



Space Utility Vehicle / Space Tug

Clean Space Industrial Days

DEFENCE AND SPACE

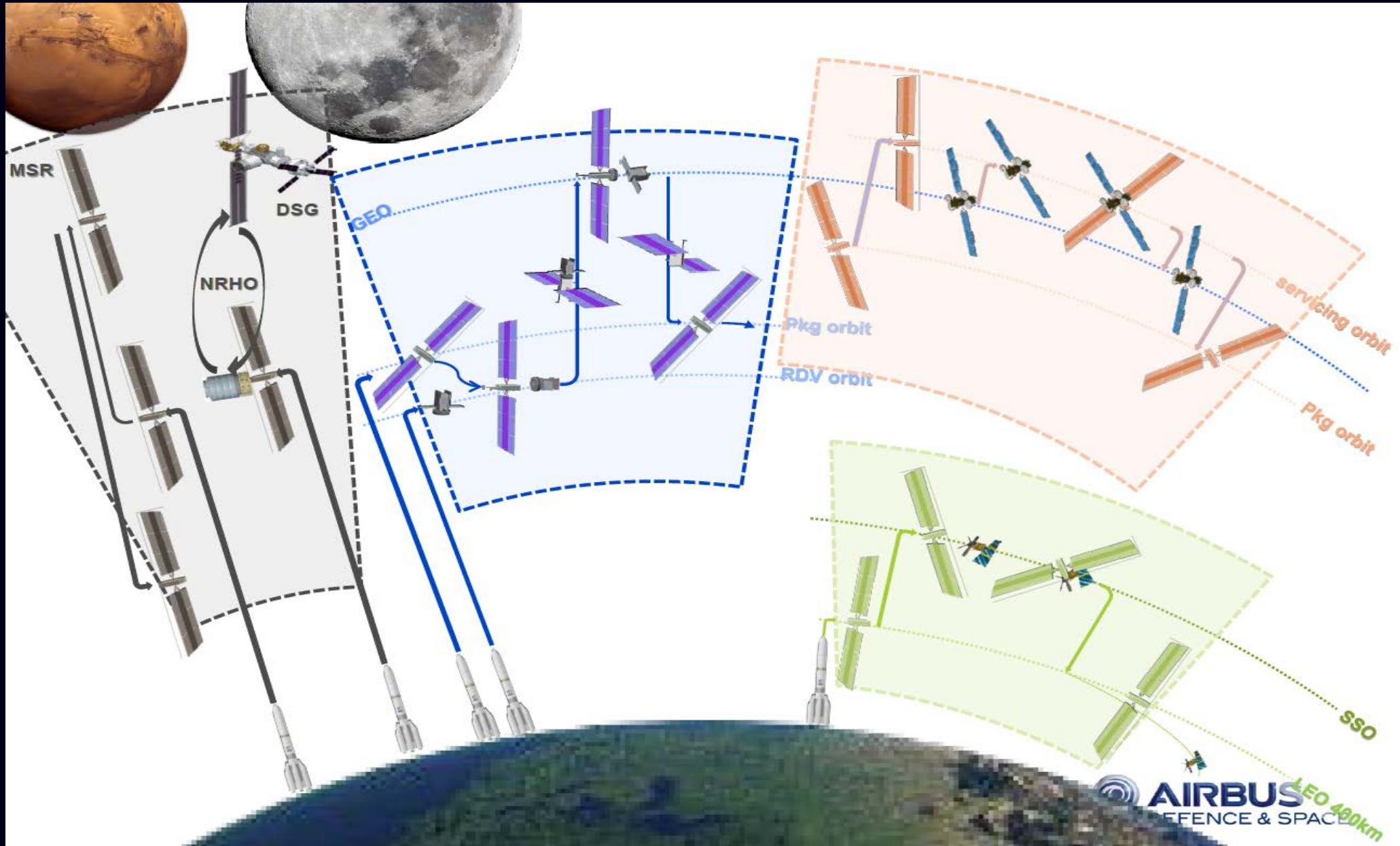
E. Ferreira
October 24th, 2017

AIRBUS

Outline

- ❑ SUV / Space Tug: what, and what for?
- ❑ Debris removal mission with Space Tug: Envisat use case
- ❑ Multi-debris mission with Space Tug
- ❑ Conclusion

