure possible at any time
- 🚀 Non-operational and non-cooperative satellite
- 🚀 No on-board capacity
- 🚀 Solutions gather in-orbit on satellite and on-ground support for tracking & warning of potential hazard
- 🚀 Solutions can cope with Servicing



Domain

Failure mode ADR



- Unknown debris motion
- Error in the relative pose
- Non sufficient lighting for capture
- High tumbling rate
- Rigid capture slippery
- Flexible capture bad location

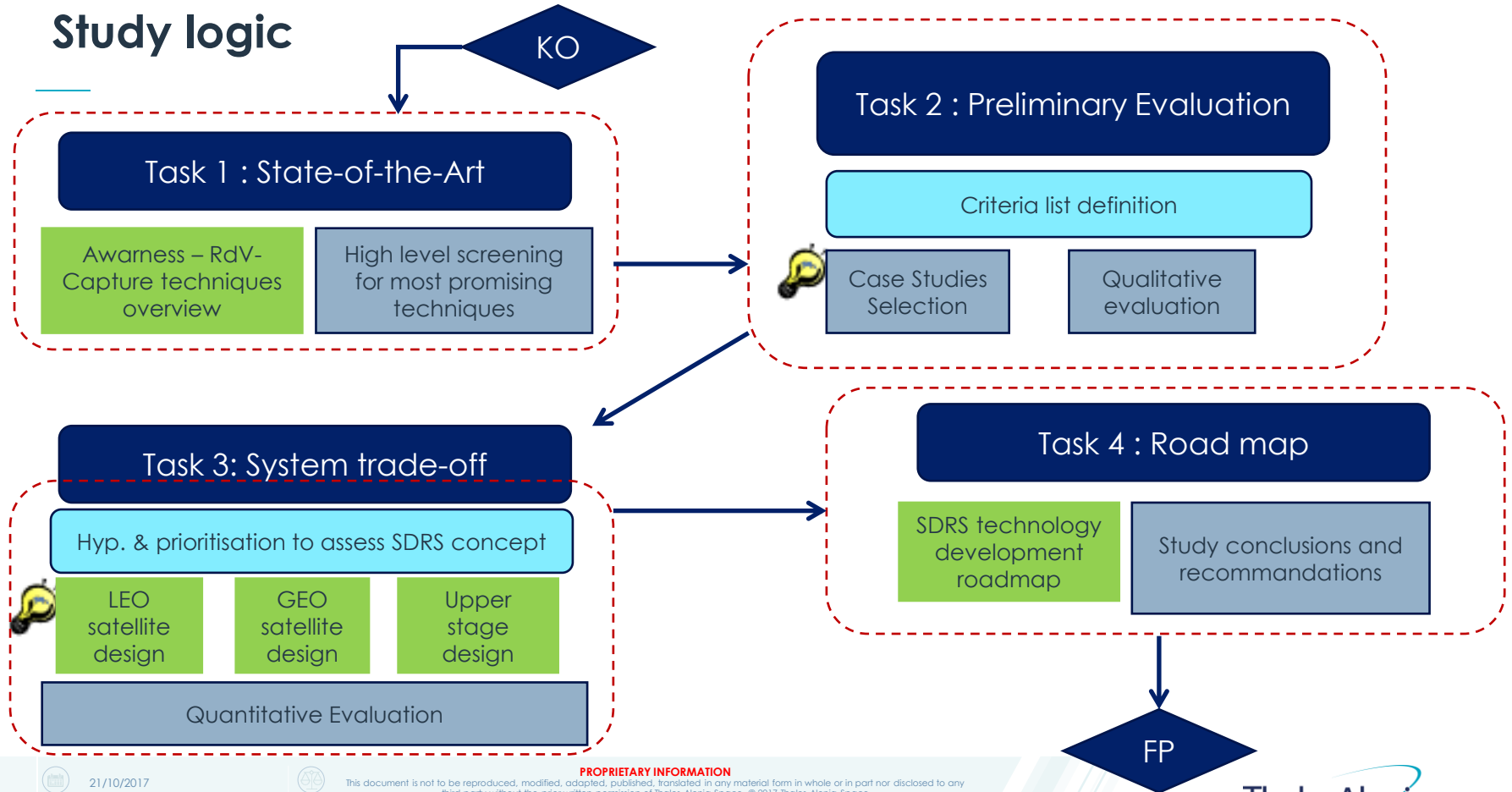


Domain

- Situational Awareness
- RDV
- Vision
- Stabilization
- Capture
- Capture & stabilization



