ESA Platform Activities

Clean Space Days 2024

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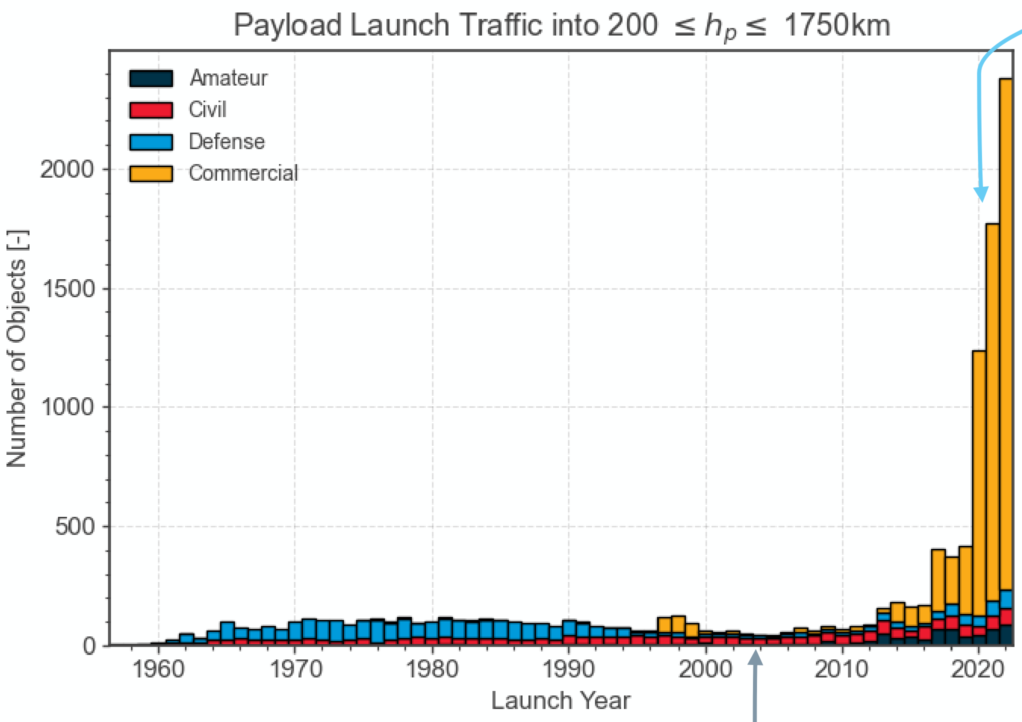
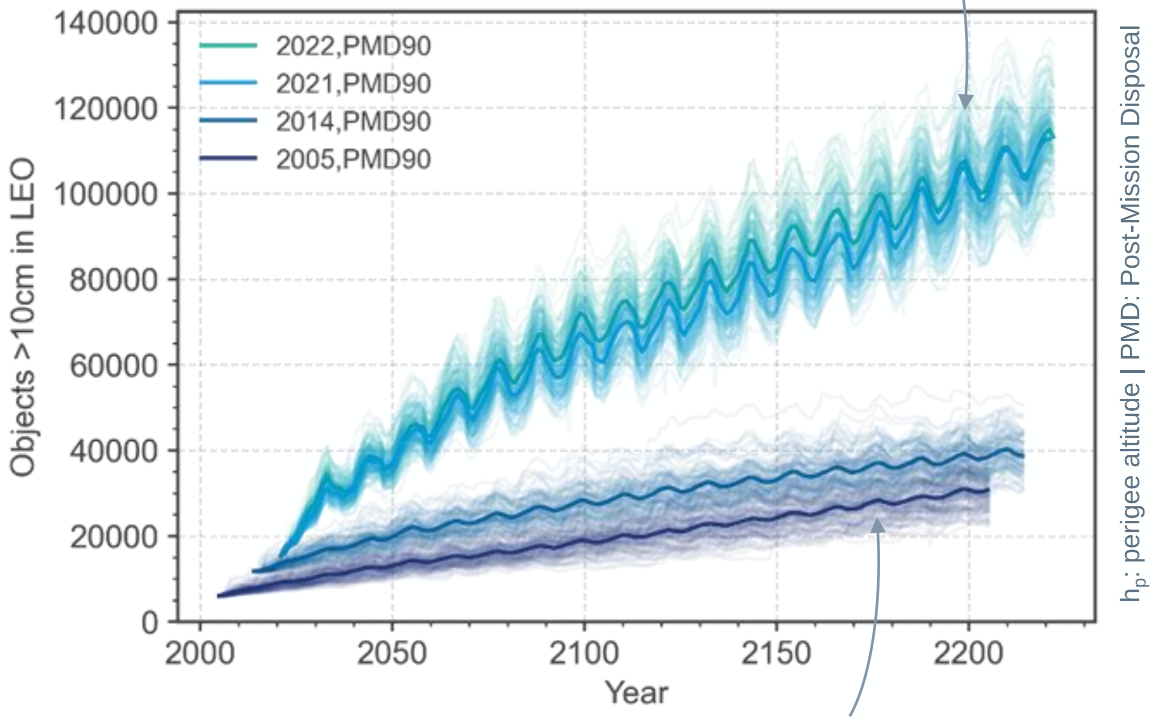
09/10/2024

Why do we need a new approach to mitigation?

