EDF-2022-DA-SPACE-ISR: Innovative multi-sensor space-based Earth observation capabilities towards persistent and reactive ISR

Indicative budget:

The Union is considering a contribution of up to EUR 40 000 000 for this topic under the call EDF-2022-DA.

Number of actions to be funded: Up to one action may be funded for this topic

Objectives

Space-based Intelligence, Surveillance and Reconnaissance capabilities are core enablers for Defence and Security missions.

Today, several European Member States own or are developing sovereign high-end space- based optical, SAR[27] and SIGINT[28] assets and associated capabilities allowing them to understand crises and complex situations outside Europe and at its boundaries. Those assets, necessary to monitor and react effectively to different threats and events related to national and international security and safety, are currently being developed nationally with different degrees of governmental and industrial collaboration in accordance with the different national and international policies and priorities.

However, these highly performing assets allow only limited revisit over an area of interest. They do not permit either a quick and smart reaction to an event detected on-board or a very quick satellite tasking and data reception upon a decision taken on the ground. Besides, some imagery applications of high interest for defence (such as optical video, low light, infrared or hyperspectral imagery and on-board processing for faster and more efficient transmission) remain insufficiently covered.

*General objective*

This topic aims at developing an affordable constellation of small satellites, including its ground segments able to handle various types of sensor payloads (*e.g.,* optical video, low light, infrared, hyperspectral, RADAR, SIGINT) for Intelligence, Surveillance and Reconnaissance (ISR) applications. Such a constellation would complement high-end existing military capabilities while allowing responsive and smart tasking and data collection for near real-time tactical use.

This topic may also pave the way towards a collective and concerted approach regarding a future operational European Earth observation capability for ISR applications.

*Specific objective*

The specific objective of this topic is to define the overall architecture of the constellation, with particular attention to miniaturization, responsiveness, affordability, and complementarity with on-going EU and national projects, and to develop the associated components (sensors, platforms, ground segments and other key sub-systems), providing global and reactive coverage to address Member States, associated countries and EU needs in terms of innovative ISR capabilities and near real time intelligence.

[27] Synthetic aperture radar.

[28] Signal intelligence.

One of the challenges is to achieve high performance payloads compatible with small satellites, in order to procure an affordable constellation that can federate European Member States and Norway around a shared capability. In this context, industry will have to propose a development that leads to an affordable solution in terms of non-recurring and recurring costs. Indeed, high revisit capability and need for variety of sensors inherently requires deploying a constellation(s) of assets: the proposed development must therefore particularly look into miniaturised, mutual and/or standard components for the satellite platforms and payloads in order to reduce the costs, and into solutions for high data rate transmission and processing.

The topic will also have to address the challenge of ensuring that the proposed solution can be adapted to various forms of cooperation (at transnational and/or multi-agency level) to build, following the EDF project, a full-fledge multi-user and multi-sensor constellation, be its components and/or the full constellation jointly or nationally procured.

## Scope and types of activities

### *Scope*

Project proposals must address the development of a European space-based Earth observation multi-sensor constellation of small satellites for ISR applications. It must include the definition of the concept of operations (CONOPS) for such capability, its overall architecture including system level activities (*e.g.,* choice of orbits, inter-satellite links (ISL), data relay satellites, ground stations, raw data management and processing and ISR post-processing analysis) and the definition of each component of the end-to-end system, composed of the satellite platform, the ISR payloads and the ground segment(s).

Project proposals must consider various options for each component of the system based on existing solutions, adapted solutions and/or new developments. Different development stages can be considered for the project, depending on the current maturity level for each component or ISR payload. Synergies with industrial technology roadmaps and with national, multinational and EU programmes, studies and projects (*e.g.,* EDIDP, EDA, EU space programme/secure connectivity) are also encouraged.

Project proposals must not duplicate the work requested in 2020 in the call topic EDIDP- MSC-MFC-2020 *Multifunctional capabilities, including space based surveillance and tracking, able to enhance the maritime awareness (discover, locate, identify, classify and counteract the threats)*[29].

[29] https://ec.europa.eu/info/funding tenders/opportunities/portal/screen/opportunities/topic-details/edidp-msc-mfc-2020

*Types of activities*

The following types of activities are eligible for this topics

| Types of activities (art 10(3) EDF Regulation) | | Eligible? |
|---|---|---|
| (a) | Activities that aim to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence (**generating knowledge**) | No |
| (b) | Activities that aim to increase interoperability and resilience, including secured production and exchange of data, to master critical defence technologies, to strengthen the security of supply or to enable the effective exploitation of results for defence products and technologies (**integrating knowledge**) | Yes (optional) |
| (c) | **Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions | Yes (mandato |
| (d) | **Design** of a defence product, tangible or intangible component or technology as well as the definition of the technical specifications on which such design has been developed, including partial tests for risk reduction in an industrial or representative environment | Yes (mandato |
| (e) | **System prototyping** of a defence product, tangible or intangible component or technology | Yes (optional) |
| (f) | **Testing** of a defence product, tangible or intangible component or technology | Yes (optional) |
| (g) | **Qualification** of a defence product, tangible or intangible component or technology | Yes (optional) |
| (h) | **Certification** of a defence product, tangible or intangible component or technology | Yes (optional) |
| (i) | Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies | Yes (optional) |

The following tasks must be performed as part of the mandatory activities of the project:

- Studies

  the development of the CONOPS, possibly considering existing space ISR capabilities in order to develop a robust and secure system. The CONOPS must:

  - include the description of how the user interacts with the ISR constellation, and how relevant parts of the tasking, collection, processing, exploitation, and dissemination (TCPED) process are done,