A product line for different missions

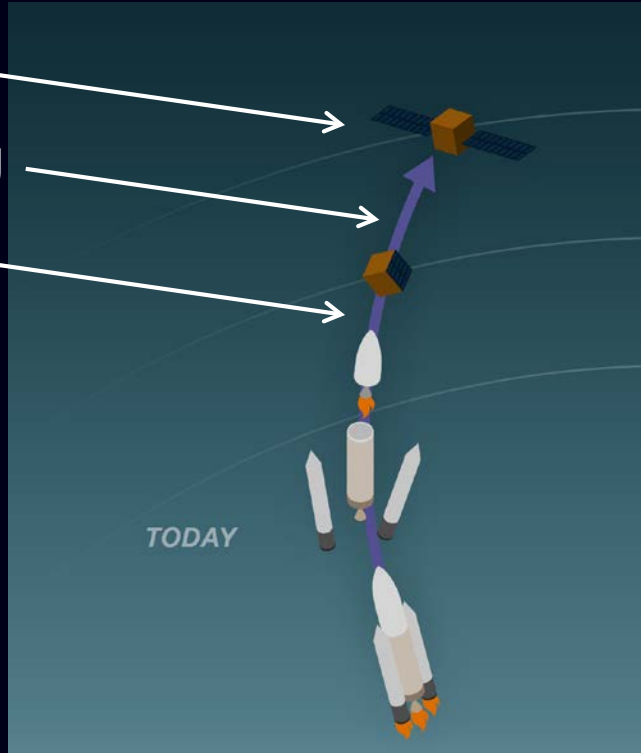


Game changer for satellites delivery in orbit

GEO arc

satellite orbit raising

launcher injection



direct injection in GEO

Space Tug back for next mission

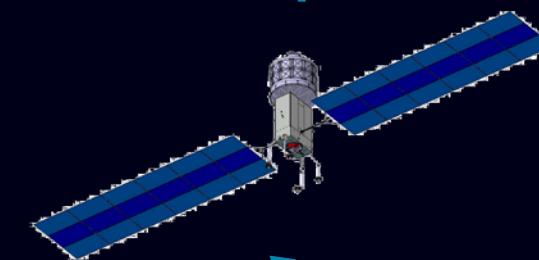
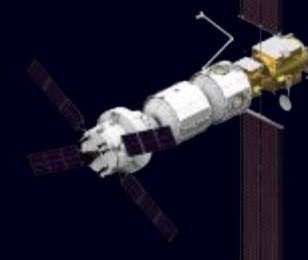
orbit raising with Space Tug

launcher injection on lower orbit



Enabler for exploration

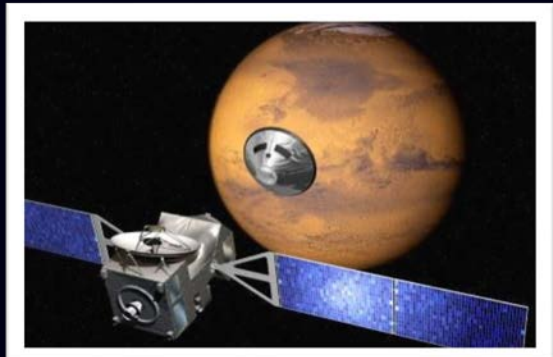
Deep Space Gateway



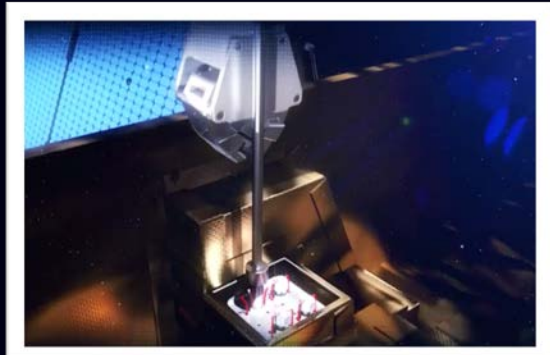
Cargo delivery to the Moon

Sample return

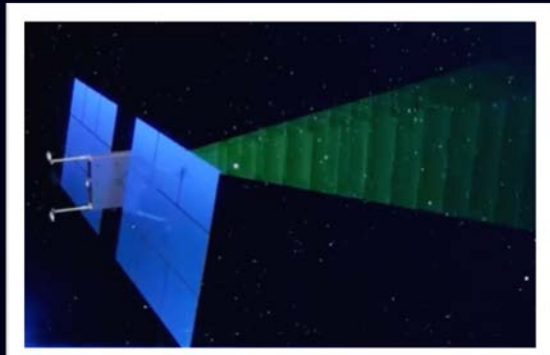
Space mining



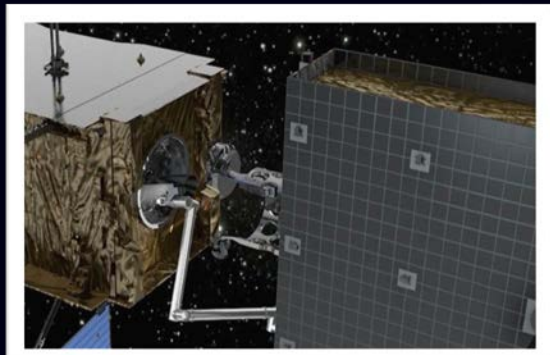
What services in Geostationary orbit?