What the 25-year rule means now: is this acceptable?





What the 25-year rule meant when IADC drafted their recommendation

ZERO DEBRIS APPROACH | ESA's bold vision to significantly limit the production of debris in Earth and Lunar orbits by 2030 for all future missions, programmes and activities.

Zero Debris Scope

Developing ESA Zero Debris approach

Engaging partners, building a community

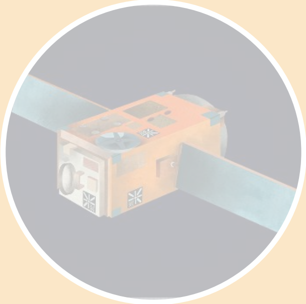
ESA SDM Policy & Standard

Technical requirements for ESA missions and contributions

ESA Technical Developments

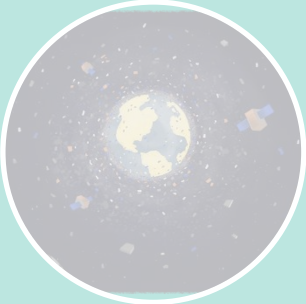
ESA support to industry's transition and compliance to SDM standards

Zero Debris Technology Booklet



Crowd-sourced technical solutions to reach Zero Debris targets by 2030

Zero Debris Charter

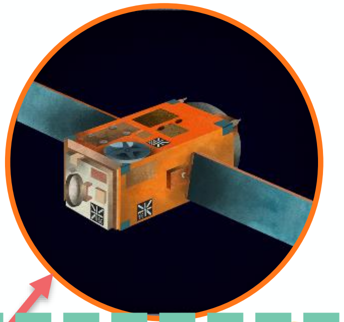


Jointly defined principles and targets for long term space sustainability

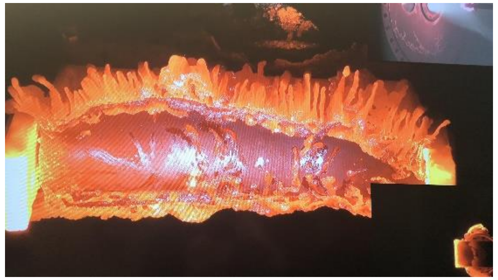
ESA technical developments

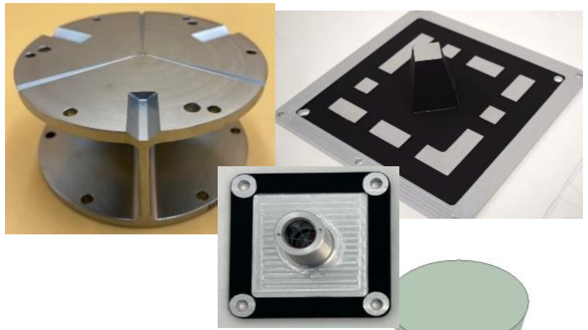
ESA Zero Debris implementation for future missions relies on a roadmap of key technical developments:

Policy Evolution



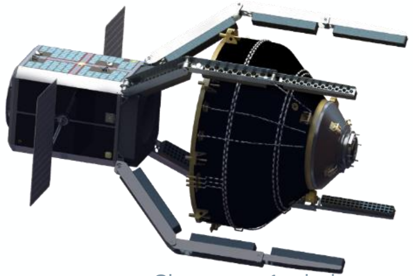
Zero Debris compliant spacecraft platforms