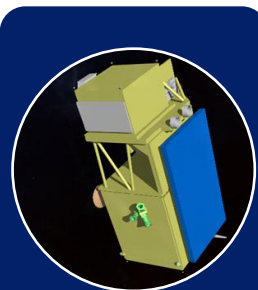
Study logic



Study cases definition

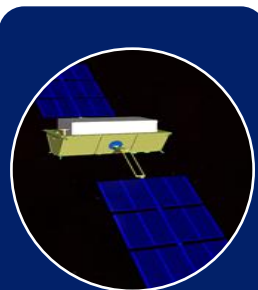
🪐 To be representative of different missions, spacecraft range

🪐 Cases built-up by IDM modelization



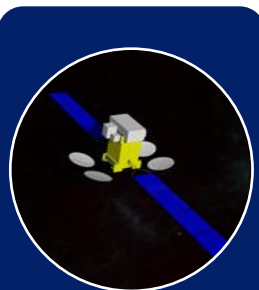
LEO

- 2200 kg
- Controlled re-entry
- Hydrazine
- 1 SA



Constellation

- 1300 kg
- High power
- Electric propulsion



GEO satellite

- 4200 kg
- Communication
- Electric propulsion



Launcher Upper stage

- AVUM
- 700 kg
- NTO/UDMH
- reignition

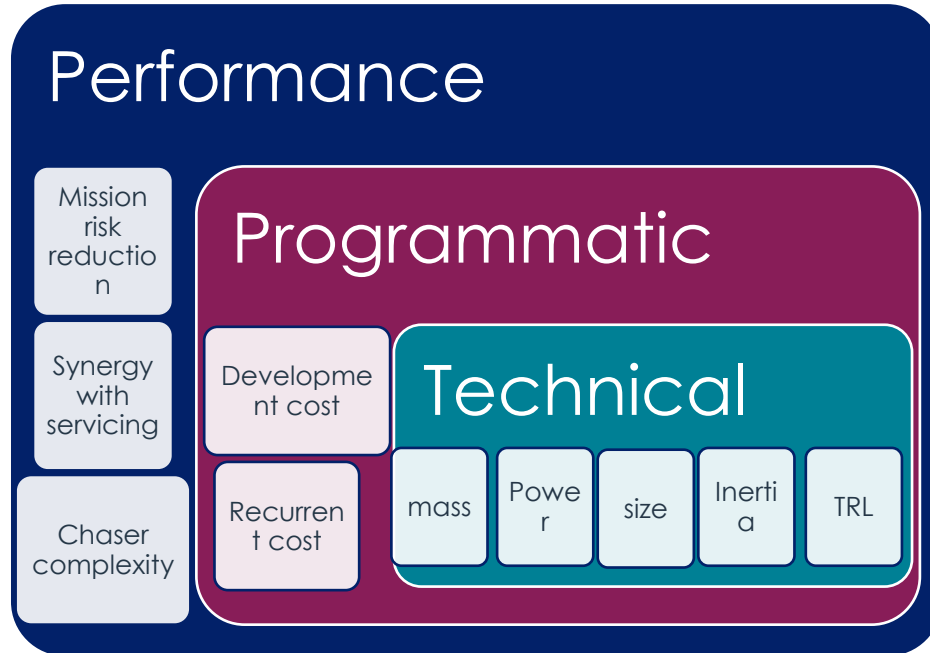
Thanks to AVIO for support on AVUM Upper stage