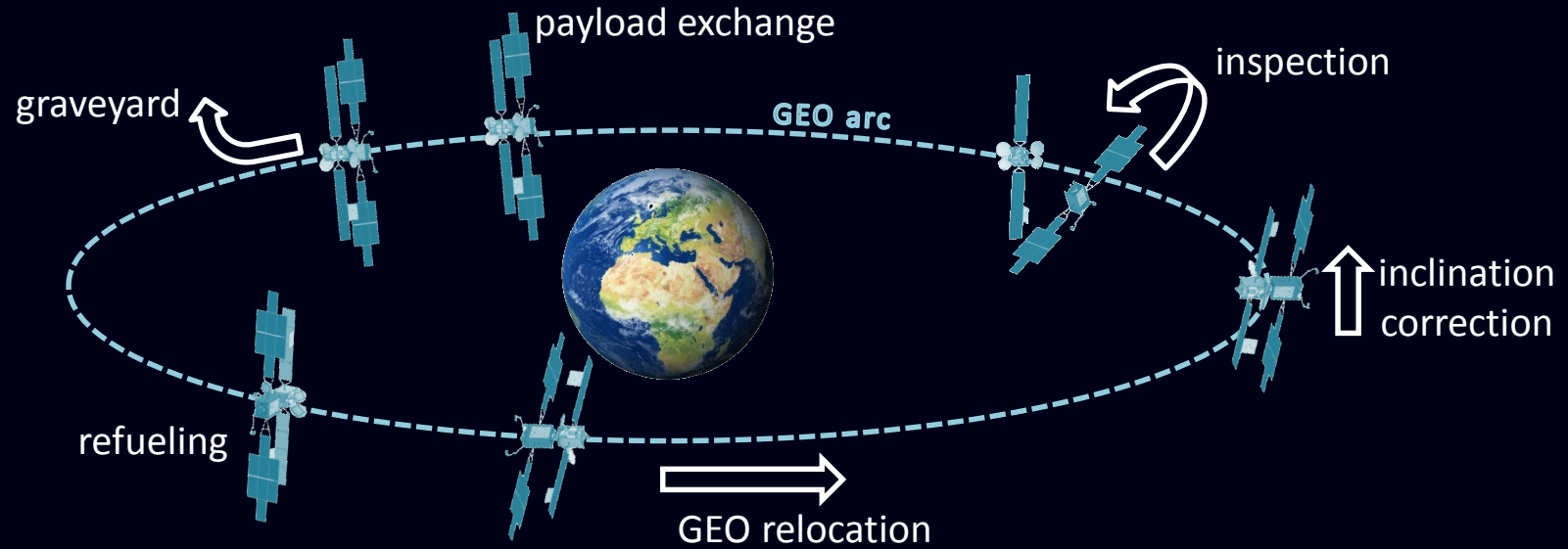
Life extension



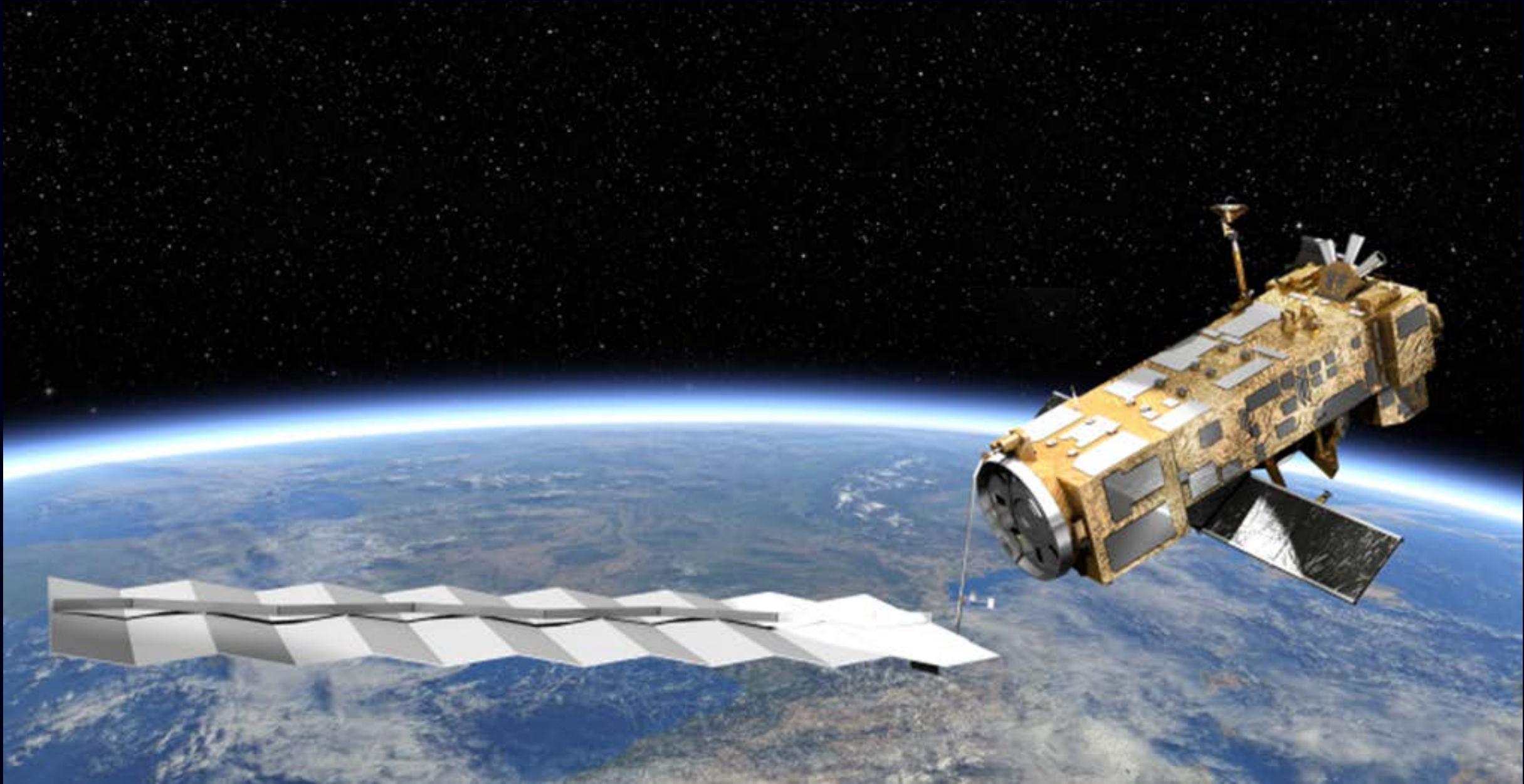
Inspection



Payload exchange



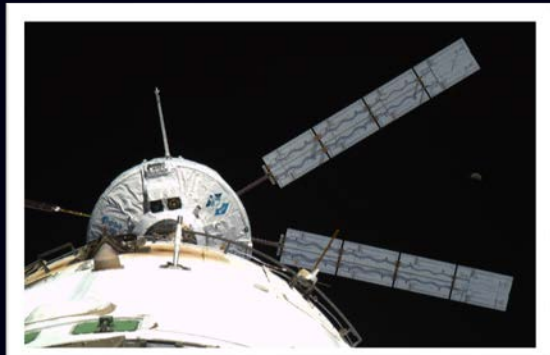
Enabler for cleaning space



Heritage at AIRBUS



Eurostar product line:
Modular platform
SEP: SK + EOR
Radiations protection



ATV:
World 1st full automated RDV
Collaborative docking
ISS reboost & refueling



DEOS / e.Deorbit:
Robotics system
Berthing concept
Non-cooperative RDV



Generic platform & common technologies

High thrust electric propulsion

Power management

Solar Arrays

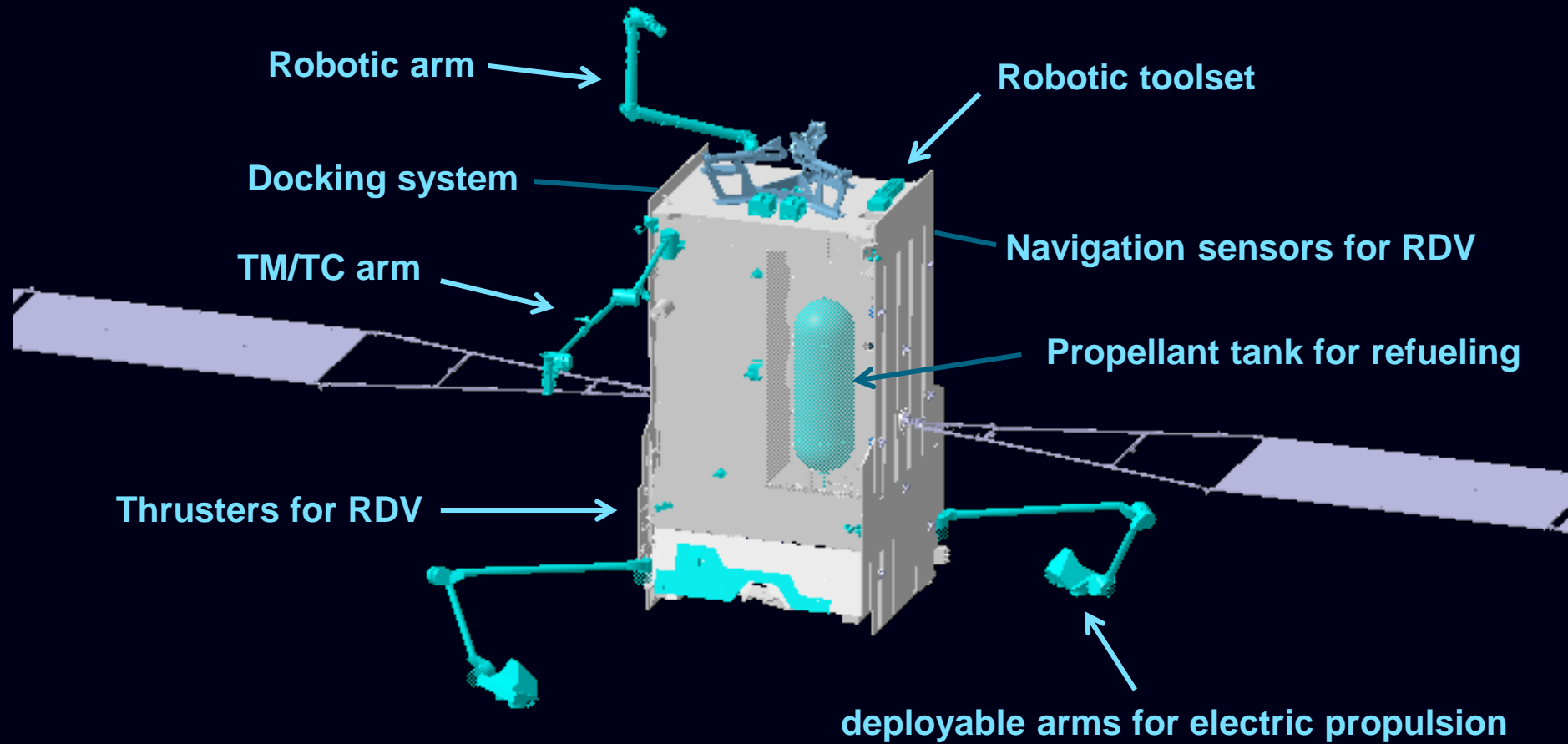
Rendez-vous

Robotics system



**Product Line with
customised vehicle by application**

What does the Space Tug look like?



Space Tug to Envisat debris removal – Approach

❑ **Mission main assignments:**

- Capture and de-orbit ENVISAT through a controlled re-entry, by 2024
- Manage tumbling of the target, estimated about 2,5 deg/s (undefined axis) by then
- Use Vega-C for the launch of the vehicle
- Limited overall mission cost

❑ **Major assumptions for handling of the mission by Space Tug:**

- GEO-Tug to be customised to handle Envisat debris removal: platform, “payload”, etc
- One-off mission is assumed: dedicated spacecraft for the specific Envisat mission
- Launch vehicle requirement to be relaxed: Ariane 62 to be baselined instead of Vega-C

❑ **Several mission scenarios analysed, to assess suitability of Space Tug**

Adaptation of GEO-Tug for Envisat mission – Main points

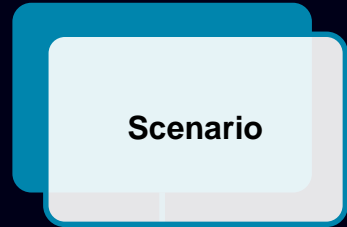
□ Different environment:

- SSO vs. GEO
- Much lower radiations level
- Less solar flux
- AT Ox on S/A and camera optics
- High atmosphere aerodynamics and aerothermodynamics
- Faster orbital dynamics, orbital period much lower, eclipse rate much higher than in GEO