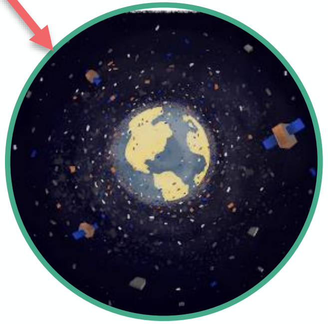


Credits: GMV/AVS

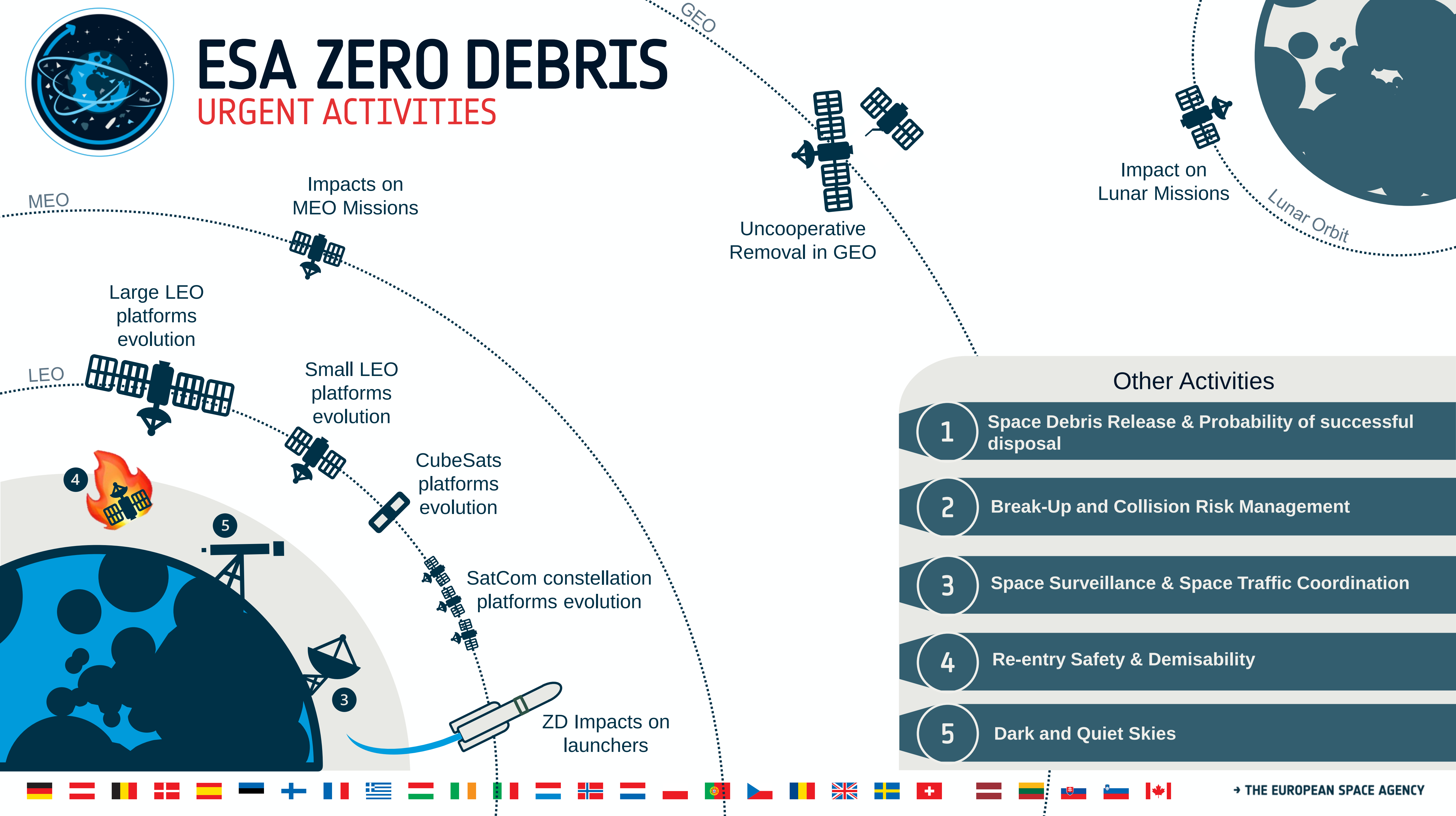
Development & Demonstration of Removal Services



Clearspace-1 mission



Technology improvement for SST and collision avoidance


ESA ZERO DEBRIS
URGENT ACTIVITIES
GEO
MEO
LEO
Lunar Orbit
Impacts on MEO Missions
Uncooperative Removal in GEO
Impact on Lunar Missions
Large LEO platforms evolution
Small LEO platforms evolution
CubeSats platforms evolution
SatCom constellation platforms evolution
ZD Impacts on launchers
4
5
3
Other Activities
1 Space Debris Release & Probability of successful disposal
2 Break-Up and Collision Risk Management
3 Space Surveillance & Space Traffic Coordination
4 Re-entry Safety & Demisability
5 Dark and Quiet Skies
→ THE EUROPEAN SPACE AGENCY

Scope of platforms evolution

For these 3 goals, 5 objectives were identified:

Zero Debris Platforms

1 Simplify End of Life

2 Understand & avoid failure

3 If failure, reduce risk

Fully demisable LEO platforms (LEO)

Reduce the on-ground casualty risk and simplify EoL management

Reliable disposal strategy (LEO, MEO, GEO, Lunar)

Deorbiting strategy to comply with 5 years (LEO)

Modular implementations of controlled re-entry (LEO)

System resilience (LEO, MEO, GEO)

Anticipate and avoid spacecraft failure in-orbit and support decision making

Platform robustness to debris impacts

Mitigatory operations (LEO, MEO, GEO)

