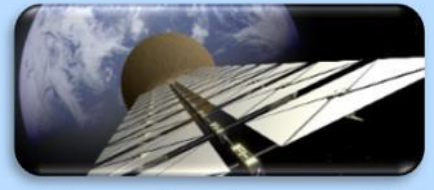
ISAM at ESA

Bérengère Houdou
Head of Space Safety Missions Implementation
ESA Operations Directorate

16/09/2025

In-Space Servicing, Assembly & Manufacturing (ISAM)

Product Use Location	Servicing Location: Orbit	Servicing Location: Planetary Body
Space	 **On-orbit manufacturing, assembly, refurbishment, repair, recycling, refuelling, inspection, life extension, relocation of spacecraft. Storage, active debris removal**	 Manufacturing, assembly, refurbishment, repair, recycling of space infrastructure on planetary bodies, including by ISRU
Earth	 In-space manufacturing of products for commercialisation on Earth (e.g. semiconductors, optical fibres, pharmaceuticals)	 Extraction of space resources from planetary bodies for commercial use on Earth

ESA Context

European Space Agency

ESA's roles in the frame of ISAM

- Support activities to unlock the potential of ISAM
- Facilitate the emergence of a new market
- Support the associated technical and legal framework
- Support the establishment of European standard interfaces

ISAM Working Group across the Agency to map activities, create roadmaps, consolidate a coordinated vision and provide recommendations for the future

ESA's Long-term Objectives for ISAM

Sustainability

- Implement the 4 Rs of in-orbit servicing: Remove, Reuse, Refurbish and Recycle
- Interconnected systems able to dispose and store parts/materials and manage waste including debris removal

In-Orbit Logistics

- In-orbit refuelling and fuel depot facilities to enable long-distance space transportation
- In-orbit logistics elements and hubs for transportation and storage

New Mission Concepts

- Demonstration of in-orbit Assembling and Manufacturing of very large antennas, optics and telescopes
- Development of modular platforms that can be refurbished and that can host multiple payloads

ESA Internal Roles

IOS/ISAM services development programmes: Space Safety (S2P) and InSPoC (STS)

- **Space Safety Program (S2P):** Validation directly with customers to develop commercially viable in-orbit services and enable circularity /sustainability in use of assets
- **InSPoC (STS)** : Validation of operational capabilities to develop an in-space transportation & logistics architecture.

IOS/ISAM technology development: main actors TEC, CSC, S2P

IOS/ISAM users: CSC, EOP, NAV, HRE, SCI

ISAM

Current overview of main missions at ESA

DEBRIS REMOVAL

ClearSpace-1 (S2P)

ELSA-M (CSC)

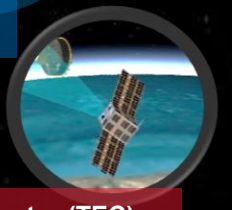
CAT-IOD (S2P)

ERASE (S2P)

TRANSPORTATION

InSPoC-1 (STS)

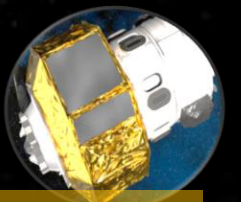
INSPECTION



e.Inspector (TEC)

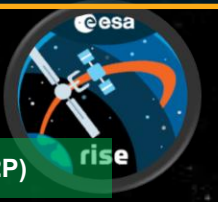
REFILLING

InSPoC-2 (STS)



ESPRIT – ERM (HRE)

Life Extension / AOCS Takeover



RISE (S2P)

ENCORE (S2P)

On-Board Autonomy

InSPoC-3 (STS)

STORAGE

InSPoC-4 (STS)

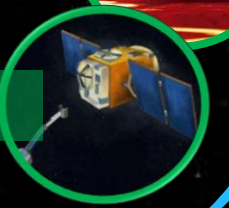
FUEL DEPOT

Odyssey (STS)

CIRCULARITY

REFURBISHMENT

RECYCLING



MANUFACTURING

And more missions will be prepared and implemented…

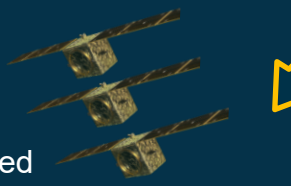
ISAM Architecture

Servicing
Providing Commercial and governmental services

- **Active Debris Removal**
- **Life Extension**
- **Refurbishment & Upgrade**

ORUM | CAT-IOD | ELSA-M | RISE | ERASE | ENCORE

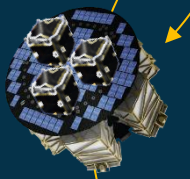
Hosting
Providing supply for docked commercial and governmental servicer and logistic spacecraft, hosting and distributing peripherals, IOD/V experiments, propellant



- **IOD/V**
- **In-orbit infrastructure**

InSPoC-4 | ODYSSEY

Logistics
Transporting cargo and supplies, disposal of old cargo, providing transport services to spacecraft



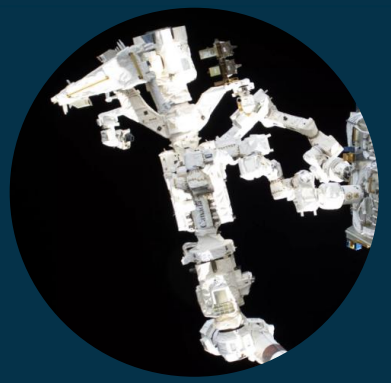
- **Transportation**
- **InSPoC**

InSPoC-1 | InSPoC-2 | InSPoC-3

- Refurbishment & Upgrade
- Modular platforms

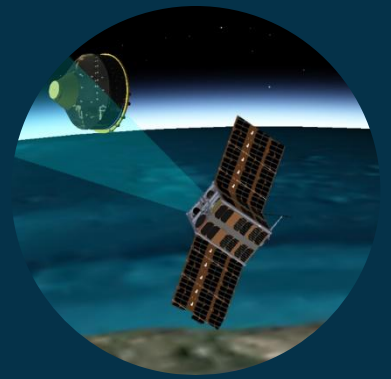
Expanding
Building an ecosystem of functional satellite upgrades (plug'n'play peripherals)

Key Enabling Technologies



Advanced Space Robotics, GNC and Autonomy
In-Orbit Servicing missions rely on autonomous GNC and robotic capabilities to capture, manipulate, and service space objects.

