European Commission

IN-SPACE OPERATIONS AND SERVICES (ISOS)

An overview of EU-funded R&I projects supporting the development of ISOS capabilities

#EUSpaceResearch
#HorizonEU

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IN-SPACE OPERATIONS AND SERVICES (ISOS)

In-Space Operations and Services address applications such as maintenance/servicing of satellites (e.g. inspection, repair, life extension, upgrade), debris removal, logistic services in space (e.g. cargo, warehousing, relocation/transport of assets), assembly/disassembly of satellites/large structures, manufacturing (e.g. recycling/reusability).

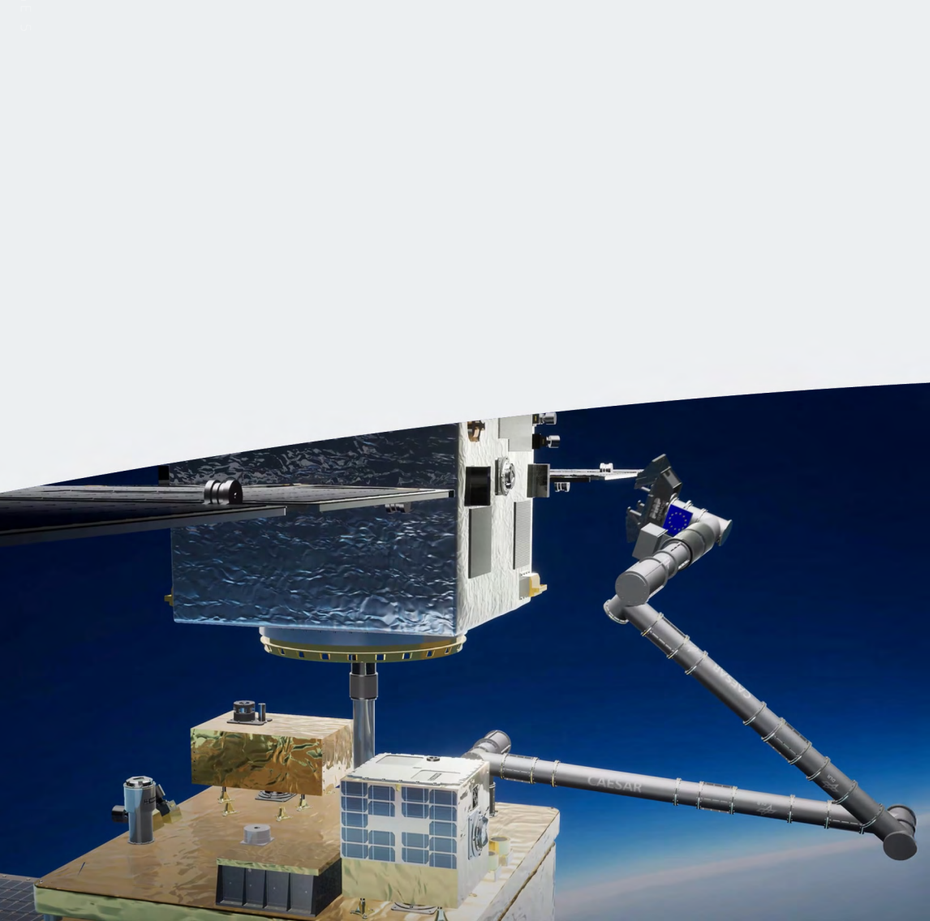
Game-changing innovations and enabling technologies are at the heart of ISOS and an important focus of future actions. The paradigm shift towards adaptive space systems builds on automation and robotics, artificial intelligence, modular and reconfigurable spacecraft concepts.

ISOS is an intrinsically disruptive domain for space. It is bound to change the way space systems are designed, manufactured, tested and operated. It is an enabler for a wide range of new applications and new markets in space (new in-space economy) as well as for operations providing enhanced resilience and sustainability of space infrastructure.

Mastering ISOS will endow the EU with the key strategic capacity to **Act in Space** and place the EU and its industrial and research actors in the driving seat of the Future Space Ecosystem.

The EU has been supporting this domain already from FP7, with the funding of the REMOVEDEBRIS project which demonstrated in-orbit basic debris removal technologies. A Strategic Research Cluster focusing on Space Robotics technologies was set up and implemented in Horizon 2020, defining and maturing key technological building blocks and delivering world-first ground demonstrators on servicing, assembly and modularity that are being further developed in current projects.