- including in terms of multi-users resource sharing and automation of the mission planning/image chain to reduce the operation activities and costs and improve timeliness of information;
- be developed considering current and expected threats, in order to steer the feasibility analysis and the design phase in terms of integrity, confidentiality and availability requirements at both space and ground segment levels;
- investigate the use of existing private and governmental assets to define and tune its development;
- consider as an objective to reduce the manpower needed to operate the system from mission planning to data processing, taking also into account the limited resources available on-board small satellites;
- where possible, take into consideration as a starting point, for the end- user consultations, the needs and requirements already commonly agreed by the Member States and Norway.

the consolidation of the mission requirements;

- Design

  the design and definition of the end-to-end capability (constellation architecture, type of satellites and sensors, associated ground segments, including operations support tools, interfaces) meeting mission requirements at least up to the Preliminary Design Review (PDR); as part of this task, the following elements must be considered:

  - the type of constellation and orbits (e.g., sun-synchronous, elliptical, inclined orbits) to maximise revisit over the areas of interest as defined in the CONOPS, while allowing for non-predictable patterns and/or observation of a given scene under a variety of conditions;
  - the type of sensors on each satellite and on different satellites to optimize collection and processing of data with respect to the type of objects of interest (ability to detect, classify, identify) and operational/environmental conditions (day/night, clouds, presence of threats…);
  - the ability to re-task for gathering additional information, for example by tipping and cueing on other satellites of the constellation and/or interfacing with external systems;
  - the technical and operational architecture, including procedures and autonomy;

  the design and definition of the associated components (platform, sensors and ground segments) and key enabling technologies;

  - innovative ISR payloads (e.g., optical video, low light, infrared, hyperspectral, SAR, SIGINT, electro-magnetic spectrum monitoring)
  - and associated mutualised and/or standardized platforms compatible with a small satellite format while achieving required performances;
  - flexible, scalable and modular processing capacity (at space and ground segments

level) allowing the implementation and testing of a variety of functionalities such as, for example, cloud detection and re-tasking, change detection, target detection, classification and recognition, resolution enhancement techniques, data compression and/or selection of area of interest in order to reduce required downlink bandwidth;

- ways to speed up satellite tasking, data delivery and information production (e.g., on board processing, autonomy, inter satellite link (ISL), use of space-based data relay infrastructure, ground stations and gateways and developing innovative communication systems);
- scalable and modular architectures for the space and ground segments, defining mutual/standardized interfaces and building blocks and thus allowing for easy scalability of the system as well as modular exchange of components for adapting to different missions and operational needs;
- ground stations and dissemination network design and alternatives (e.g., higher frequency band) to improve the data rate and compensate the low on-board transmitting power and automatic allocation of contact opportunities;
- ISR data processing solutions (e.g., making use of AI30-based and/or high-performance computing technologies) in order to obtain a better situational awareness, considering the reuse and complementarity of functionalities and infrastructures available in the EU and developing dedicated interoperability layers to allow a secure and effective exchange of data among the EU Member States and associated countries;
- definition of generic import/export functions and formats in view of possible interface with external systems such as governmental and commercial systems and database;
- encryption means both for the downlink and the uplink, in order to provide secure communication links for military, governmental or any other application that requires confidentiality.

The following tasks may be performed as part of the optional activities of the project:

- Prototype
  - the development of a prototype for selected payloads and/or subsystems;
- Testing and qualification
  - testing (test campaign) and qualification (up to qualification review) of selected payloads and/or subsystems.

[30] Artificial intelligence

Functional requirements

The capability to be developed should meet the following functional requirements:

- high revisit: develop a scalable solution allowing to accommodate a growing number of satellites (same or different payloads) within the constellation, ultimately to reach, for some use cases, intra-hour revisit;
- affordable very high spatial resolution: achieve resolution below 0.5 m with small satellites for optical visible video/still imagery and SAR (*e.g.,* low altitude orbit, on- board processing);
- operational timeliness improvement: develop the capability to dynamically (re)task a satellite (*e.g.,* within a few minutes); ability to perform automatic tipping and cueing; reduce downlink latency and enhance data downlink throughput; for some use cases, reduce time between tasking of the constellation and delivery of the relevant information to the end-user (*e.g.,* tactical use);
- highly digital architecture allowing advanced and flexible on-board processing: enable autonomous extraction of actionable information from the captured imagery and data, and automatic preparation of complementary tasking of the constellation(*e.g.* autonomous decision to lock image over a defined object or area of interest pin- pointing), even with different acquisition modes (*e.g.* video) for target detection and analysis (classification, recognition, identification) depending on task/mission, including SIGINT;
- space-to-ground efficiency: allow both high data rate downlink and optimisation of downlink efficiency, where relevant making use of on-board processing capabilities;
- new space imagery and SIGINT applications for Defence and Security: develop new sensors, processes and processing compatible with a small satellite and allowing to provide new type of products of interest for Defence and Security;
- big data analysis: to develop a system that could support Big Data management to achieve high-speed analysis (including fusion) and streaming of multi-sensor data for ISR purposes;
- interoperability: develop a system that is inter-operable with external systems (*e.g.,* with interfaces allowing information exchanges across participating Member States and associated countries and with the EU);
- security requirements: develop a system that takes into account the necessary needs for integrity, confidentiality and availability (this should include affordable crypto for up- and down-links) and the multi-user dimension of the constellation (while anticipating possible future access by other institutional users for civilian missions (*e.g.,* security or emergency).

Expected impact

Such new ISR capability will have a very high impact over the tactical means of the European stakeholders before and during a crisis, in term of:

- reactivity (rapid availability of information after request);
- added value of the information collected (nature, resolution and complementarity with other ISR sources).

The nature of the solution (constellation of small satellites allowing sharing of resources between

EU Members States, Norway and other users) will also allow shared or joint procurement and in-service support while preserving a sufficient level of sovereignty.