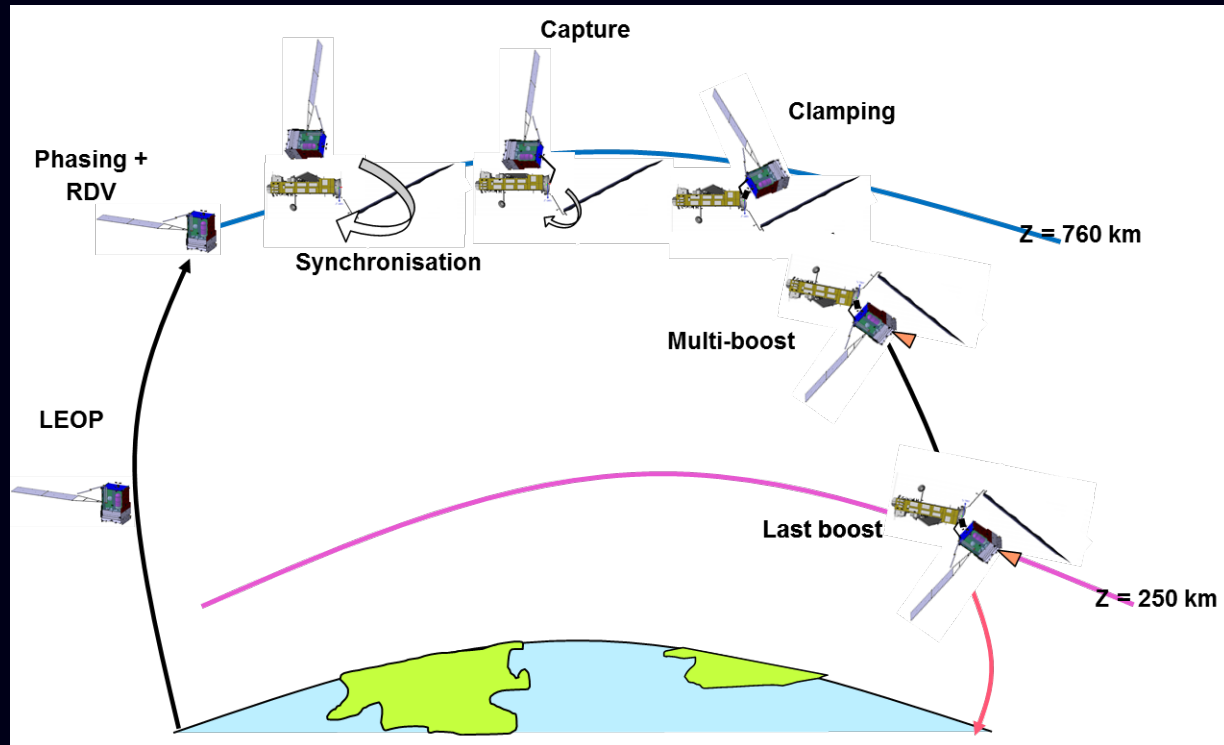
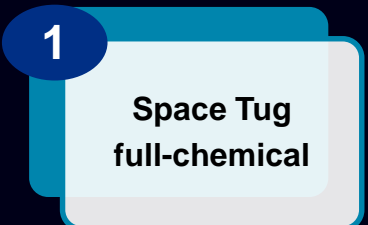
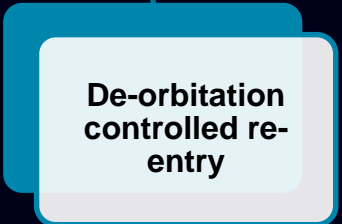
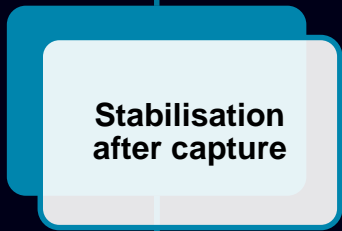
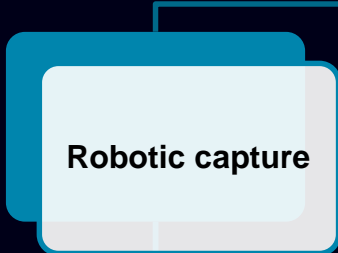
□ Different mission outline:

- Different size & shape, as well as attitude (and attitude rate) of the serviced client
- Single mission (one-off)

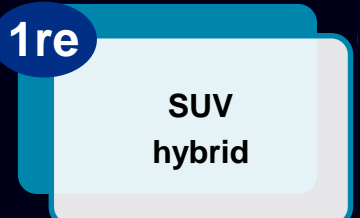
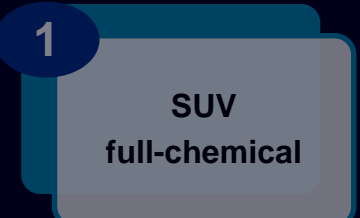
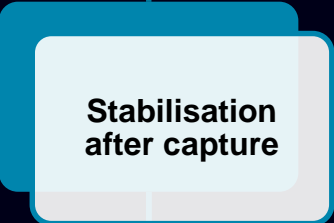
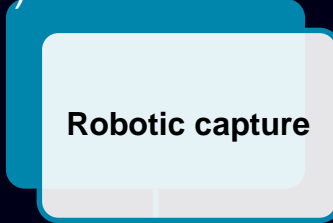
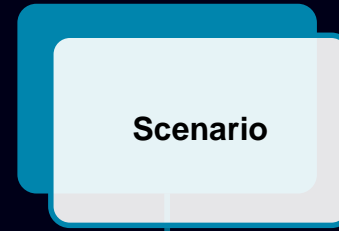
Considered mission scenarios