The projects featured in this brochure set the foundations for EU-funded R&I in the domain of ISOS. These complementary developments will feed the inception, definition and implementation of the next chapter in the history of ISOS: The **EU ISOS Pilot Mission**, to be deployed by 2030.



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PROJECTS

CRYSALIS

CRYSALIS

Cryogenic storage and refuelling in space

Research and Innovation Action (RIA)

1 January 2024 – 30 June 2028

EU contribution: €**7 430 994**

Focus area: **Cryogenic propellant, in-orbit refuelling**

Coordinator: **Absolut System SAS (FR)**

Participants:
The Exploration Company GmbH (DE), Université de Liège (BE), Universitat Politècnica de Catalunya (ES)

CRYSALIS aims to develop a system for the transfer and long-term storage of cryogenic propellant in microgravity, culminating in a 6-month small-scale orbital demonstration. The demonstration system serves to validate cryogenic propellant storage and transfer tests in the space environment, unlocking novel opportunities for exploration, including in-orbit transportation, long-duration missions, and in-orbit storage.

The project stands as a flagship project propelling space exploration and the evolution of the European space transportation ecosystem. By enabling the launch of a spacecraft and its cryogenic propellant separately, the technologies developed will increase the size and duration of missions to Mars and the Moon, facilitating new frontiers in space exploration.

The project's far-reaching impacts encompass logistics and transportation applications such as cryogenic propellant refuelling, maintenance, life extension, storage, and disposal in orbit.

KEY OBJECTIVES

ZBO storage: demonstrate zero-boil off (ZBO) long term storage of cryogenic propellant in a microgravity environment.

Acoustic mass gauging: illustrate acoustic mass gauging of cryogenic propellant in a microgravity environment.

Characterisation: improved characterisation of behaviour of cryogenic propellant in a microgravity environment.

Acoustic systems: demonstrate the use of acoustic systems to aid in cryogenic propellant management (bubble control/aid with settling).

Boil-off reduction: showcase the use of an acoustic system to reduce boil-off in orbit.

Lossless transfer: demonstrate the transfer of cryogenic propellant between two tanks without venting in an orbital environment.

LEARN MORE

CORDIS:
europa.eu/!xTKWJ6

Website:
crysalis-project.com

LinkedIn:
crysalis-project

EROSS SC

European robotic orbital support services - servicing component

Research and Innovation Action (RIA)

1 January 2023 – 31 March 2025

EU contribution: €**25 983 822**

Focus area: **Robotic Servicer Mission**

Coordinator: **Thales Alenia Space France SAS (FR)**

Participants:

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DE), Fundación Canaria Parque Científico Tecnológico de la Universidad de Las Palmas de Gran Canaria (ES), GMV Aerospace and Defence SA (ES), GMVIS SKYSOFT SA (PT), Kinetik Space GmbH (DE), Kongsberg Defence & Aerospace AS (NO), Network Research Belgium SA (BE), PIAP Space sp. z o.o. (PL), Sener Aeroespacial Sociedad Anónima (ES), SINTEF AS (NO), Space Applications Services NV (BE), Thales Alenia Space España SA (ES), Thales Alenia Space Italia SpA (IT), Tipik Communication Agency SA (BE), Universidad de Las Palmas de Gran Canaria (ES)

Associated Partners:

Almatech SA (CH), CSEM Centre Suisse d'Électronique et de Microtechnique SA - Recherche et Développement (CH), Thales Alenia Space Switzerland AG (CH)

EROSS SC aims to demonstrate the European solutions for the Servicers and the Serviced LEO/GEO satellites, enabling a large range of efficient and safe orbital support services.

The Servicing Component (SC) phase of the EROSS project is the fourth part of the R&D partnership developed with the European Commission. The project showcases a mission design that will provide both life extension and life enhancement to future space systems, therefore answering both short-term customer needs and anticipating future new business perspectives.

These space vehicles will be able to carry out a wide range of operations in orbit, including controlled re-entry of space debris, robotic manipulation, the extension of a satellite's operational life, in-orbit refuelling, inspection, and many more.