Modular Spacecraft
Refurbishing and upgrading spacecraft will require new modular architectures with containerised subsystems or payloads



In-Orbit Verification
The creation of structures and satellites in orbit will require new approaches to verification and testing.

Standardised Interfaces
Standardised interfaces between subsystems and between payloads and platforms will be required to achieve modular spacecraft and reduce the complexity of services

ISAM Acceleration Platform

Multi-directorate ESA ISAM acceleration platform to be established

Objectives

- Develop a marketplace for ISAM, organize B2B workshops and an annual ISAM conference
- Boost ESA support and involvement with commercial initiatives
- Foster international collaboration
- Establish knowledge sharing platforms for the community and promote European developments worldwide
- Support a coordinated development and exploitation of ISAM-dedicated test facilities, ensuring commercial and technical relevance (based on offer and demand), through complementarity

ESA Operations Directorate:

ISAM & the Space Safety Programme (S2P)

Bérengère Houdou
Head of Space Safety Missions Implementation
ESA Operations Directorate

16/09/2025

ADRIOS Cornerstone of S2P (OPS Directorate)

ADRIOS - Active Debris Removal and In-Orbit Servicing – missions:

- driven by industry who sees promising commercial services applications,
- while serving the objectives of ESA (and of potential other institutional customers) to avoid harmful debris and improve space sustainability.

Progressively deployed and complemented over the periods of the S2P programme in order to:

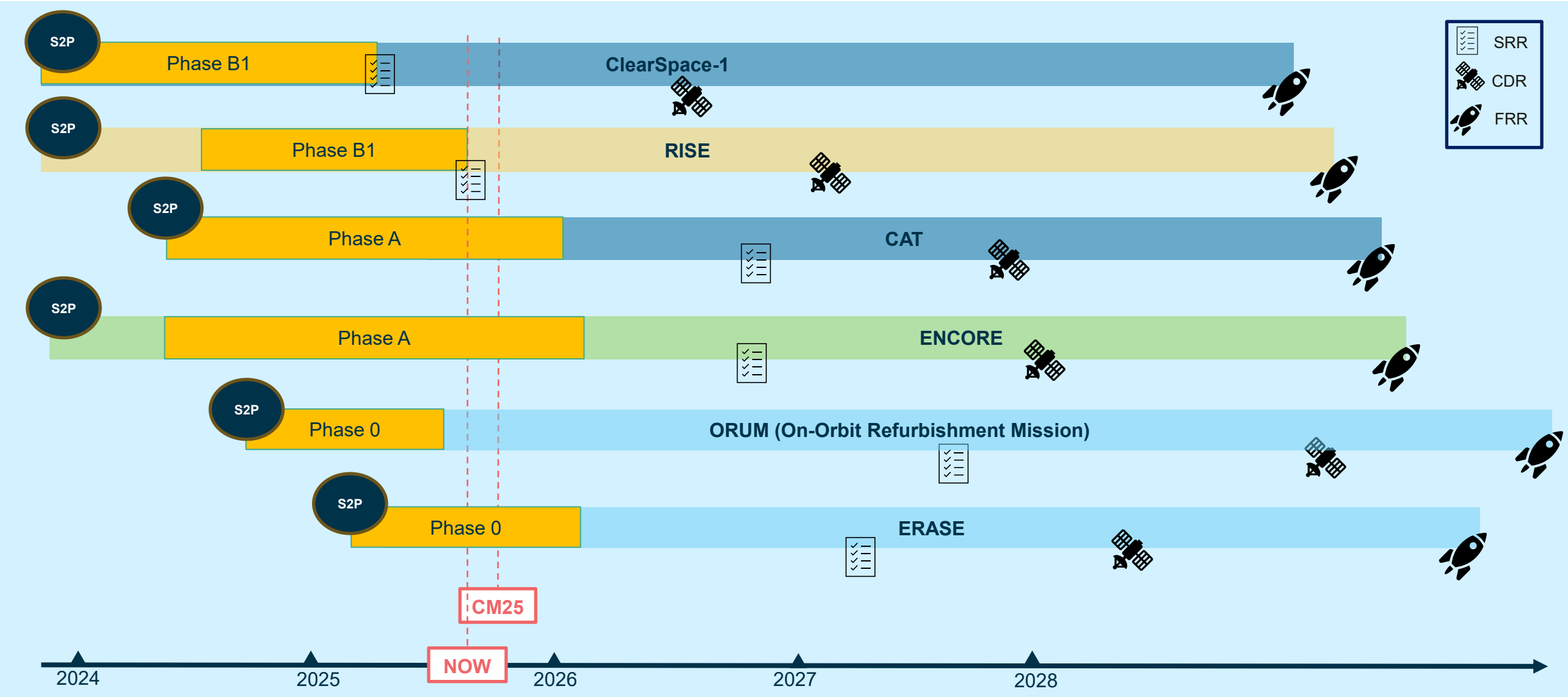
1. Establish a broad spectrum of capabilities and technical solutions in Europe for Active Debris Removal and In-Orbit Servicing of various types of satellites, noting the technology synergies between the two
2. Encourage the development of European end-to-end services in those two fields
3. Prone new markets with multiple types of customers and needs, and then support their maturation, in Europe and worldwide
4. Support a competitive industry, including the supplier chain.