SDRS technique

Situational awareness, active Debris Removal and on-orbit Servicing

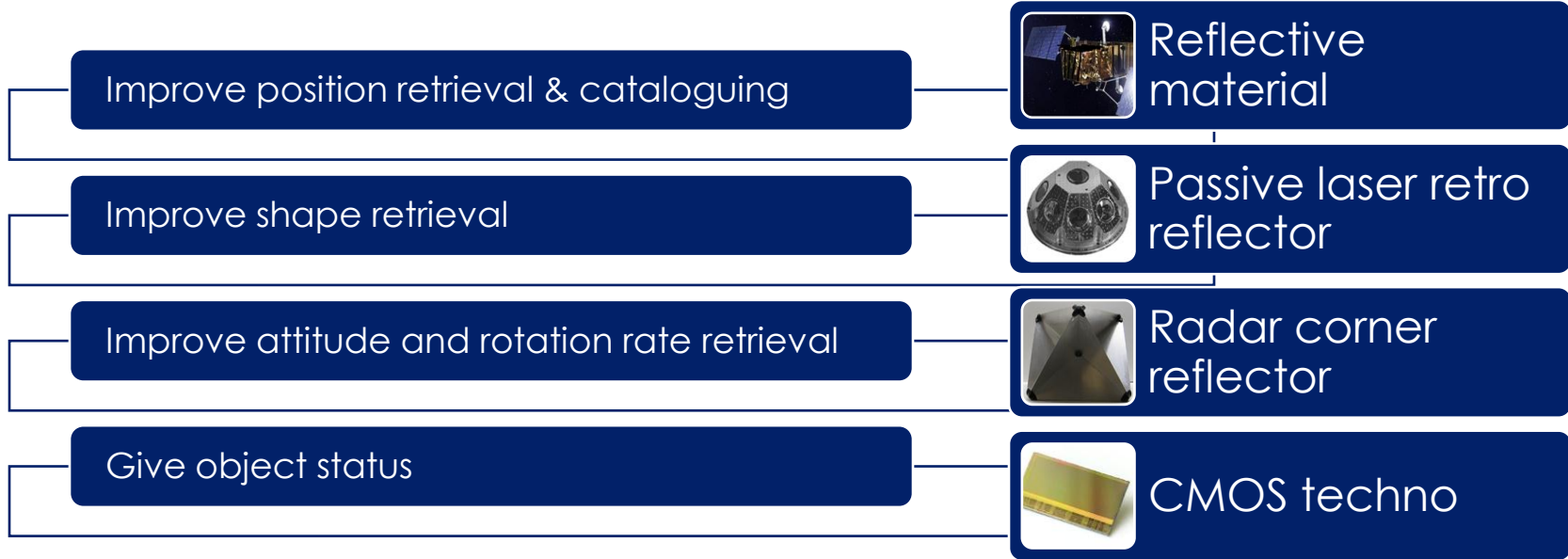
🚀 Definition of criteria for quantitative evaluation



Scoring criteria depend on mission

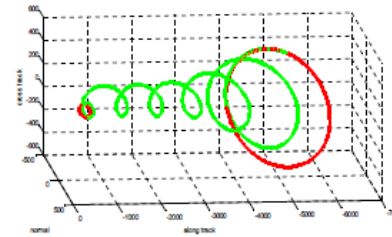
SSA – Space Situational Awareness

 Definition of criteria for quantitative evaluation

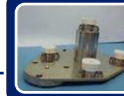


Rendezvous & vision

🚀 Definition of criteria for quantitative evaluation



Radar or camera for Inspection & RDV



Retro reflectors

Close range : Pose estimation



Reflective tapes & markers

Communication with Debris



2D-3D markers

Reactivate solution with wake-up system

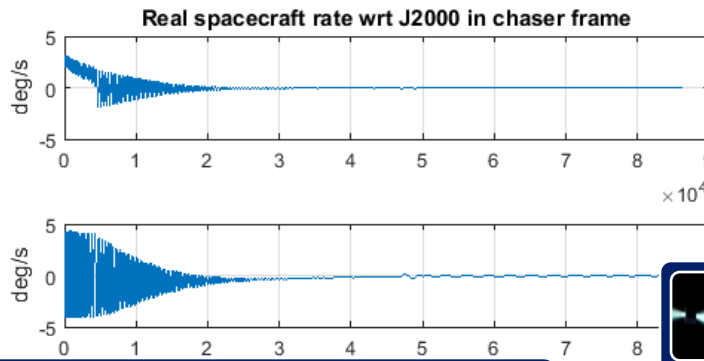


Gyro & RF

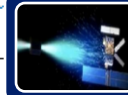


Formation flying RF

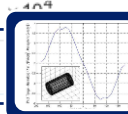
Stabilization



Active with contact or interaction



Friction, blowing, IBS, laser ablation, plume ...



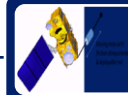
Deployed magnets, MTB in short circuit

Deployable surface for gravity gradient or solar pressure stabilization



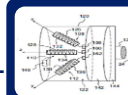
Tether, mast, solar sail

Design satellite optimisation for stabilization



Spin, energy dissipation

Transferred actuators



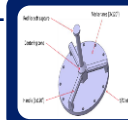
Transferred AOCS

Capture

 Definition of criteria for quantitative evaluation

Rigid capture – robotic

- Mechanical I/F or LAR



Handle for arm capture,
or peripheral attach

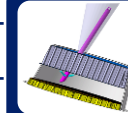
Rigid capture – clamping, docking mechanism



Probe and drogue,
Assist

Flexible capture

- reduce risk of debris generation



Harpoon canister,
magnetic, hook for net..