The demonstration mission concept includes the complete orbital rendezvous phase of a Servicer satellite with a collaborative Client satellite prepared for On-Orbit Servicing that shall be followed by the capture and then servicing operations. The whole idea is to validate the capability of carrying out on-orbit operations of this type for future missions.

KEY OBJECTIVES

Technology maturation: support the maturation of rendezvous and autonomous robotic technologies for space application, leveraging on the previous building blocks developed in prior H2020 and other European projects.

Mission development: further design and prepare a high-impact, low-cost in-orbit mission to demonstrate the capability of European industry to propose sustainable, highly automated, flexible and economically viable space infrastructures.

Commercial exploitation: explore the emerging OOS (Inspection/surveillance, Life extension, Change of Orbit, End-of-life removal/Deorbiting) and longer term markets (Refuelling, Upgrade, Assembly) to prepare a viable European commercial solution in a sustainable context.

Shift to New Space ecosystem: support and enable the shift of paradigm and pave the way towards On-Orbit Manufacturing, Repair, Recycling and Re-use, shifting from conventional to adaptive and intelligent solutions for space.

ORU accommodation: allow late integration of an ORU, as a demonstration of the modularity for next generation of space assets.

LEARN MORE

CORDIS: europa.eu/!JgfRj7

Website: eross-sc.eu

LinkedIn: eross-sc

EU-RISE

European robotics for space ecosystems

Research and Innovation Action (RIA)

1 December 2023 – 30 November 2025

EU contribution: €**2 324 918**

Focus area: **In-Space Manufacturing and Assembly End-to-End Demonstration**

Coordinator: **Airbus Defence and Space GmbH (DE)**

Participants:

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH (DE), Magellium SAS (FR), Airbus Defence and Space SAS (FR), Sener Aeroespacial Sociedad Anónima (ES), The Exploration Company GmbH (DE), Oikoplus GmbH (AT), Libre Space Foundation (EL)

Associated Partner:

Airbus Defence and Space Ltd (UK)

EU-RISE draws upon the maturation of space robotics that has paved the way for new capabilities for in-space servicing, assembly and manufacturing (ISAM). These capabilities offer significant business opportunities and promise to increase the efficiency and resilience of the orbital infrastructure.

The project contributes to Europe's positioning as a leader in the global space industry. The establishment of a European ISAM capacity and defining the future space ecosystem will have a significant impact.

By developing and implementing these new capabilities, Europe can maintain its competitiveness on the global stage, create new jobs, and drive economic growth through increased investment in the space industry.

Furthermore, the development of a sustainable space ecosystem will have a positive impact on the environment, reducing the amount of waste and pollution in space and contributing to a more sustainable and cleaner space environment.

KEY OBJECTIVES

Undertake a market analysis of in-space services, in-space assembly and manufacturing, and related domains, and develop two reference scenarios that will be analysed and used to define an end-to-end demonstration scenario.

Define and set-up a End2End demonstrator based on one of the defined demonstration scenarios to mature the building blocks and relevant robotic elements further and demonstrate the full system capabilities and operations with representative elements.

Development of open-source software solutions for the continuing maturation of space robotic building blocks.

LEARN MORE

CORDIS:
europa.eu/!bGwDRn

Website:
eu-rise.space

LinkedIn:
eu-rise

GEORyder

Enabling access to the GEO orbit through a green reusable kickstage vehicle allowing multiple transfers from GTO to GEO

Research and Innovation Action (RIA)

1 March 2024 – 28 February 2026

EU contribution: €**6 057 684**

Focus area: **Kickstage from GTO to GEO**

Coordinator: **Infinite Orbits (FR)**

Participants:

Arianespace SAS (FR), Berlin Space Technologies GmbH (DE), Dawn Aerospace Nederland B.V. (NL), Deimos Engineering and Systems SLU (ES), Elecnor Infrastrutture e Aerospazio SRL (IT), Politecnico di Milano (IT), SkyLabs Vesoljske Tehnologije DOO (SL), Space Applications Services NV (BE)

The GEORyder project addresses space transportation technologies for in-orbit servicing systems, particularly in response to Europe's limited access to GEO orbit. With smaller newcomers offering GEO services and the impact of upcoming REACH regulations, there is a clear need for efficient orbital transfer vehicles (OTVs) to support European GEO access.