ADRIOS programmatic element of S2P: covers mission implementation (Phase B/C/D), once adopted following mission study in the COSMIC element of S2P.

S2P COSMIC – Developing future ISAM services

- Study of new ISAM mission concepts
- Preparation of Future ISAM missions
  - Circular Economy Calls
  - Selection and preparation of ISAM missions up to SRR (e.g. ORUM, ERASE)
  - Maturation of missions and consortiums for adoption at Ministerial Council
- ISAM Technology Development
  - Robotics Payloads, GNC, Standardized Interfaces, CPO guidelines, etc.
- ISAM Acceleration Platform
  - Focal point for collaboration with commercial initiatives and international partnerships
  - Support commercialisation of new services, in collaboration with user-programmes
  - Knowledge sharing, promote standard

S2P ISAM Missions Roadmap



S2P ADRIOS: ClearSpace-1 Mission Summary

ClearSpace-1 aims to aims to actively remove an ESA legacy space object from Low Earth Orbit (LEO) – now PROBA-1 .

- First mission to remove an ESA-owned object, unprepared and uncooperative
- Complex rendezvous and capture in LEO due to dynamics and illumination conditions
- Change of object to be removed from VESPA to PROBA-1
- Standard ESA development contract for an In-Orbit Demonstration Mission
- No co-funding
- OHB DE as Prime and CS CH as mandatory subcontractor

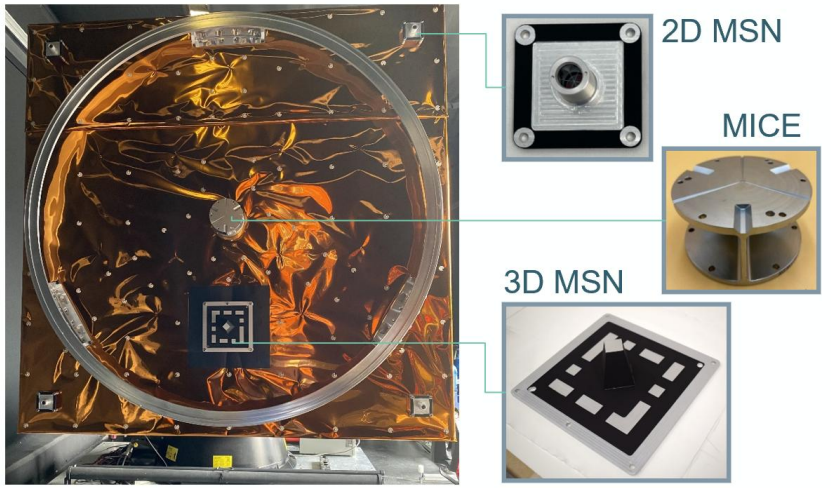
S2P ADRIOS: RISE Mission Summary

RISE aims to bring together a service provider and a customer for the verification of life extension of a satellite through Attitude and Orbital Control Takeover (AOCS Takeover) in geosynchronous graveyard orbit (GGO).

- Industry led mission – industry defining the mission and system requirements
- Through RISE, D-Orbit aims to develop a recurrent service
- End-to-end contract covering Phase A to E (Currently Phase B1)
- 20% co-funding
- Following the verification in graveyard orbit, ESA role ends, industry to continue with commercial service
- First European Mission for AOCS Takeover in Europe
- Requires cutting edge technology for rendezvous and capture, driving the critical path/schedule
- Requires customer (i.e. existing telecom operator) participation in development, and customer satellite in GGO, baseline today is Eutelsat.

CAT – Demonstration of ADR of prepared satellites

Major step towards Zero Debris Policy by 2030



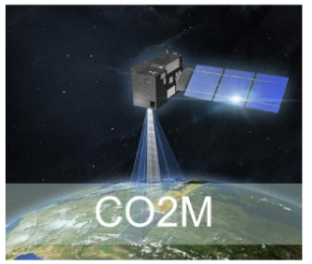
Key objectives for CAT-IOD:

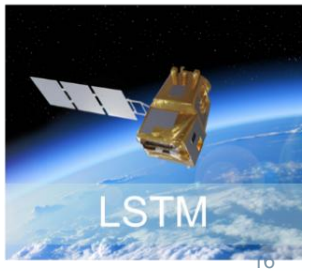
1. **In-Orbit Verification of the D4R Standard Interface**
2. **Demonstration of End-of-Life (EoL) Removal Operations**
3. **Demonstrate of Active Debris Removal (ADR)** and robustness of the CAT Payload system
4. **Derisk for Future ADR and Servicing Missions**

First potential users

Copernicus Expansion missions (CHIME, CO2M, CRISTAL and LSTM – at least 9 satellites) pioneers in the implementation of standardised removal interfaces.

→ The first satellite, CO2M-A, to be launched in 2026, CO2M-B 6 months later.