Collision avoidance manoeuvring procedures and capabilities

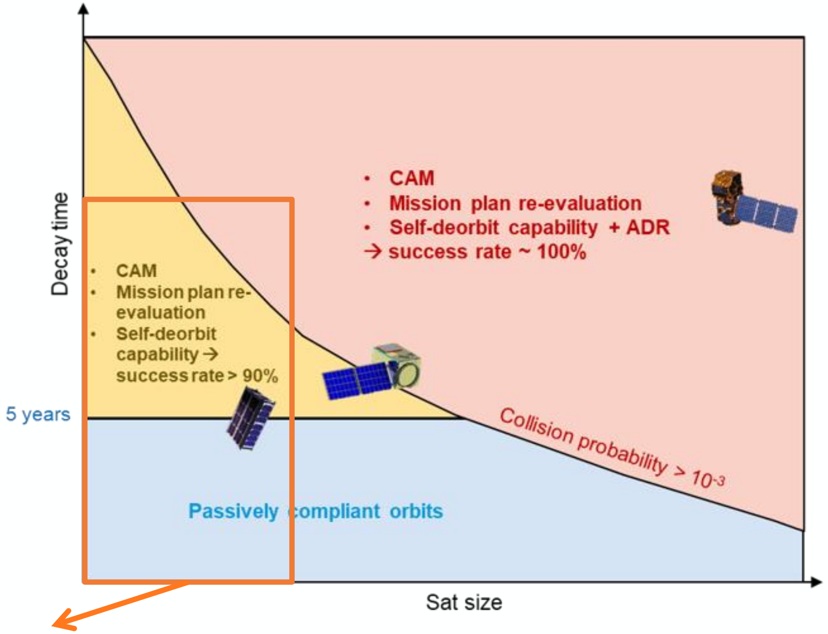
Limit debris generation in case of failure in-orbit (e.g. passivation)

Design for Removal (LEO, MEO, GEO)

Ease removal by external servicer and decrease associated costs

+ Dark & Quiet skies design solutions

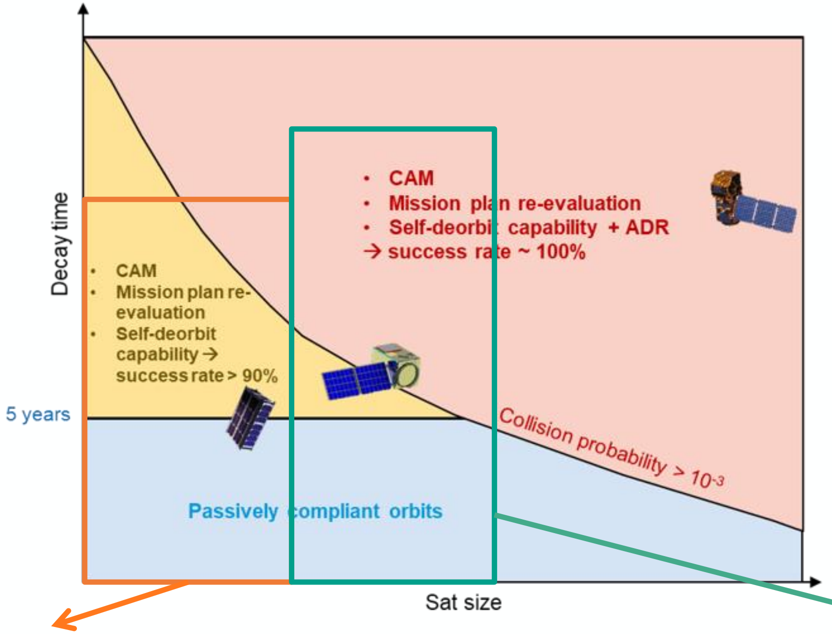
Overview of platform challenges



Cubesats <50kg

- Deorbit to ensure decay within **5 years**
  - Passively compliant
  - Reliable deorbiting technologies (e.g. propulsion, passive systems)
- **Passivation** solutions for Cubesats
- Monitoring of **probability of successful disposal**
  - Gathering of lessons learned on COTS and recurrent units
- **Collision risk management:**
  - Trackability and identification up to 1 day after injection
  - CAM capability and procedure (timeline, risk threshold, etc)

Overview of platform challenges



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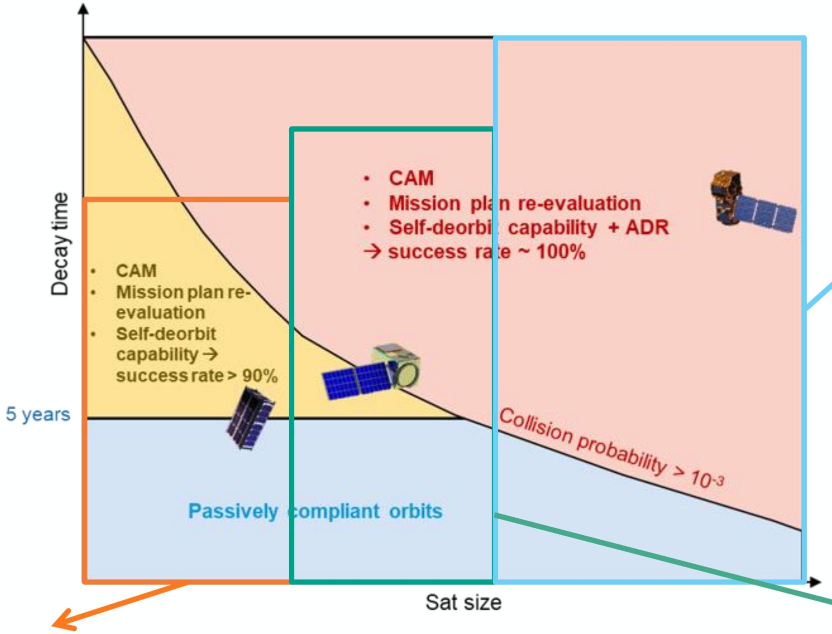
Smallsats < 500kg

