Digitalisation for Commercial Space solutions

Space Partnership recommendations for Horizon Europe Work Programme Call 2025

Version FINAL – Approved by the SPACE AISBL Board on March 7th 2024

The recommendations for the 2025 work programme implementation of the *GCSS Partnership* will address *Digitalisation for Commercial Space solutions* pursuing high-level objectives:

- Define the overall technology and demonstration developments that will be achieved at the end of the 3-year Partnership.
- Establish the 3-year development plan for these activities, concerning the technologies and experiments which will be integrated in the final demonstration, in-flight or on-ground.
- Produce the mission and overall system requirement documentation necessary for the development of the various ground and space hardware and software which will contribute to the demonstration missions, towards the objectives listed in the framing document
- Identify and select the most relevant technologies (game-changer/key technologies) to be included in the demonstration in order to create a pathway for quick maturation and – if possible -- space qualification

The partners propose to implement the objectives via 4 separate calls in 2025, with a total budget allocation of 32M€:

- Collaborative Earth Observation and Satcom missions for Space solutions – Low to mid TRL developments – RIA – 6M€
- Digital solutions for autonomy for space transportation systems, design and simulation tools – Low to mid TRL developments – RIA – 3M€
- Collaborative Earth Observation and Satcom missions for Space solutions – Mid to high TRL developments – IA – 11M€
- Digital solutions for autonomy for space transportation systems, design and simulation tools – Mid to high TRL developments – IA – 7M€

Collaborative Earth Observation and Satcom missions for Space solutions

This call will focus on the fast increment of the Low to Mid TRL level building blocks for critical technologies required by EO & SatCom competitiveness.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR 1.00 to 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 6.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B.
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome

Projects are expected to contribute to the following outcome(s):

In Communications satellites

Objectives are:

- To enable the European Space Industry to maintain a significant share of the global connectivity market by increasing the performance of space satellite networks, new type of control and ground segments being fully integrated into the terrestrial networks. This will also be needed in enabling the European Space Industry to maintain its global leadership role in Earth observation missions and systems.
- To target new commercial services and applications enabling a digitalisation of space solutions. Such solutions could be addressing in synergy the requirements of data transfer for analytics and observation system, and deploying a 5G/6G network in space, enabling massive data repatriation, direct to device services (D2D, i.e. satellite communications with unmodified smartphones) and non-terrestrial network (NTN) integration, Quantum applications, … A continuous development of key technology stacks will ensure European sovereignty in the future and will strengthen the industry against the competition from USA, China and others.

In Earth Observation satellites

Objectives is:

- To develop advanced Earth observation payloads, technologies and processing means (on ground and in space), for all types of observation missions.

Digitalisation is a major enabler for enhancing the value of an E2E EO system. Indeed, processing applied to the multi-sensor data, on-board or on-ground, with or without calling for IA, can significantly enhance the resolution of the final data set and resulting image/analytics (e.g. digital SAR back-end electronics, optical images post-processing etc.). Besides, persistent imagery modes (e.g burst, video) require new generations of digital processors and on-board memories. Furthermore, digital optimisation of the data flow (autonomous decision, selective downlink, ground-

segment efficiency) directly improves the E2E timeliness of an EO system (from request to delivery). Lastly, the enhancement of E2E data resilience and integrity calls for digital technologies on-board and, on the ground, end-to-end objectives.

Operational objectives

In Communications satellites

- Improving ground and space data distributed computing and processing
- Edge computing/cloud capacity close to the payload (ground-space segments optimisation)

In Earth Observation satellites

- Digitally enhance EO system and data performance and mission timeliness
- Advanced EO-payload systems and technologies, including onboard and ground processing

Synergies

- Direct tasking by end-users and on-board treatment of data
- Harmonisation of building blocks interfaces
- Enhancing data security and system resilience in Space and Ground Infrastructures
- Advanced space network architectures allowing, through in-orbit resources sharing, for lowering the environmental impact of future missions.

Development goals

- Fast increment of the Low to Mid TRL levels building blocks technologies of EO & Satcom competitiveness
- On-ground or in orbit demonstration and market readiness
- Focus on software and digital tools (e.g algorithms), supporting HW (e.g processors, electronics) from design to operation phases

Scope

For Communications satellites

- End to End Mission capabilities
  - Satellite network interconnectivity
  - Seamless integration into the terrestrial networks
- Energy efficient connectivity and compatibility with 5G & 6G waveforms.
  - Constellation and Network software management system
  - Optical communication
- Satellites as network nodes in a distributed system
  - Flexible and modular testbed: Multi-orbit and terrestrial integrated satcom architecture
  - Need common protocols across the comms chain. (similar to SDA standard but for civil)
  - Faster reaction time between the acquisition and the availability of data
  - Ubiquitous use of orbital resources

- Distributed computing – do the computing where the data is, how best to combine final result