S2P ISAM-related Budget

Request: 190 MEuros

	CM22	CM25	CM28
ADRIOS element: Mission implementation	ClearSpace-1 RISE ENCORE	RISE CAT	ERASE CE1 - ORUM
COSMIC element (part): Mission preparation & Technos	CAT	ERASE CE1 - ORUM + techno development	CE2

Request: ~25 MEuros

THANKS

Backup slides

ADRIOS Participants Workshop

Remote meeting

19/0/2025

ADRIOS Cornerstone of S2P: General

Essential that ADRIOS evolves in Period 3 considering:

- Lessons-learned from set-up and early phases of ClearSpace-1, RISE and ENCORE
- Latest implementation schemes and status of the already on-going missions
- High complexity of those types of mission (technical, industrial, operational, legal)
- Growing industry interests in ADR/IOS and the orientation of the S2P programme towards industry-driven initiatives with a commercial perspective
- Growing interests in general of ESA Member States and many institutional actors (e.g. national agencies, EC, Eumetsat), noting the potential synergies with dual-use applications
- Need for flexibility and adaptability to multiple types of actors and implementation schemes
- Need for reactivity to changes along the projects since the field is very dynamic

ADRIOS to move progressively towards a portfolio of missions, bringing programmatic consistency to this segment of S2P, in close coordination with COSMIC for their preparation.

ClearSpace-1 Mission Summary

ClearSpace-1 aims to aims to actively remove an ESA legacy space object from Low Earth Orbit (LEO) – now PROBA-1 .

- First mission to remove an ESA-owned object, unprepared and uncooperative
- Complex rendezvous and capture in LEO due to dynamics and illumination conditions
- Change from the initial “service contract” to an ESA development contract
- Change to an In-Orbit Demonstration Mission
- No co-funding anymore
- Change from an end-to-end contract covering Phase A to E to a phased approach
- Change of industrial consortium with OHB DE as Prime and CS CH as mandatory subcontractor
- Change of object to be removed from VESPA to PROBA-1

ClearSpace-1 OHB Proposal

- Phase B2/C/D/E proposal evaluated not acceptable
  - Complex consortium and responsibilities sharing; intricated work logic
  - Inconsistencies between contractors' levels
  - Criticality of payload TRL raising plan
  - Trade-offs at system level not all fully justified
  - Phase B2 very much front-loaded
  - High overall effort
- CCB currently paused
- Several management meetings with OHB and CS held last week

- **Way forward under discussion:**
  1. **Start immediately a "payload-centric" phase**
  2. **In parallel, ask OHB for an updated offer**

ClearSpace-1 Current Status

- OHB
  - Is ready to radically re-think the technical solution and industrial setup, together with ClearSpace
  - A technically optimised approach might not fit with the current CaC
- Clearspace
  - Is open to consolidate TRL raising plan, re-consider critical suppliers and to restructure costs
- Specific workshop organised next week with CS CH&UK, OHB and ESA to agree on the scope <-> duration <->budgetary envelope

GOAL:

Propose the payload-centric phase for approval to SSA PB, ideally at the 4-5 June PB, more realistically at an ad-hoc PB in the course of June, including a pre-ATP for a commitment beginning of July.

Note: the co-primeship scheme would still be the contractual tool

ClearSpace-1 Funding Overview		
CaC	**159 M€**	*To be revised*
Subscribed in P1 & P2	159 M€	
CM25	-	
CM28	tbc M€	

ClearSpace-1 Envisaged Payload-Centric Phase Objectives

- Maturity raising of the payload critical technologies/equipment/functions with a target to reach TRL 6 (from a HW&SW point-of-view) – following a similar “payload-first” approach as in EOP
- Progress on the payload design
- Specific support from the Prime to the CS activities above
- Revision of certain trade-offs at system levels, with possible impacts on the platform (e.g. propulsion, OBC)
- Work on platform design to provide reasonable assumptions about platform environment specifications and other inputs needed by the payload to progress
- Consortium organisation optimisation and revision of AIV logic
- Continuity of activities during proposal update preparation and evaluation
- Improvement further the working mode, exchange and visibility between OHB and CS (and ESA)

Benefits:

- **derisking of the payload: highest development risks and on the schedule critical path, contributing to establish a supply chain for ADR/IOS applications**
- **while consolidating the platform design specifically for this type of mission, possibly with a recurrence perspective**

RISE Mission Summary

RISE aims to bring together a service provider and a customer for the verification of life extension of a satellite through Attitude and Orbital Control Takeover (AOCS Takeover) in geosynchronous graveyard orbit (GGO).

- Industry led mission – industry defining the mission and system requirements
- Through RISE, D-Orbit aims to develop a recurrent service
- End-to-end contract covering Phase A to E (Currently Phase B1)
- 20% co-funding
- Following the verification in graveyard orbit, ESA role ends, industry to continue with commercial service
- First European Mission for AOCS Takeover in Europe
- Requires cutting edge technology for rendezvous and capture, driving the critical path/schedule
- Requires customer (i.e. existing telecom operator) participation in development, and customer satellite in GGO, baseline today is Eutelsat.

RISE Indicative Industrial Consortium

Italy:
- DOrbit (Prime, System Engineering..)
- Sitael (Electric propulsion)
- Telespazio (Ground segment infrastructure)
- Refraschini (Structures)

Germany
- DLR(ERCOLE Robot Arm Analysis)
- KINETIK (ERCOLE Robot Arm)
- iBOSS (Robotic Interfaces)
- Other platform equipment (e.g. tank, pressure regulator, reaction wheel)

United Kingdom
- D-Orbit (UK) (Customer acquisition and market analysis)
- CGI (Security Analysis and Security Risk
- Management)
- LMO (Close Proximity Operations sensor selection and analysis)

Switzerland
- Almatech (Mechanisms)

Spain
- GMV (Relative Proximity Operations verification)
- DHV (Solar Arrays)

Belgium
- SpaceBel (Software)
- Scoup (Propulsion elements)

Sweden
- BeyondGravity (OBC)

Poland
- Mechanisms

Denmark

France
- PPU, SADM (ADS)

Still, a number of roles remain open.

