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ANNEX 3

ANNEX

to the

Commission Implementing Decision

on the financing of the European Defence Fund established by Regulation (EU) 2021/697 of the European Parliament and the Council and the adoption of the work programme for 2024 - Part 2 and amending, concerning the provision of business coaching services, the Commission Implementing Decision C(2021) 4910 final on the adoption of the work programme for 2021, the Commission Implementing Decision C(2022) 3403 final on the adoption of the work programme for 2022 - Part II, and the Commission Implementing Decision C(2023) 2296 final on the adoption of the work programme for 2023 - Part II

2024 call topic descriptions

ANNEX 3

2024 call topic descriptions

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1. Content of the document

This document contains the description of all topics to be addressed by the seven EDF 2024 calls for proposals.

2. Call topics description

2.1. Call EDF-2024-RA

- **Targeted type of actions:** Research actions
- **Form of funding:** Actual costs grants following the call for proposals
- **Targeted type of applicants:** Any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation
- **Indicative budget for the call:** EUR 154 500 000[1] to support the following 8 call topics addressing 7 categories of actions:

2.1.1. EDF-2024-RA-SENS-ART: Advanced radar technologies

- **Indicative budget:** EUR 35 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

New types of threats are difficult to detect and track, in particular those with stealth characteristics, hypersonic speeds, slow airborne motion, small highly manoeuvring and when saturation attack tactics are used. Facing such threats, existing surveillance radar systems are reaching their limits in terms of detection range, angular domain coverage, tracking and recognition capabilities. Consequently, the objective of this topic is to mature the required technologies and concepts to cover the need for situational awareness by achieving advanced high-performance and a highly integrated multifunction system that may support radar, electronic warfare (EW) and possibly communication functions when feasible and advantageous, enabled through the development of active electronically scanned array (AESA) antennas.

Specific objective

This topic addresses the maturation of new RF sensor technologies, such as, but not limited to, high-power, high-frequency (up to Ka band), multi and wide band operation both active and passive, adaptive waveform design, modern AESA antennas with digital beam-forming, advanced resource management, innovative signal processing and spectrum-sensing techniques, multiple-input/multiple-output (MIMO) radar, multi-static configurations and cognitive capabilities with for instance Artificial Intelligence/Machine Learning (AI/ML). The aim is to render radars highly versatile and adaptive, while being compatible with operational constraints in terms of performance, size, weight, power consumption and cost (SWaPC).

[1] The budget earmarked on 2024 appropriations for this call may be complemented by an amount of up to EUR 44 500 000 from 2025 appropriations. This 2025 complementary budget is subject to the adoption of a separate financing decision.

These advances are expected to continue paving the way for more integrated capabilities with respect to radiofrequency (RF), microwaves and electronics, permitting the integration of the functions of radar, electronic warfare and desirably communications into existing or new platforms when feasible and advantageous. The specific understanding, development and management of AESA antennas is essential in this regard.

Scope and types of activities

Scope

Proposals must address research on innovative RF sensor technologies able to improve the performance of current radar systems and deepen into the concept of multifunctional capabilities when feasible and efficient.

As agreed with supporting Member States and EDF Associated Countries, challenging scenarios must be proposed, Associated Countries, after being analysed by using different combinations of radar techniques and selected as the most appropriate solutions in terms of performance, feasibility and cost. In that regard, the proposals should consider active and/or passive RF systems, stationary and/or mobile, single band and/or multiband using a wide coverage of the spectrum, multiplatform, adaptive and flexible with cognitive capabilities that suppose a strong impact and significant effects in the theatre of operations, increasing survivability, interoperability and resilience of the EU Member States’ and EDF Associated Countries’ Armed Forces.

This set of technologies should be conceived to be integrated in different platforms and with the capacity to be part of a network able to cover wider areas and work synergistically in order to improve the detection, tracking and identification capabilities of challenging targets. Examples of those are the stealthy ones (low RCS), tactical ballistic missiles (TBM) and hypersonic missiles, or when saturation attack tactics are used and targets are immersed in clutter or protected by jamming.

Proposals should not address the network aspects.

The improvement of the technological enablers of the AESA antennas should be covered as a mean to allow the multifunctional concepts and improve the general performance of the radar against new types of threats.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover the following tasks as part of mandatory activities:

- Generating knowledge:
  - Development of novel algorithms and methods for the previously mentioned challenging scenarios including difficult functionalities. Development and simulation of the specific innovative waveforms to be used. Development of scenarios where challenging targets should be included.
  - Generating knowledge on the application of cognitive techniques (e.g., AI techniques like reinforcement learning) for adaptive waveform and beamforming design, signal processing (e.g., inverse synthetic aperture radar (ISAR)) and radar resource management, aimed at improving clutter mitigation, signal to noise ratio (SNR) enhancement and target classification development and improvement. Particularly, research to define and learn decision-making policies in unknown dynamic environments.

- Development of innovative spectrum sensing techniques and waveform design algorithms to capitalise spectrum awareness to face with spectrally crowded scenarios.

- Research and development of new electronic sensing/electronic attack/electronic protection (ES/EA/EP) techniques incorporating advanced and sophisticated algorithms. Develop and apply AI/ML or other methods to modern EW to probe, sense and characterise threats and then automatically generate countermeasures to new types of threats in real-time autonomously and adaptively.

- Studies on innovative solutions for environmental antenna protection for efficient multi and wideband operations (up to Ka-band).

- Research on EU Multifunctional RF AESA enabling technologies and architectures optimised to specific scenarios (improving the size, weight and power -SWaP- when imposed by the platform) maturing compact and high-performance building blocks including, but not limited to, RF antennas, front ends and digital hardware (HW).