- Deorbit to ensure decay within **5 years**
  - Reliable deorbiting technologies
- **Improved re-entry assessment + D4D**
- Monitoring of **probability of successful disposal**
- **CAM process**:
  - CAM capability and procedure (timeline, risk threshold, etc)
  - Inclusion of a space surveillance segment
  - Sharing of ephemerides
- **Design for Removal**

Overview of platform challenges



Large platforms > 500 kg

- Deorbit to ensure decay within **5 years + cumulative collision probability**
- **Improved re-entry assessment + D4D**
- **Modular controlled re-entry**
- **CAM process**: best practices implementation
- **System resilience:**
  - Enhanced Health monitoring for disposal functions
  - PF robustness to debris impacts
- **Design for Removal :** both cooperative and uncooperative modes

Cubesats <50kg

- Deorbit to ensure decay within **5 years**
  - Passively compliant
  - Reliable deorbiting technologies (e.g. propulsion, passive systems)
- **Passivation** solutions for Cubesats
- Monitoring of **probability of successful disposal**
  - Gathering of lessons learned on COTS and recurrent units
- **Collision risk management:**
  - Trackability and identification up to 1 day after injection
  - CAM capability and procedure (timeline, risk threshold, etc)

Smallsats < 500kg

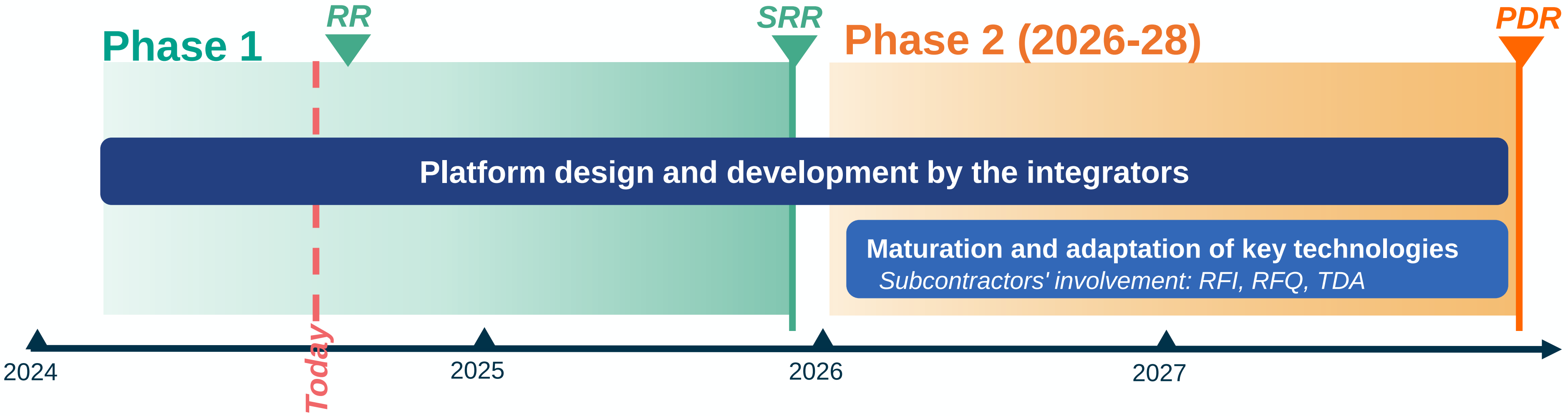
- Deorbit to ensure decay within **5 years**
  - Reliable deorbiting technologies
- **Improved re-entry assessment + D4D**
- Monitoring of **probability of successful disposal**
- **CAM process**:
  - CAM capability and procedure (timeline, risk threshold, etc)
  - Inclusion of a space surveillance segment
  - Sharing of ephemerides
- **Design for Removal**

Zero Debris Platform activities

Funded

Funding TBD CMIN25

Large LEO platforms



- **3 parallel contracts with the primes**
- **2.7M** co-funded by **OPS – S2P COSMIC**, and **by EOP**
- **Scope:**
  - Definition of platform design evolution up to SRR
  - Preliminary trade-offs
  - Preliminary suppliers consultation and development of roadmap for phase 2