Funding Overview		
CaC	**256 M€**	*Including 20% co-funding of D-orbit. Consolidation on-going in the frame of the SRR*
CM22	79 M€	
CM25	128 M€	
CM28	tbc M€	

ENCORE – Status May 2025

ESA Activity

- At CMIN-22 ESA received 42 Meuro for ENCORE
  - ESA released an RFQ for an end-to-end contract in Q1 2023
  - Proposal lacked a platform provider within the geo-return constraints.
- ESA issued the Phase A ITT (1.9 Meuro) in November 2023 aimed at consolidating the platform.
  - Procurement was slowed down due to parallel discussions about Clearspace-1.
  - Negotiations were initiated in April 2024 with an open point on the platform provider role.
  - ClearSpace LUX could not find an agreement with a platform provider from the UK after discussing with ADS UK and SSTL.
  - Due to delay in procurement ADS-UK withdrew from the proposal
  - Negotiations stalled due to lack of platform provider
  - As of Q2 2025 ESA/CS-LUX procurement action remains open

Luxembourg kicked-off a National Activity (Phase A) in Q1 2025

- PRR is scheduled in June 2025
- Way Forward to be defined after PRR

ENCORE – Budgetary Situation

	Budget	Comments
MC22 subscription	42 MEuros	Not committed
Phase A	2 MEuros	Approved by PB. Final negotiations conducted, but procurement not concluded and still open. Waiting for LUX guidance.
THEIA (new)	20 MEuros	Proposed partial reallocation of available ENCORE budget (see next slides)
Phase B?	20 MEuros	Remaining budget available from original ENCORE budget

THEIA – Proposal for a NEW ADRIOS “Mission Class”

- Already planned ADRIOS missions: complex, with launch dates after MC28
- Proposal for a new ADRIOS small mission:
  - To increase the robustness and consistency of the programme, with a complete spectrum of mission class including small
  - Answering to the interests of different industrial players (e.g. concerning the platform)
  - Offering opportunities for in-orbit demonstration of parts of the RdV and Proximity Operations Suite, as a test bed for future and innovative solutions to be embarked on more capable/operational missions
  - Broadening of the supply chain for ADR/IOS
  - No pre-defined specific programmatic link between THEIA and the already on-going/planned missions
- Requires a fast-track implementation, matching the level of rather limited financial exposure

- Funding: Proposal to use part of the ENCORE budget available from Period 2

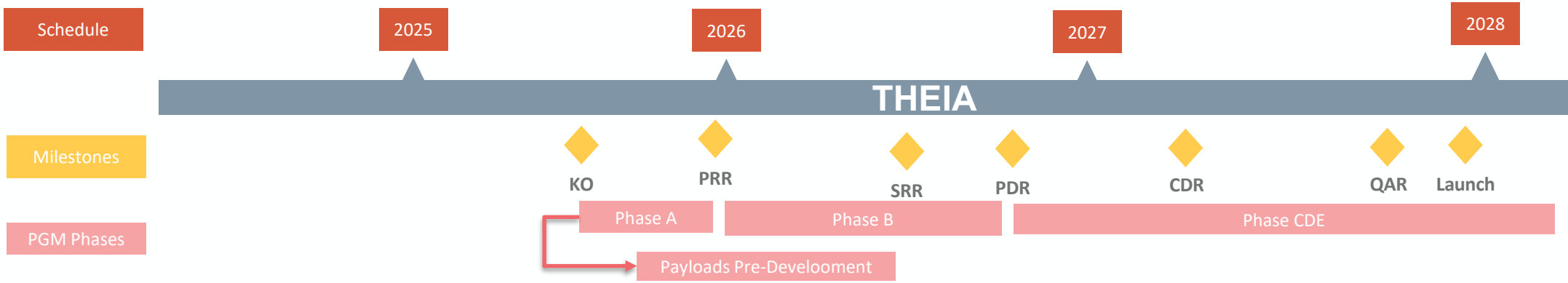
Funding Overview		
CaC	**20 M€**	
CM22	20 M€	*Use of ADRIOS ENCORE available budget*

THEIA - Safe Close Proximity and Relative Navigation Demonstration

Mission Objectives:

- Demonstration of Safe Close Proximity Operations
- Collect images and videos of ESA object in-orbit (or 3rd party)
- Demonstrate GNC algorithms for precise relative navigation
- Demonstration of high-performance relative navigation sensor-suit
- Demonstrate operational concept for far and close range
- Launch before 2028

Theia : Greek goddess of sight and vision

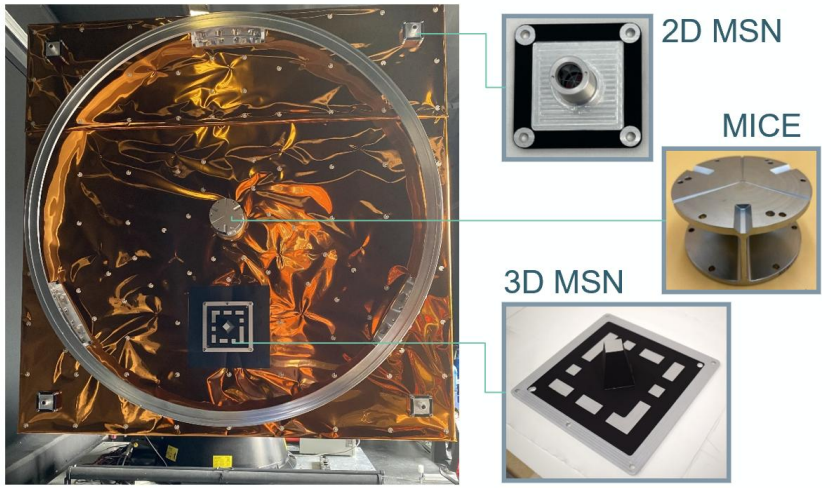


Member States	Phase A Georeturn Target (TBD)
LU	0-100%
UK	0-100%
CH	0-50%
ES	0-50%
CA	0-25%
RO	0-25%
All others	0-10%