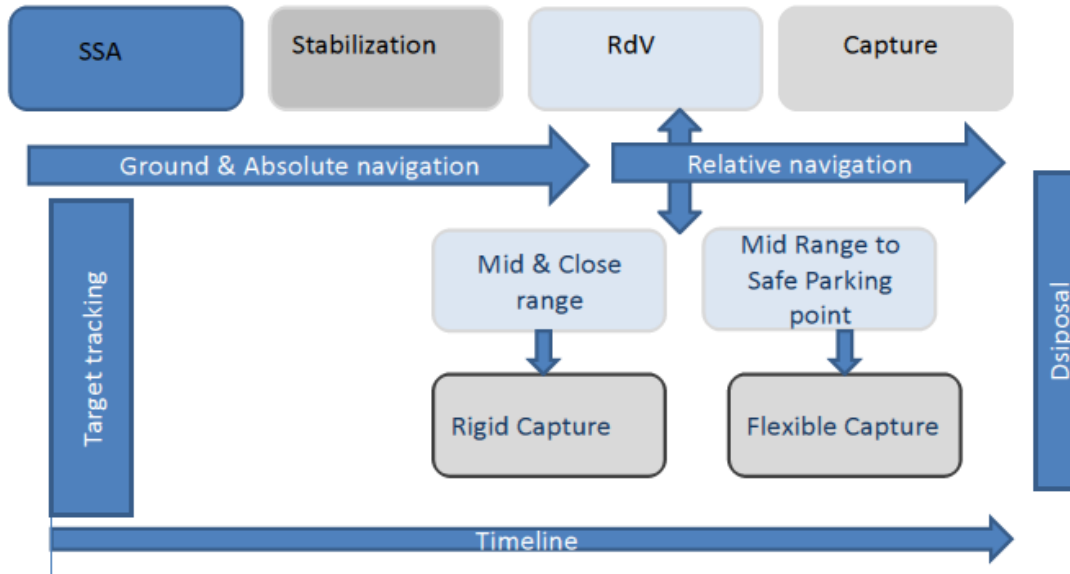
Others



Support bracket for
Deorbit Kit

SDRS techniques mapping

Mission scenario timeline



SDRS techniques implementation

Sizing of device

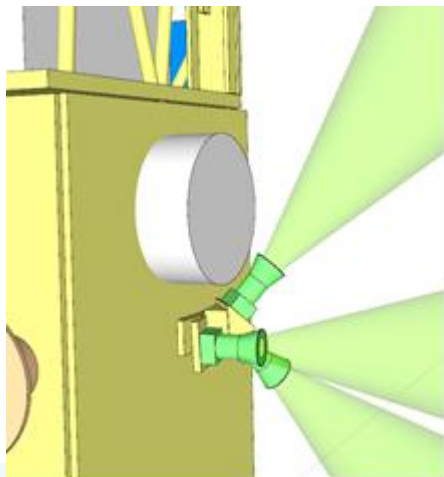
- Hypothesis on chaser (thrust and torque load)
- Material & Mass & conceptual design

Accommodation

- Verification of interference
- System budgets
- MCI wrt AOCS databank

Programmatics

- SDRS concepts need to be qualified
- Structural part on panels around PDR
- Before acceptance tests



Next steps

TRL7

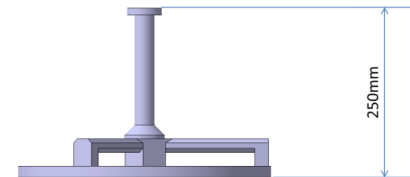
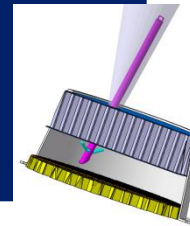
- Long term reliability of ADR mission to cover
- Recurrent cost to improve
- miniaturisation

Additional activities

- To rely on smaller radar than TIRA - system
- Alternative material to MLI for lifetime duration

Maturation needed

- Stabilization by energy damping or SA windmill
- Drogue for servicing
- Harpoon canister



Conclusion

D4R to reduce ADR
identified risks

- 🚀 D4R covers failure cases
- 🚀 SDRS device will support in-orbit servicing
- 🚀 Simple concepts offer maximum potential added value
- 🚀 Some technics needs to raise TRL
- 🚀 Roadmap to build in coherence with ADR definition