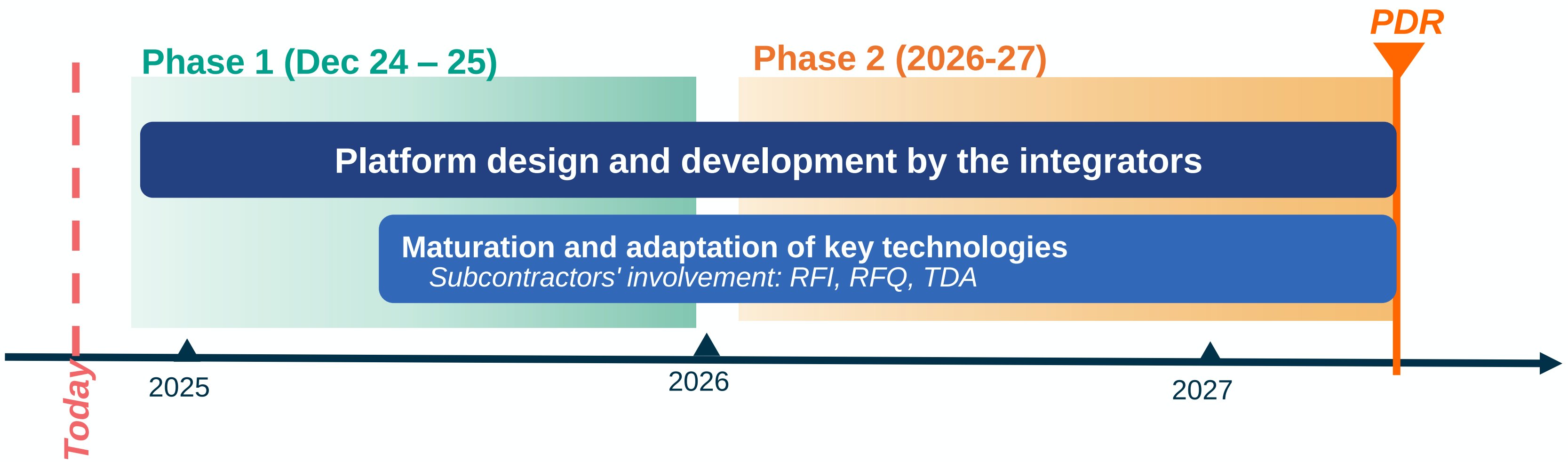
- **3 parallel contracts with the primes**
- **TBD M€ per contract**
  - **50%** of the budget: **work with subcontractors** for maturation and adaptation of **key technologies**
- **Scope:**
  - Implementation of platform design evolution up to PDR
  - Technical developments and technology adaptation/maturation

Zero Debris Platform activities

Funded

Funding TBD CMIN25

Small platforms



- **Up to 3 parallel contracts – open competition →** ITT closure 18/10/24
- **1.2 M** co-funded by **OPS – S2P COSMIC**, and **by EOP**

- **3 parallel contracts**
- **TBD M€ per contract**

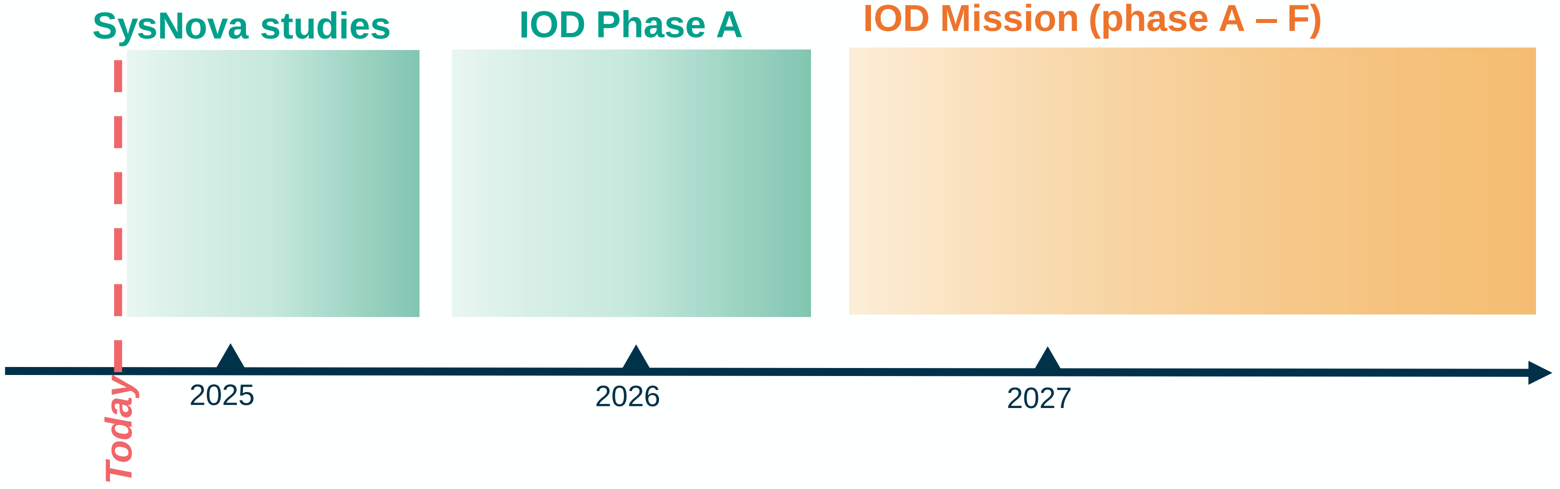
- **Scope:**
  - **50-500kg** satellites
  - Assess Impacts of Zero Debris on small satellites in Earth Orbits
    - Evolution of platform up to PDR
    - Identification and development of building blocks for smallsats