- CDF study and other activities of relevance (e.g. under GSTP) already performed in the past
- **Phase A proposed for approval at June PB, two contracts in parallel**

CAT – Demonstration of ADR of prepared satellites

Major step towards Zero Debris Policy by 2030



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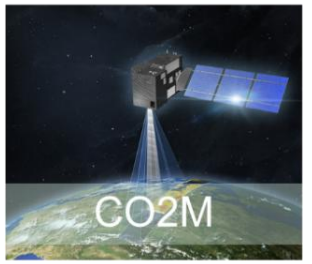
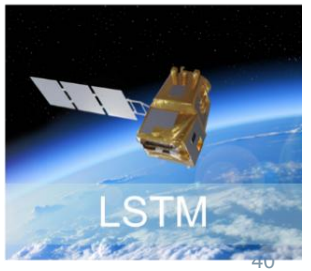
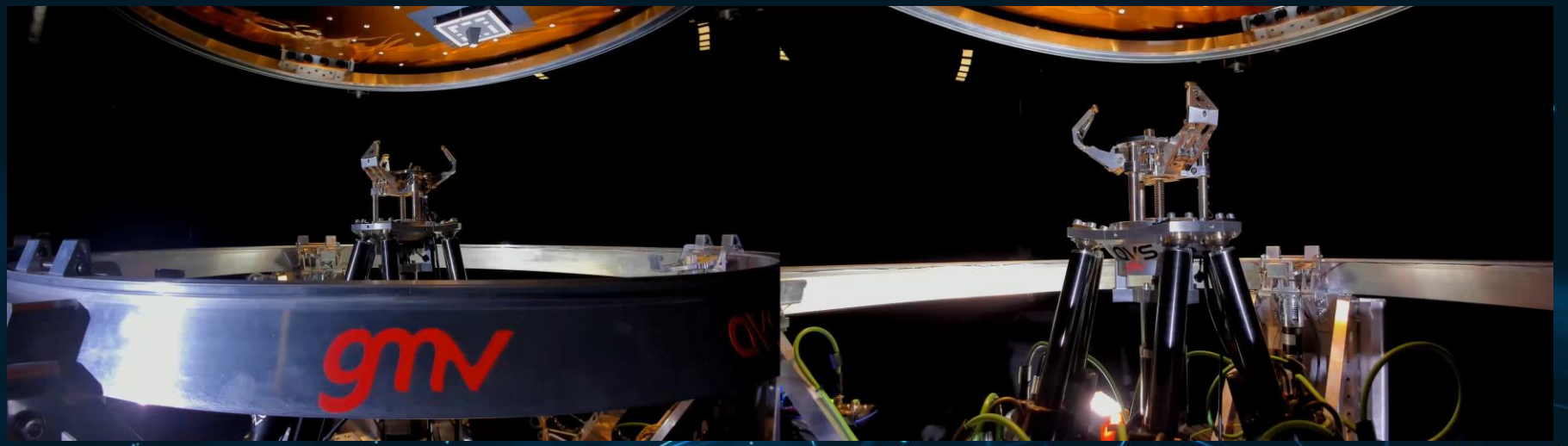
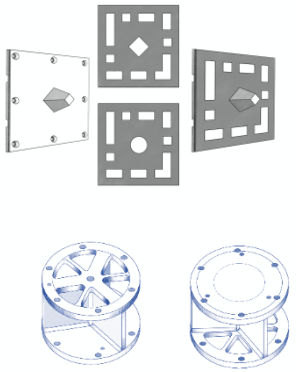
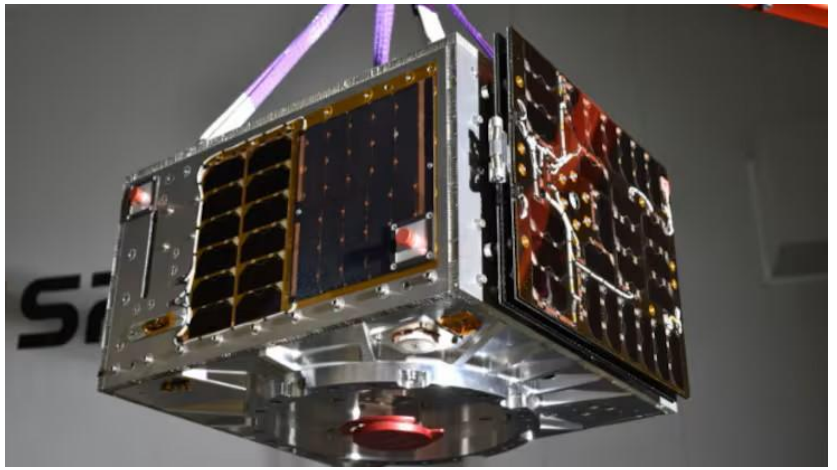