GEORyder combines a reusable Kickstage vehicle with OTVs that feature rendezvous and refuelling capabilities. This cost-effective system will use green propellant and be designed for future cryogenic storage and transfer, aligning with the European Green Deal and ESA's goals. The project is led by Infinite Orbits (FR), with contributions from Berlin Space Technologies (DE) on structure, Dawn Aerospace (NL) on propulsion, and other partners managing refuelling, avionics, electronics, and proximity operations. Arianespace (FR) will oversee service commercialisation and market analysis.

KEY OBJECTIVES

Provide Europe with a reusable platform acting as the first reusable kickstage vehicle, providing strategic European access to GEO for small (mini) satellites (< 400 kg), qualified up to TRL > 5.

Enable the global objective by focusing on the industrialisation and reusability aspects of the mission.

Ensure a sustainable and reusable mobility approach compliant to the European strategic roadmap and ESA vision.

In-orbit logistics market anticipation by optimising the design for in-space rendez-vous.

Foster EU non-dependence by using avionics modularity and agnostic hardware architecture.

Develop a space mission-specific environmental impact indicator, assessing technology trade-offs and reusability.

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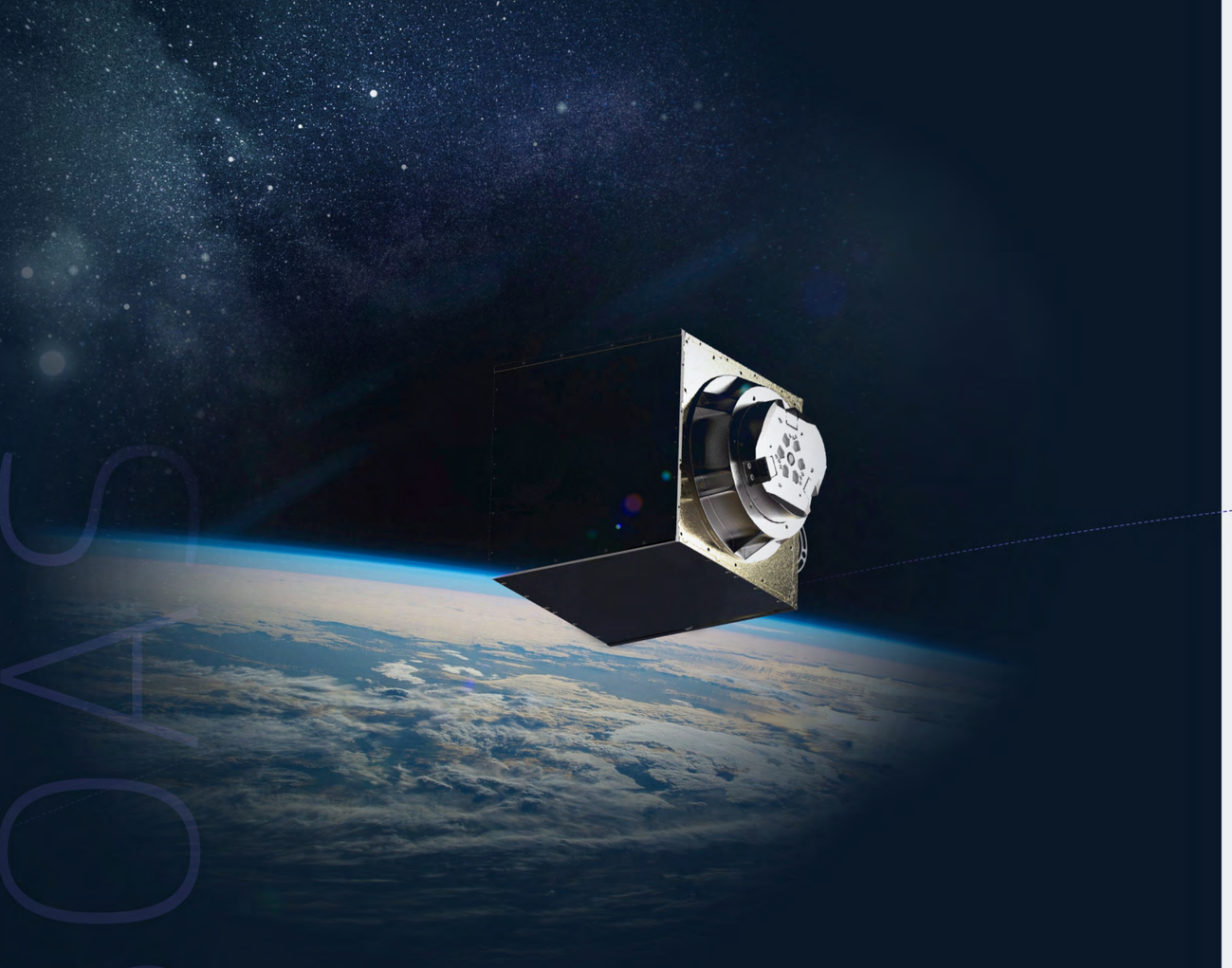
CORDIS:
europa.eu/!mfKKWF