At first:
nominal scenario as e.Deorbit reference

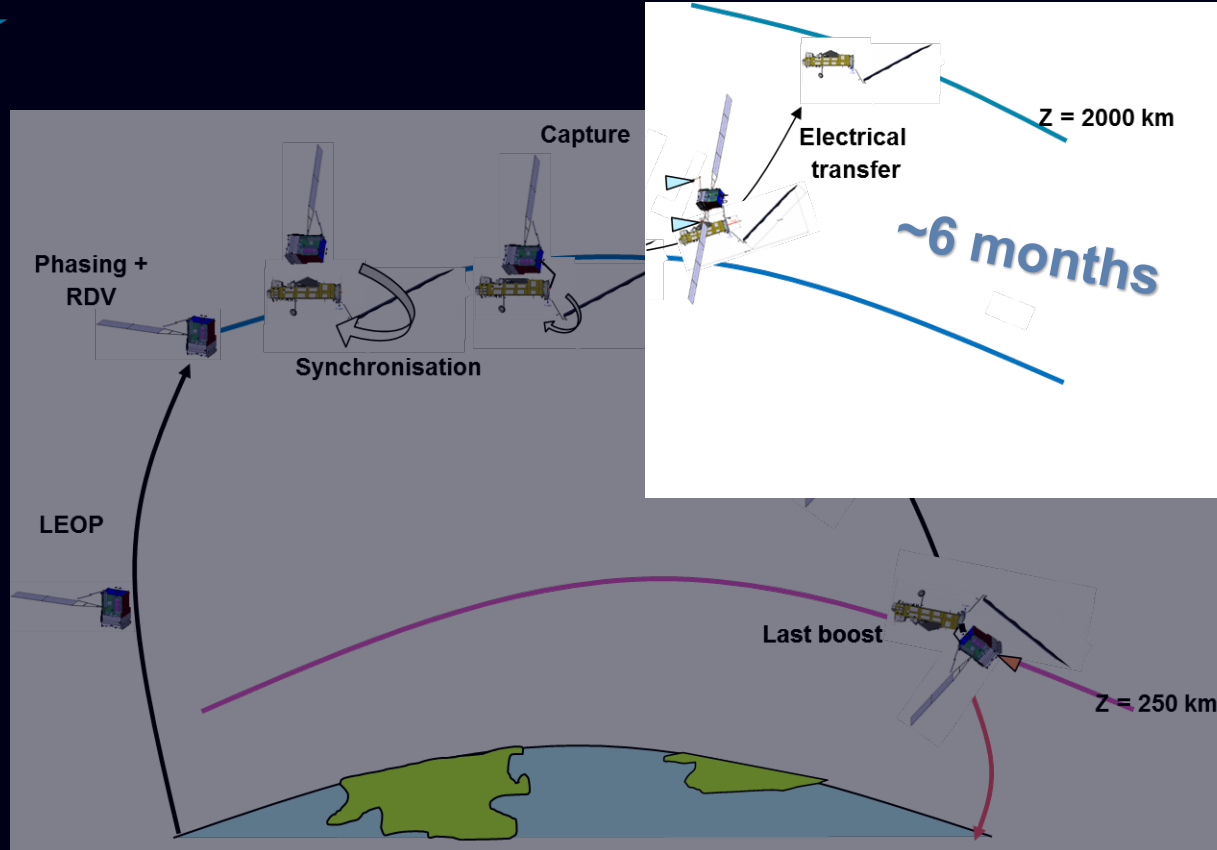


Considered mission scenarios

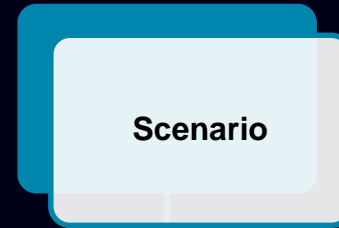


First variant: Re-orbitation scenario (> 2000 km)

- already addressed in e.Deorbit phase A
- re-opened in e.Deorbit ITT
- compliant with IADC rules (TBC)



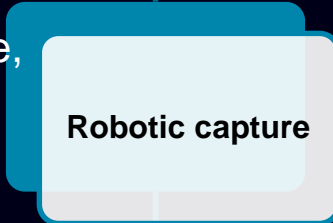
Considered mission scenarios



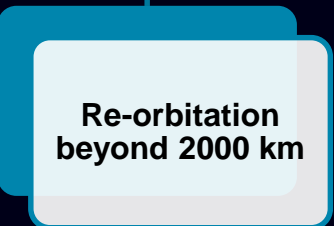
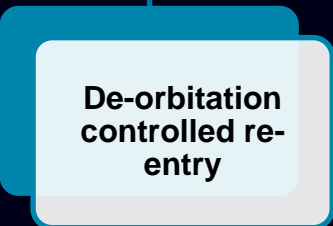
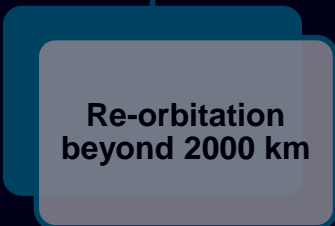
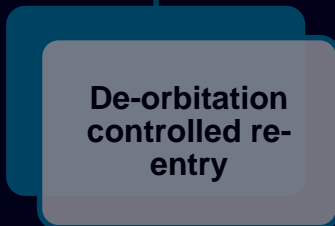
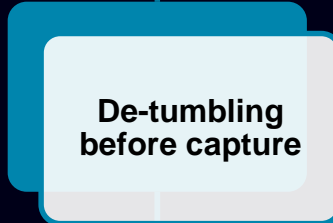
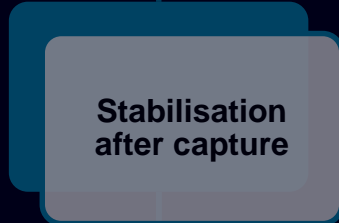
Variant in capture scenario:

active de-tumbling of Envisat prior to capture,

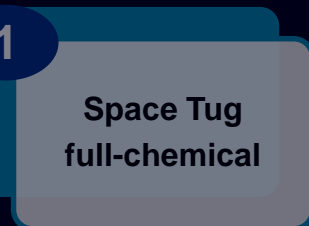
- in order to mitigate risks
- and potentially reduce costs