Zero Debris Platform activities

Funded

Funding TBD CMIN25

Cubesat IOD



- **5-8 parallel studies**
- **100k** per study

- **2 parallel contracts**
- **250k** each

- **1 IOD mission**
- **TBD M€** in total
  - 1 M (TBC) funded by ESA
  - Co-funding needed

Scope:

- Zero Debris system concepts for **1-16U Cubesats in LEO**
- Demonstration of **Zero Debris capabilities for Cubesats**
- **Commercial opportunity for IOD –** identification of customer for primary passenger/payload

Satcom constellations - challenges

Satcom constellations

- Deorbit to ensure decay within **5 years**
- Monitoring of **probability of successful disposal**
  - Limit **intra-constellation collision risk** in case of unsuccessful disposal
- **Improve collision avoidance**
  - Automation : reduce operator burden
  - Coordination : reduce interruptions
  - Accuracy & Knowledge : reduce risk
- **System resilience** :
  - Limit failures in orbit
- **Improved re-entry assessment + D4D**
- **Design for removal**
  - interfaces for constellation / standardization

→ Upcoming activities on that topic

Zero Debris Thresholds Activity

- Study to understand **system impacts** of **future evolutions of numerical thresholds present in Zero Debris policy,** e.g.
    - 10^{-3} Cumulative Collision Probability
    - 5-year orbital lifetime
    - Vulnerability aspects
- Definition of **achievable targets for 2030**
- Analysis to be backed by **long-term simulations of the orbital environment,** traded-off against the **impact on mission design**

Satellite Test Cases

1. GEO
2. MEO
3. LEO Constellation
4. Medium-Size LEO
5. Small LEO
6. LEO CubeSat

Trade-off and selection of thresholds and requirements evolution

Conclusions and way forward for Zero Debris thresholds

Verification methods

Critical analysis of Zero Debris thresholds

Impact assessment of thresholds on the **Orbital Environment**

Impact assessment of thresholds on **Mission Design**

Commercialisation analysis

Jul 2024

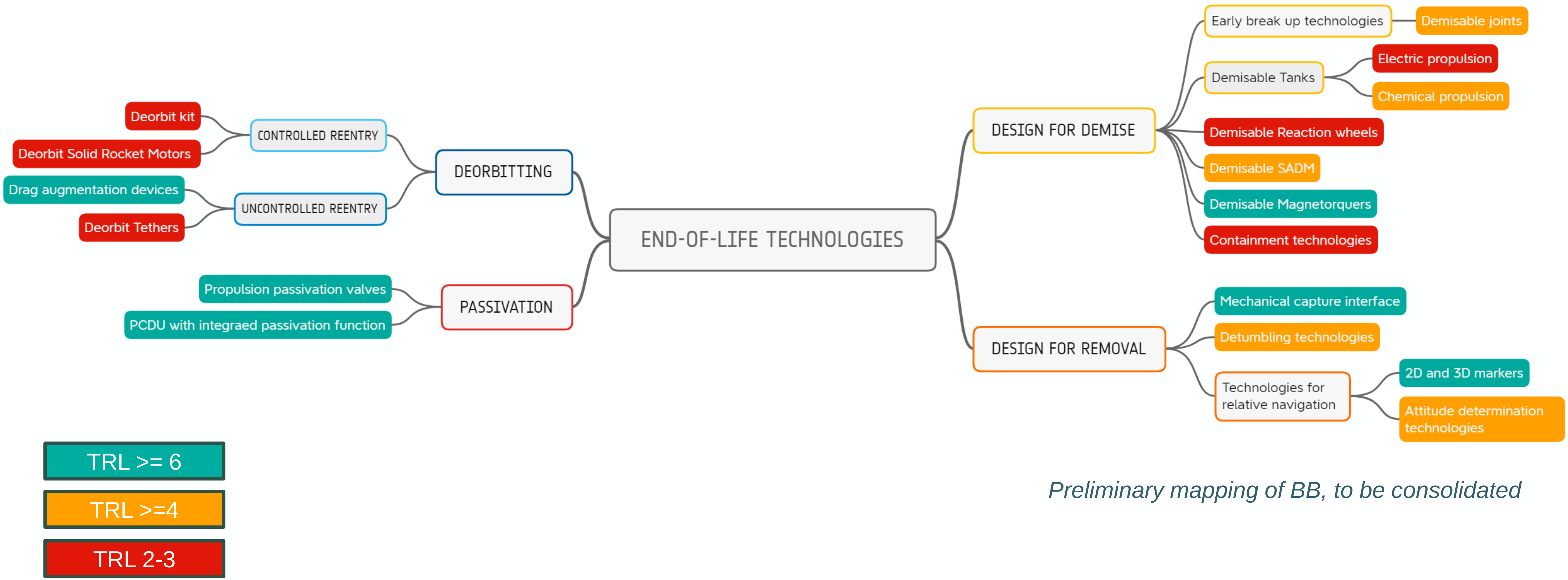
Today

2025

Mid-2025

Maturation of key building blocks

- In parallel of all platform activities, maturation of key building blocks is needed → Opportunity for suppliers