ORU-BOAS

ORU based on building blocks for advanced assembly of space systems

Research and Innovation Action (RIA)

1 January 2023 – 31 December 2024

EU contribution: €**1 969 335**

Focus area: **Orbital Replacement Unit**

Coordinator: **Sener Aeroespacial Sociedad Anónima (ES)**

Participants:

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DE), EASN Technology Innovation Services BVBA (BE), ISIS - Innovative Solutions in Space BV (NL), Thales Alenia Space France SAS (FR), Thales Alenia Space Italia SpA (IT)

ORU-BOAS is focused on the development of a concept allowing the assembly, repair, or upload of space infrastructures directly in-orbit.

With a strong focus on in-orbit services, the project aims to develop an ORU-BOAS standard module up to TRL5/6. This plug-in module will be compatible with a wide range of payloads and will include standard interfaces for interaction with other ORUs, satellite platforms, or robotics elements, as well as with the elements developed in the PERASPERA roadmap.

Several types of services like life extension, refuelling, repairing, and other station-keeping missions will be elaborated, upgrading the European strategic autonomy and robotic missions.

KEY OBJECTIVES

Beyond in-orbit demonstration (IOD) mission and future ORU applications: identify future applications of the satellite construction kit concept. In the longer term, ORU-BOAS will behave as fully autonomous satellite that can dock to other ORUs to form larger and more complex satellite systems.

Design and Development Specifications for a Satellite Construction Kit (DSSCK): develop both technical requirements and the verification and validation plan to define ORU-BOAS candidate payloads accommodation, simplifying their integration in the overall system.

First Functional Satellite Module: define the most versatile ORU standard module service provider to upgrade, repair or reconfigure a satellite platform or modular space system in an orbital scenario.