CAT - IOD of Capture Payload Bay for ADR







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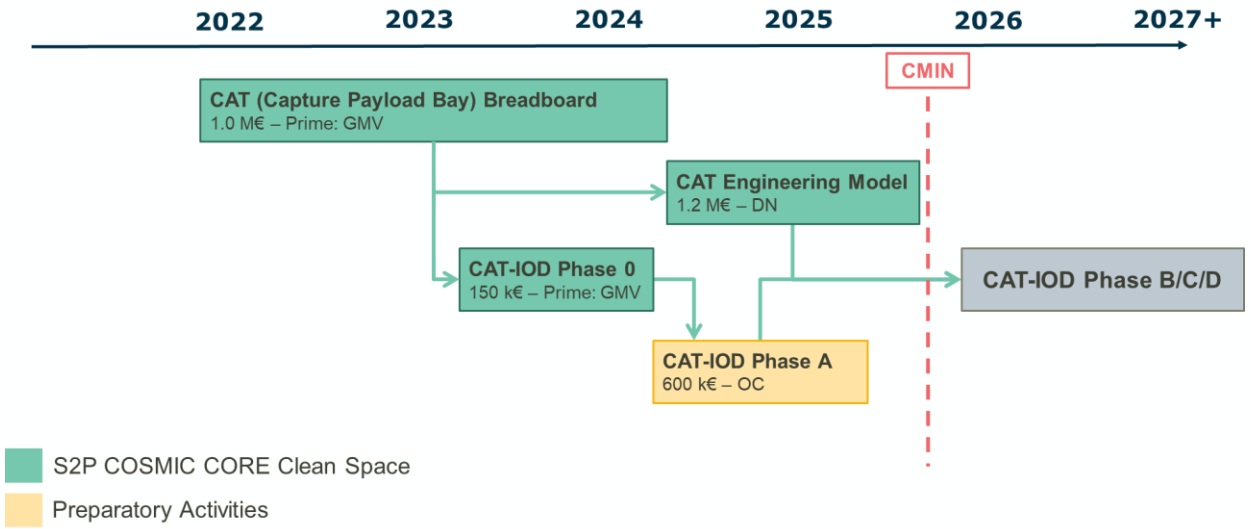
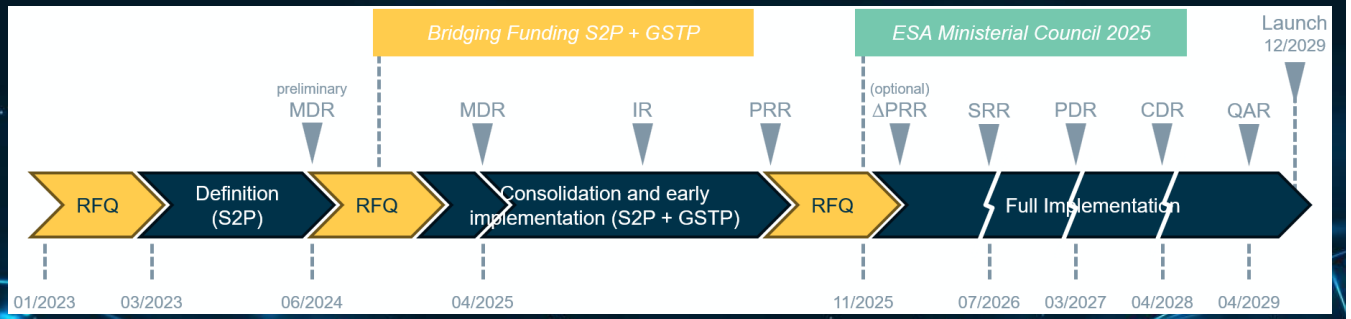
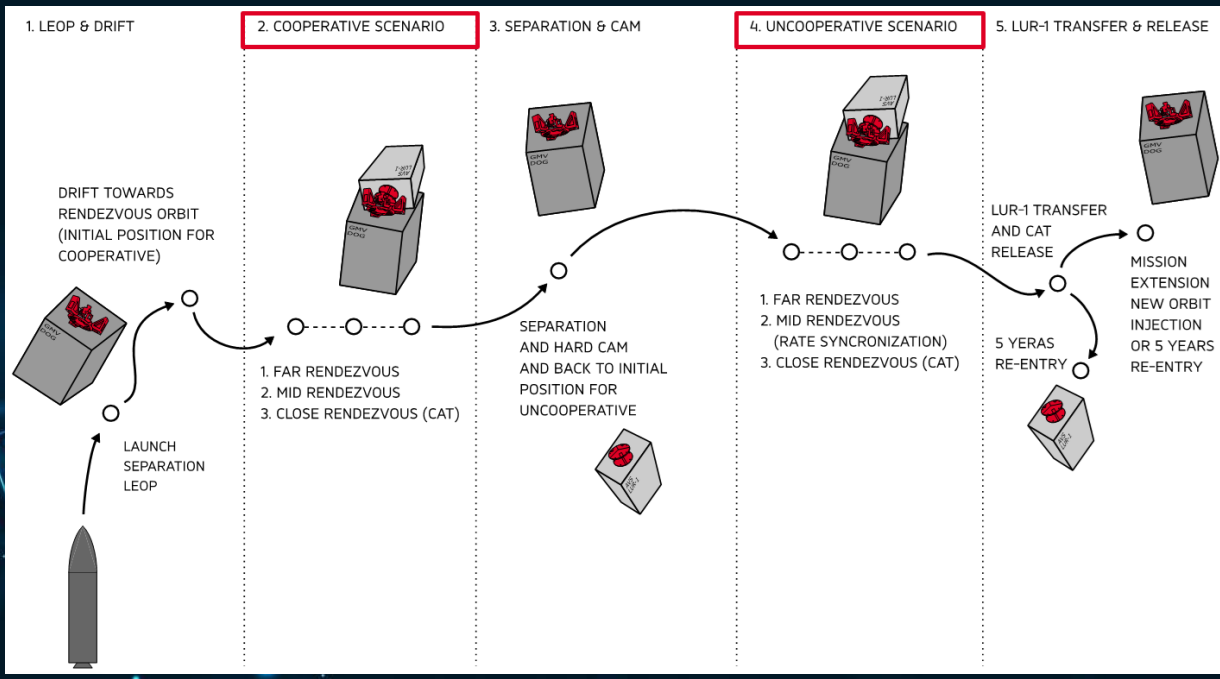