Preliminary mapping of BB, to be consolidated

Beyond 2025 - Zero Debris Workplan for CMIN25

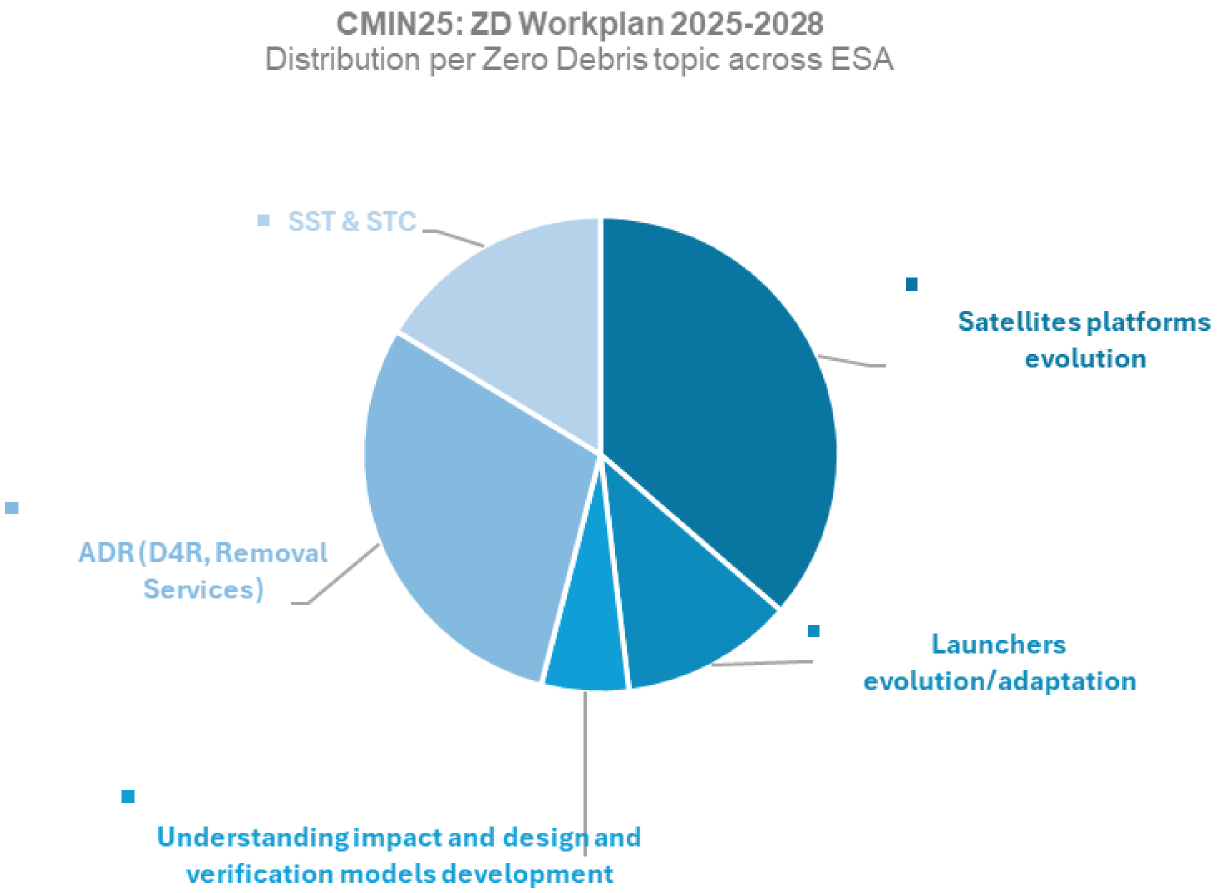
Satellites platforms evolution
- System level integration & validation aspects
- Reliability and resilience of disposal systems
- De-orbiting Systems
- Passivation Systems
- D4D
- Dark and Quiet Skies

Launchers evolution/adaptation

Understanding impact and design and verification models development
- System studies
- Reliability and resilience
- Passivation
- D4D
- Dark and Quiet Skies
- Impacts of spacecraft re-entry on the Earth's environment

ADR (D4R, Removal Services)
- D4R
- Removal Services (CAT, multi-debris removal studies, debris removal in protected regions…)

SST & STC



During these Clean Space Days,
we invite you, the industry, to communicate your ideas
on this Zero Debris Workplan 2025-2028

Conclusions

- ESA supporting the transition towards **Zero Debris for 2030**:
  - Integration of key ZD technologies at system level in future European platform products
  - Non-recurrent costs linked to Platform evolutions
- Upcoming Opportunities for **technical developments** (e.g. D4D, D4R, deorbiting and passivation technos, health monitoring solutions, etc):
  - As part of Platform activities
  - As stand-alone R&D activities to complement
- **Collaborative effort needed**:
  - Encouraging Integrators to **adopt** ZD technologies
  - ZD technology suppliers to **adapt** their products to Integrators needs

- Upcoming **CMIN 2025**: it's time to open up the discussion and anticipate future needs

Thank you for your attention.
Any questions ?