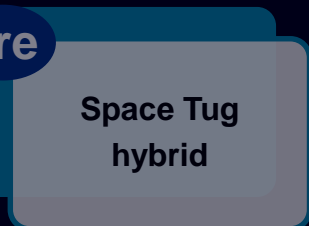
Use of either chemical or electrical propulsion:



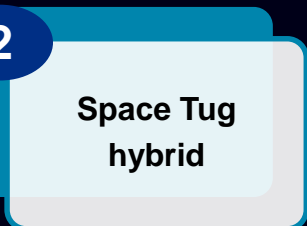
1



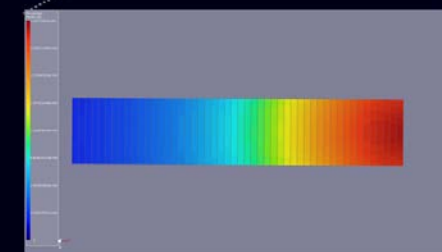
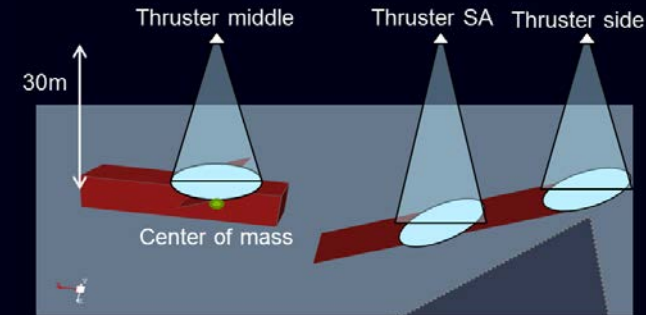
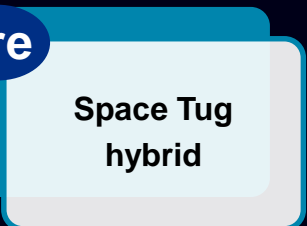
1re



2

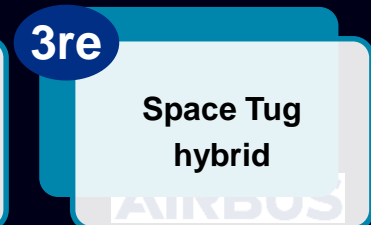
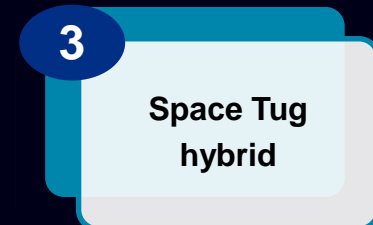
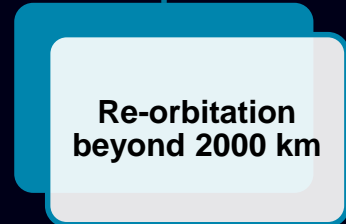
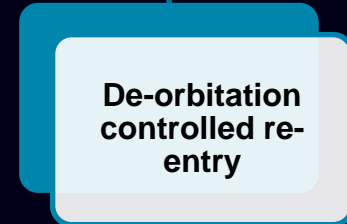
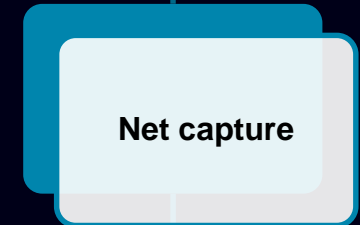
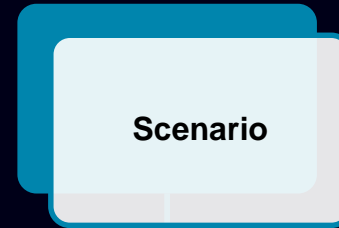