CAT - Planning and Funding Overview

Proposed to be moved from COSMIC to ADRIOS.





Funding Overview		
CaC	**82 M€**	
CM25	46 M€	*Phase B/C/(D)*
CM28	36 M€	

ADRIOS: Missions and Funding Periods Summary

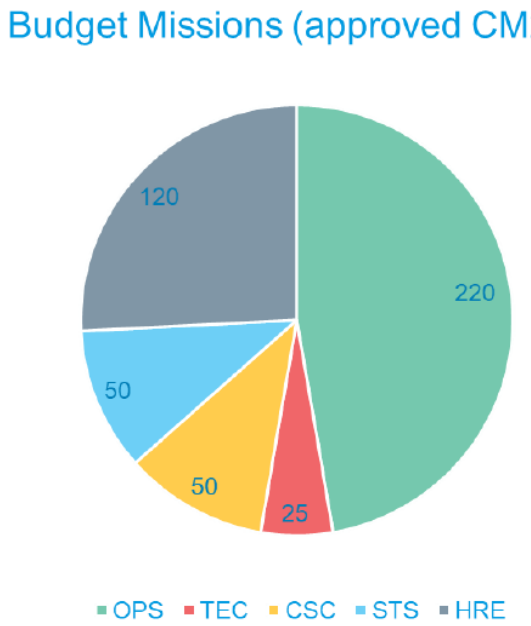
	past MCs	MC25 Request	MC28 Projection
ClearSpace-1 (M)	159		tbc
RISE (L)	79	128	tbc
ENCORE	42 ⇨ 22		?
THEIA (XS) - NEW	20		
CAT (S) - moved from COSMIC		46	36 (tbc)
ADRIOS Reserve		15	tbc

ADRIOS indicative mission class (CaC MEuros):
L: >250
M: 100-250
S: 50-100
XS: <50

TOTAL ADRIOS Segment Request at CMIN25: 189M

S2P is working as ISAM services development programme for the Preparation and Implementation of several servicing missions

And more projects will be prepared and implemented…



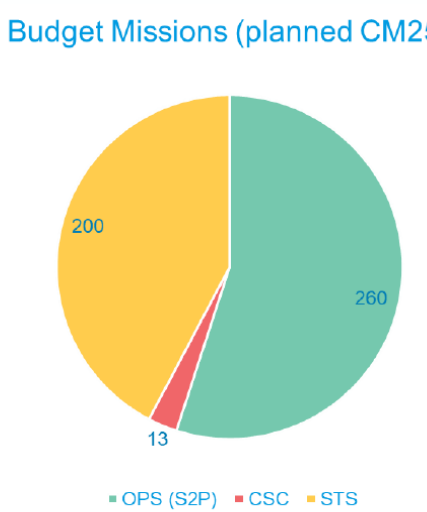


***Figure 5**: budget (in million Euro) allocated to ISAM main missions per directorate. Please note that: 1) only directorates with budgets allocated above 10ME are considered, 2) the estimation for HRE is related to ESPRIT with an assumption of 40% allocation of the entire contract value for the only refuelling module ERM and 3) the estimation for the planned budget is uncertain and only limited info were made available to this WG. Note: the full list of activity is available in Annex F*

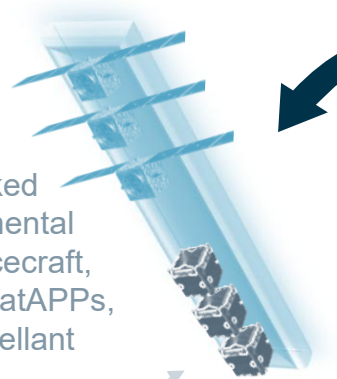
ISAM Architecture

Servicing
Providing Commercial and governmental services

- Active Debris Removal and Life Extension
- Refurbishment & Upgrade

ORUM | CAT-IOD | ELSA-M | RISE | ERASE

Hosting
Providing supply for docked commercial and governmental servicer and logistic spacecraft, hosting and distributing satAPPs, IOD/V experiments, propellant



- IOD/V
- In-orbit infrastructure

InSPoC-4 | ODYSSEY

Logistics
Transporting cargo and supplies, disposal of old cargo, providing transport services to spacecraft

- Transportation
- InSPoCs

InSPoC-1 | InSPoC-2 | InSPoC-3

Pilot Mission ISOS4I
In-Space Operations & Services 4 Infrastructure
Pre-cursor for continuous provision of on-demand in-space services to the Space infrastructure

- ESA involvement under discussion

satAPPs
Building an ecosystem of functional satellite upgrades (plug'n'play peripherals)

- Refurbishment & Upgrade
- Modular platforms

ADRIOS Cornerstone of S2P: Evolution