Earth Observation satellites

- On-board processing to optimize EO missions' performance or timeliness
  - Standardized software framework to host embedded edge-computing applications (AI, Machine Learning, ...)
  - Data/signal image processing to optimise algorithms, AI-based or not (e.g addressing compression, autonomous action, front-end/back-end performance etc.)
  - Enhanced downlink and uplink capabilities (e.g. for better reactivity)
- EO ground segment interfaces and data flows standardisation and adoption (evangelisation)
  - Development of ground-segment digital building-blocks in coherence with adopted standards
- Smart multi-source EO intelligence information fusion
  - Innovative intelligence information extraction and fusion exploiting multiple data sources (EO sensors and other space-based data along with ground-based data)

Synergies

- Maturing high performance processing payload H/W to support space network capabilities including an improvement in downlink and tasking capabilities of the European infrastructure.
  - In-orbit re-configurability
  - Network resilience
    - Multi-band transmission
    - Interference: detect, identify, locate and isolate
    - Vulnerability assessment of spacecrafts systems
    - Space weather free communications
  - Data integrity
  - Data security
    - Low-cost Cyber Security
      - Genuine European low-cost solutions
      - Quantum technologies chips and sensors
    - Data encryption
  - Data authentication
  - AI/ML chain covering both imagery and signal data
- Maturing technologies and products improving system security and threats identification
  - Host/Network Intrusion Detection/Prevention Systems for space systems and networks (space segment)
  - Security engineering of space systems architecture (end to end)
  - Capability to safely operate systems by different users with strict security boundaries
  - Improve the interoperability of our systems to enhance their mutualisation in system of systems
- Resources usage optimization
  - Operational optimization: increase the mission envelope and lifetime thanks to a better knowledge of the system in real time based on digital twinning

- Design optimization: increase future systems efficiency thanks to a better use of the operational return of experience of legacy systems
- Advanced techniques for large system of systems or multi-missions' operations optimization

- Environmental impact minimization of future missions
- Tools to support the measure of key environmentally driven criteria through increased resource sharing: minimization of the mass to be launched, development cycle reduction, digital nodes sharing through several missions, optimization of the ground systems for a lower environmental footprint, etc.

Digital solutions for autonomy for space transportation systems, design and simulation tools

This call will focus on the fast increment of the Low to Mid TRL level building blocks for critical technologies required by New Space Transportation Solutions competitiveness.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR 1.00 to 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used
Technology Readiness Level	Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project – see General Annex B.

Expected Outcome

Projects are expected to contribute to the following outcome(s):

Key areas for service improvement are health monitoring systems, enabling real time subsystem monitoring through all mission phases, including predictive maintenance and refurbishing in case of reuse, high speed sensor networks for on board real-time data feeds, enhanced ground-board high-

data rate communication and multicore on-board computer and using Artificial Intelligence algorithms to process high volumes of data.

Models for mission, system design and optimisation, able to integrate life cycle analysis, engineering and environmental models for optimisation of development through manufacturing and mission implementation.

Operational objectives

- Improving space systems and launcher developments sustainability
- Reducing cost and operational constraints
- Improving monitoring and autonomy

Development goals

- Fast increment of the Low to Mid TRL levels building blocks technologies of New Space Transportation Solutions
- On-ground demonstration and/or market readiness
- Focus on software and digital tools

Scope

- Advanced technologies and digital sensors for new space transportation, such as:
  - Smart avionics with modularity and reusability drivers
  - Health monitoring system and smart sensors
  - Structural health monitoring addressing thermo-mechanical monitoring and damage detection

Collaborative Earth Observation and Satcom missions for Space solutions

This call will focus on the maturation of the Mid to High TRL level for developments of EO & SatCom technologies.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR 2.00 to 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 11.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply:

	If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used
Technology Readiness Level	Activities are expected to start at TRL 5-6 and achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome

Projects are expected to contribute to the following outcome(s):

In Communications satellites

Objectives are:

- To enable the European Space Industry to maintain a significant share of the global connectivity market by increasing the performance of space satellite networks, new type of control and ground segments being fully integrated into the terrestrial networks. This will also be needed in enabling the European Space Industry to maintain its global leadership role in Earth observation missions and systems.
- To target new commercial services and applications enabling a digitalisation of space solutions. Such solutions could be addressing in synergy the requirements of data transfer for analytics and observation system, and deploying a 5G/6G network in space, enabling massive data repatriation, direct to device services (D2D, i.e. satellite communications with unmodified smartphones) and non-terrestrial network (NTN) integration, Quantum applications, … A continuous development of key technology stacks will ensure European sovereignty in the future and will strengthen the industry against the competition from USA, China and others.

In Earth Observation satellites

Objectives is:

- To develop advanced Earth observation payloads, technologies and processing means (on ground and in space), for all types of observation missions.

Digitalisation is a major enabler for enhancing the value of an E2E EO system. Indeed, processing applied to the multi-sensor data, on-board or on-ground, with or without calling for IA, can significantly enhance the resolution of the final data set and resulting image/analytics (e.g. digital SAR back-end electronics, optical images post-processing etc.). Besides, persistent imagery modes (e.g burst, video) require new generations of digital processors and on-board memories. Furthermore, digital optimisation of the data flow (autonomous decision, selective downlink, ground-segment efficiency) directly improves the E2E timeliness of an EO system (from request to delivery). Lastly, the enhancement of E2E data resilience and integrity calls for digital technologies on-board and, on the ground, end-to-end objectives.