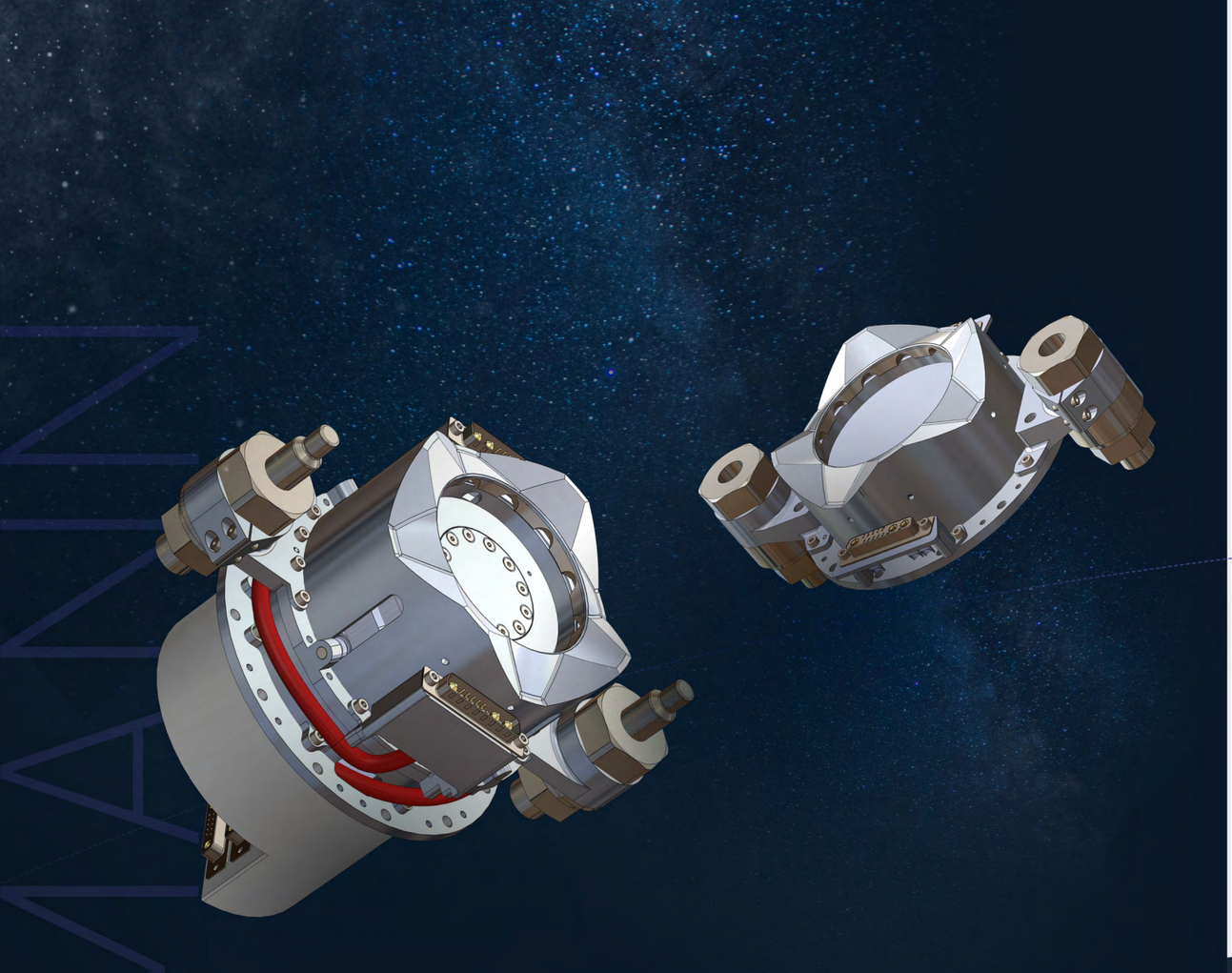
LEARN MORE

CORDIS: europa.eu/!qCvfQQ

Website: oru-boas.eu

LinkedIn: oru-boas

X: oru-boas



SCHUMANN

Satellite construction kit for highly unified modular assembly in newspace applications

Research and Innovation Action (RIA)

1 January 2023 – 31 December 2024

EU contribution: €**1 999 869**

Focus area: **Orbital Replacement Unit**

Coordinator: **Space Applications Services NV (BE)**

Participants:
ArianeGroup GmbH (DE), FZI Forschungszentrum Informatik (DE), GMVIS Skysoft SA (PT), ReOrbit Oy (FI)

SCHUMANN ambitions to make the development of modular spacecraft elements simpler, more affordable, and more straightforwardly integrable by satellite manufacturers.

Two main tracks are being implemented to this end:

– the first track addresses the development and maturation of a modular refuelling module which shall serve for satellite life extension;

– the second track deals with the development of a software toolkit called SCK (Satellite Construction Kit) which will support developers of Functional Satellite Modules (FSM, aka. “Tier 1”) by ensuring at design stage the compliance of required subparts (aka. “Tier 2”) and the overall FSM consistency in perspective of their use in the Future Space Ecosystem.

SCHUMANN “SCK certification” will help making FSM more easily and modularly integrable into satellites.

KEY OBJECTIVES

Functional satellite module technology maturation: develop and mature a Functional Satellite Module (FSM), in the shape of a refuel tank, dissociated from on-going missions preparation, and demonstrate the capability to make this module compatible for further mission integration.

Design and Development Specification for Spacecraft Construction Kit (DSSCK): develop a software tool and related design and testing specifications, that future FSM developers can use to ensure modules are compatible and usable in a single ecosystem.