2re



duration: a few hours

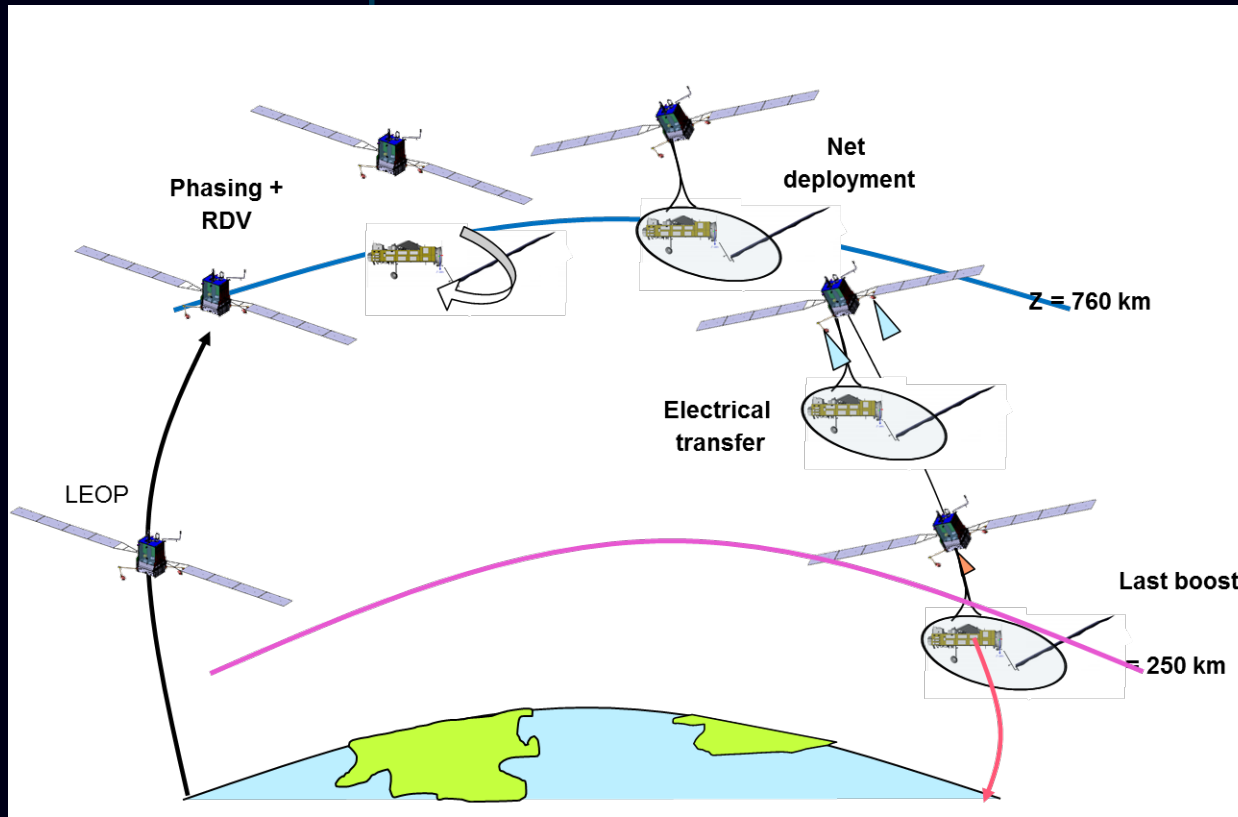
Considered mission scenarios



Other variant in capture scenario:

capture by net then tether control
(stabilisation of composite via flexible link)

- option addressed in e.Deorbit phase A
- modification of risks related to capture



Space Tug adaptations required for Envisat mission

Ful GEO-Tug reuse

Adaptations

Envisat mission specific

Scenario 1 – e.Deorbit reference mission

Full Chemical variant of Space Tug is required:

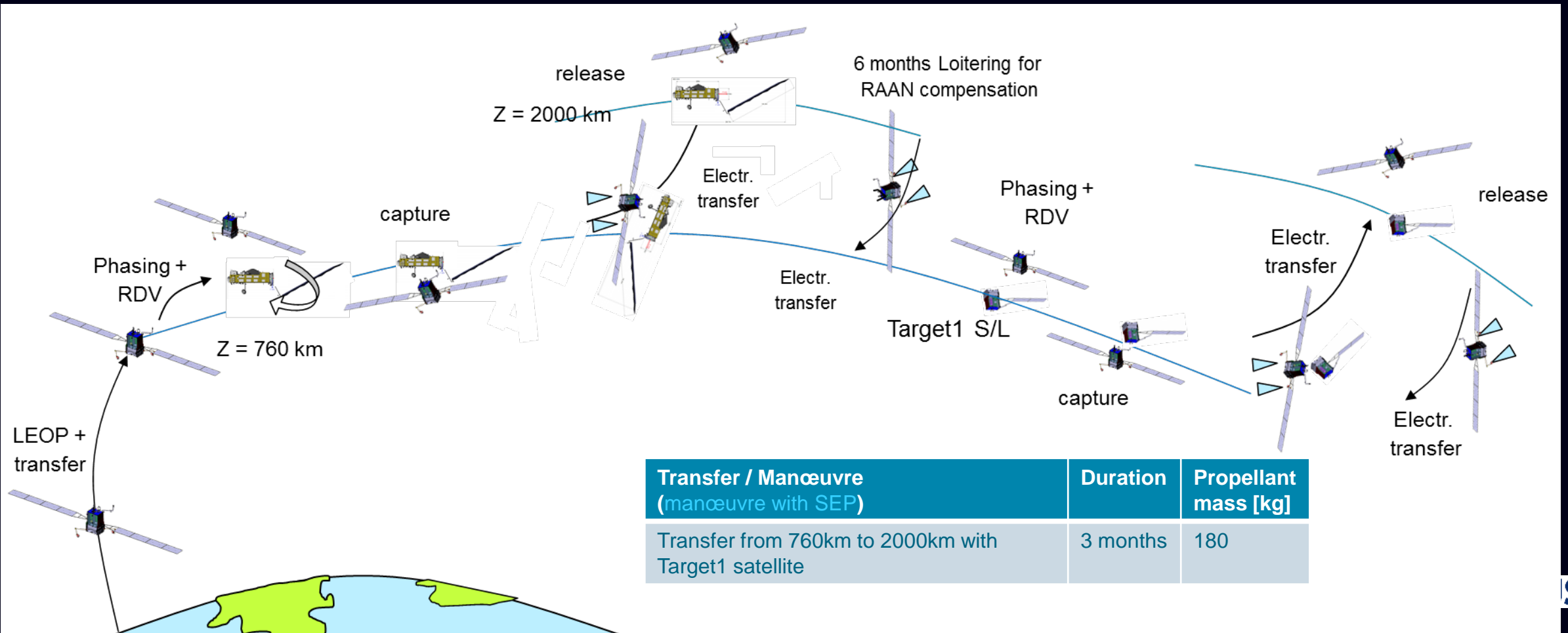
Scenarios 2 & 3

Hybrid variant of Space Tug is suitable:

Multi-debris scenarios – example with re-orbitation

Scenario involving other debris re-orbitation, on top of Envisat:

- Extra propellant mass still compatible with tank capacity of design previously described



Space Tug for Envisat debris removal – Synthesis

❑ Various scenarios feasible with adapted Space Tug, thanks to its flexibility

- Level of adaptations and re-use from GEO Tug depends on the scenario
- Yet, impact on launch scenario, as platform is heavier and larger than current e.Deorbit baseline

❑ Timeframe for development is compliant with target date for the mission

❑ Costs considerations:

- Depending on launcher scenario, significant reduction can be reached on overall mission cost (i.e. total PFM + launch)
- Cost per mission can be even decreased with a scenario involving several debris removal, which is meaningful for the Space Tug concept

❑ Synergies btw Space Tug and Envisat mission to be further detailed in the frame of next e.Deorbit study

Thank you