Operational objectives

In Communications satellites

- Improving ground and space data distributed computing and processing
- Edge computing/cloud capacity close to the payload (ground-space segments optimisation)

In Earth Observation satellites

- Digitally enhance EO imagery performance and mission timeliness
- Advanced EO-payload systems and technologies, including onboard and ground processing

Synergies

- Direct tasking by end-users and on-board treatment of data
- Harmonisation of building blocks interfaces
- Enhancing data security and system resilience in Space and Ground Infrastructures
- Advanced space network architectures allowing, through in-orbit resources sharing, for lowering the environmental impact of future missions.

Development goals

- Mid to High TRL targets for EO and SatCom technology developments
- On-ground and in orbit demonstration and/or market readiness
- Focus on software and digital tools (e.g. algorithms), supporting HW (e.g. processors, electronics) from design to operation phases

Scope

For Communications satellites

- End to End Mission capabilities
    - Satellite network interconnectivity
    - Seamless integration into the terrestrial networks
- Energy efficient connectivity and compatibility with 5G & 6G waveforms.
    - Constellation and Network software management system
    - Optical communication
- Satellites as network nodes in a distributed system
    - Flexible and modular testbed: Multi-orbit and terrestrial integrated satcom architecture
    - Need common protocols across the comms chain. (similar to SDA standard but for civil)
    - Faster reaction time between the acquisition and the availability of data
    - Ubiquitous use of orbital resources
    - Distributed computing – do the computing where the data is, how best to combine final result

Earth Observation satellites

- On-board processing to optimize EO missions' performance or timeliness
    - Standardized software framework to host embedded edge-computing applications (AI, Machine Learning, ...)

    - Data/signal image processing to optimise algorithms, AI-based or not (e.g addressing compression, autonomous action, front-end/back-end performance etc.)
    - Enhanced downlink and uplink capabilities (e.g. for better reactivity)
- EO ground segment interfaces and data flows standardisation and adoption (evangelisation)
    - Development of ground-segment digital building-blocks in coherence with adopted standards
- Smart multi-source EO intelligence information fusion
    - Innovative intelligence information extraction and fusion exploiting multiple data sources (EO sensors and other space-based data along with ground-based data)

Synergies

- Maturing high performance processing payload H/W to support space network capabilities including an improvement in downlink and tasking capabilities of the European infrastructure.
    - In-orbit re-configurability
    - Network resilience
        - Multi-band transmission
        - Interference: detect, identify, locate and isolate
        - Vulnerability assessment of spacecrafts systems
        - Space weather free communications
    - Data integrity
    - Data security
        - Low-cost Cyber Security
            - Genuine European low-cost solutions
            - Quantum technologies chips and sensors
        - Data encryption
    - Data authentication
    - AI/ML chain covering both imagery and signal data
- Maturing technologies and products improving system security and threats identification
    - Host/Network Intrusion Detection/Prevention Systems for space systems and networks (space segment)
    - Security engineering of space systems architecture (end to end)
    - Capability to safely operate systems by different users with strict security boundaries
    - Improve the interoperability of our systems to enhance their mutualisation in system of systems
- Resources usage optimization
    - Operational optimization: increase the mission envelope and lifetime thanks to a better knowledge of the system in real time based on digital twinning
    - Design optimization: increase future systems efficiency thanks to a better use of the operational return of experience of legacy systems
    - Advanced techniques for large system of systems or multi-missions' operations optimization
- Environmental impact minimization of future missions
- Tools to support the measure of key environmentally driven criteria through increased resource sharing: minimization of the mass to be launched, development cycle reduction,

digital nodes sharing through several missions, optimization of the ground systems for a lower environmental footprint, etc.

Digital solutions for autonomy for space transportation systems, design and simulation tools

This call will focus on the maturation of the Mid to High TRL level for New Space Transportation Solutions technologies.

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of EUR 4.00 to 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 7.00 million.
Type of Action	Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used
Technology Readiness Level	Activities are expected to start at TRL 5-6 and achieve TRL 7-8 by the end of the project – see General Annex B.

Expected Outcome

Projects are expected to contribute to the following outcome(s):

Key areas for service improvement are health monitoring systems, enabling real time subsystem monitoring through all mission phases, including predictive maintenance and refurbishing in case of reuse, high speed sensor networks for on board real-time data feeds, enhanced ground-board high-data rate communication and multicore on-board computer and using Artificial Intelligence algorithms to process high volumes of data.

Models for mission, system design and optimisation, able to integrate life cycle analysis, engineering and environmental models for optimisation of development through manufacturing and mission implementation.

Operational objectives

- Improving space systems and launcher developments sustainability
- Reducing cost and operational constraints

- Improving monitoring and autonomy

Development goals

- Mid to High TRL targets for New Space Transportation Solutions developments
- On-ground demonstration and/or market readiness
- Focus on software and digital tools

Scope

- Advanced technologies and digital sensors for new space transportation, such as:
  - Smart avionics with modularity and reusability drivers
  - Health monitoring system and smart sensors
  - Structural health monitoring addressing thermo-mechanical monitoring and damage detection