LEARN MORE

CORDIS: europa.eu/!N6c9QV

Website: horizon-schumann.eu

LinkedIn: SCHUMANN - Horizon EU

X: SCHUMANN_EU

SPACE USB

SPACE Universal Serial Bus

Research and Innovation Action (RIA)

1 January 2024 – 31 December 2025

EU contribution: €**1 904 716**

Focus area: **Interoperable System Interconnects for an Open standard**

Coordinator: **Thales Alenia Space France SAS (FR)**

Participants:

Deutsches Forschungszentrum für Künstliche Intelligenz GmbH (DE), iBOSS GmbH (DE), In Extenso Innovation Croissance (FR), Sener Aeroespacial Sociedad Anónima (ES), Space Applications Services NV (BE)

SPACE USB seeks to pave the way for a more flexible, universal and serial interface (USB-type) leveraging the existing standard interconnects for On-Orbit Servicing and assembly applications.

After the definition of a standardisation level, the design of a universal and serial standard interface will be proposed and demonstrated orienting its features towards compactness, docking symmetry, large docking misalignment tolerances, large loads transfer, data/power transfer redundancy and especially interoperability with other interfaces.

Currently interoperability is the only remaining requirement which is not met by any existing space connector/interface. The project will then perform a dedicated experimental benchmark to confirm the achievement of this specific requirement as well as its prospective industrial exploitation.

KEY OBJECTIVES

Definition of a complete and self-consistent technical specification for development of future space standard interconnects (SIs): upgrade of parameters and protocols for development of a universal and serial interface (USB-like) able to mechanically connect two space elements and to provide data and power transfer between them when assembled on orbit.

Concept and verification of new standards: definition of a technology concept and its demonstration in a laboratory environment for OOS and assembly applications. The proposed technology prototype shall leverage as much as possible the existing SIs mainly including aspects of interoperability between them.

Technology maturation through industrial collaboration: synergistic working approach among European SIs manufacturers will be employed to firstly define a complete and self-consistent technical specification for the development of a universal and serial space interface (USB-like), and then, to develop and demonstrate applicability of the proposed specification by leveraging on the existing technology solutions.

LEARN MORE

CORDIS: europa.eu/!674NQX

Website: spaceusb.eu

LinkedIn: space-usb

X: space-usb

STARFAB

A space warehouse concept and ecosystem to energize European OSAM

Research and Innovation Action (RIA)

1 January 2024 – 30 June 2026

EU contribution: €**2 416 798**

Focus area: **Orbital Warehouse**

Coordinator: **Space Applications Services NV (BE)**

Participants:

Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung e.V. (DE), Société Nationale de Construction Aérospatiale Sonaca SA (BE), Thales Alenia Space France SAS (FR)

Associated Partner:

University of York (UK)

STARFAB aims to explore a novel concept of an automated orbital Warehouse Unit (WU) within the context of both OOS and ISAM (also known as OSAM) commercial perspectives. It seeks to address a critical gap in the future space ecosystem, serving as an enabler for sustainable OSAM business models.

The project will develop a Phase A equivalent concept and demonstrator of an orbital WU, drawing inspiration from state-of-the-art automated warehousing practices on Earth, while considering the challenging environmental conditions encountered in space.

STARFAB seeks to advance the necessary technologies for handling goods in space (incl. modular and custom-shaped components, raw materials for manufacturing, fuel, water, and more), using robotics and automation. This will encompass storage elements with varying levels of protection, the Items Handling Solution (IHS), featuring custom automation tools for operations within the warehouse structure, and the Item Transfer System (ITS), designed as a robotic manipulator to provide flexible external item transfer within the WU. The concept will also include provisions for robotic inspection and minor maintenance tasks, primarily for STARFAB's own integrity but possibly also as a service for spacecraft docking or berthing with STARFAB.

At the end, STARFAB will produce a roadmap outlining the path forward for technology maturation, model philosophy, market opportunities, and subsequent exploitation measures.

KEY OBJECTIVES

Sustainable Concept: elaborate a viable concept of an In-Space hub supporting ISOS.

Robotics: explore relevance of robotic & automation technologies in such a facility.

Ground Demonstration: develop and build a partially representative ground demonstrator (TRL4) for validating concept and technologies.

Technology Maturation: maturation of robotic actuators (TRL6) leveraging previous H2020 Space Robotics heritage.

Roadmap Definition: define a roadmap and exploitation prospects in the future ISOS ecosystem.

LEARN MORE

CORDIS:
europa.eu/!YfdnxX

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