- Incorporate Modelling & Simulation, digital twin techniques and methodologies from the beginning in order to have a deeper insight of the real system behaviour from the concept development until system development, operation and end of life covering the entire lifecycle.

- Improvement of inverse synthetic aperture radar (ISAR) techniques.

- Integrating knowledge:

  - Studies on different concepts and architectures of radar systems, including stationary vs. mobile, multiband/multichannel/multifunction or passive vs. active to understand the benefits and possibilities of the different options and configurations for challenging targets.

  - Integration capabilities with respect to RF, microwave, electronics or processing as enablers for the development of new systems and architectures that can confer superiority against the adversary.

  - Research on the integration of the functionalities given by radar and electronic warfare together with the communication functionality, when feasible and advantageous to achieve a multifunctional capability.

- Feasibility studies:

  - Feasibility studies of the selected technologies for the optimised functions in specific configurations including multifunction.

  - Studies on digital engineering methodology adoption within the design and development cycle i.e., digital twin implementation and modelling.

- Research on passive radars technology with the analysis of the feasibility and availability of different illuminators of opportunity (IOs).
- Study to explore ubiquitous 3-D radar concepts and evaluate possible performance benefits enabled by new system architectures consisting of a rose of equi-spaced staring beams over 360 degrees, which can be steered in elevation (i.e., multibeam architectures and cylindrical arrays), especially in terms of enhanced Doppler characterisation of targets with respect to conventional 3-D radar.

- Design:
  - Design a multifunction RF sensor based in compact AESA antennas with the multiplicity of characteristics requested: active/passive, single band or multiband, multiplatform, stationary and mobile. It should be able to select the most appropriated configuration for each specific kind of target.
  - Design and develop demonstrators of the subsystems, techniques and components necessary to achieve the previously mentioned system.
  - Modelling of new processing algorithms of radar, EW and possibly communications as part of a potential future digital twin/simulator, enabler for the optimisation of a multifunction system.

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of sensors, notably those described in the call topics EDF-2021-SENS-R-RADAR related to *Advanced radar technologies* and PADR-EMS-2019 related to *Electromagnetic Spectrum Dominance*.

Additionally, the proposals should substantiate synergies and complementarities with the foreseen activities as described in the call topics EDF-2023-DA-SENS-GRID[2] related to *Sensor grid*, EDF-2023-RA-SENS-EMSP[3] related to *Electromagnetic signal propagation*, and EDF-2024-DA-C4ISR-AIMA related to *AI-based multifunctional AESA SD transceiver*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- The architecture of the multifunctional system should allow the integration of existing and new technologies and should follow an integrated modular and scalable architecture (IMOSA) paradigm.

- The design and architecture of the sub-systems and the technologies to be integrated in mobile small platforms should be modular, SWaP-C scalable, supporting miniaturisation.

[2] Funding & tenders (europa.eu)
[3] Funding & tenders (europa.eu)

- Capability of airborne/ground/seaborne targets detection and tracking of challenging threats including stealth, hypersonic missiles/glide vehicles, TBM and drones together with cognitive radar management and processing methods.

- Target recognition should exploit techniques like ISAR, range-Doppler as well as micro-Doppler signature information and enhance system capabilities thanks to AI/ML classification algorithms.

- Increase the survivability and resilience of common future European radar surveillance systems by flexible use of active and passive modes to augment each other or replace if necessary.

Expected impact

The outcome should contribute to:

- More precise and valid situational awareness information through the flexible use of cognitive capabilities in an RF sensor system combining multiple functions like radar, electronic warfare and, (when viable and beneficial) communications, through multiple bands and agile waveforms, working in active or passive modes to strengthen the recognised air/ground/maritime picture.

- Standardisation of hardware, waveforms, software, data transmission protocols, data format, procedures etc., within the framework of an interoperable, modular and scalable architecture, in order to increase interoperability among participating parties and existing or designed products.

- Reduction of the electromagnetic spectrum use and achievement of the higher level of survivability of the overall system, and particularly for the platforms involved, through the development and integration of cognitive capabilities.

- Demonstration of the capacity and feasibility of the different innovations developed in the project through tangible and measurable results.

2.1.2. EDF-2024-RA-DIGIT-ASMEP: Automated structural modelling for effect prediction

- **Indicative budget:** EUR 15 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several actions may be funded for this topic.

Objectives

The effects of attacks on structures such as buildings, plants, oil tanks, pipelines, bridges, dams, etc., are a common subject of concern to military planners and engineers, weaponeers, munition designers, battle damage assessors, and modelling and simulation analysts and developers. However, predicting such effects currently involves a large uncertainty due to the difficulty in estimating the relevant characteristics of these structures. There is therefore a need to efficiently estimate such characteristics from available data such as imagery or documentation and to combine them with effect prediction models to provide reliable predictions. During operations, this should be performed in a limited time and possibly with limited available computing power. This is especially important for relatively large urban areas including many structures.

Software solutions for automated structural modelling and effect prediction should therefore be developed. They should offer the best possible accuracy, and trust should be ensured in the measurement of their performances. Given the complexity of the task, they need to rely not only on physics-based models but also on artificial intelligence, and they should be evaluated in an objective manner on data that is representative of the targeted use cases. This involves the collection and annotation of representative data. In order to ensure the reproducibility of experiments and for economic reasons, it is important that such data is reusable for similar developments, including by other technology developers. It also involves the testing of systems on new data using documented metrics and testing protocols, in a way that ensures comparability with similar systems developed by such other actors.

Models for the prediction of effects of weapons on structures are often used in conjunction with other models in decision support tools, for example to estimate freedom of manoeuvre or effectiveness of communication. Scalability and compatibility with such other models and tools should therefore be ensured.

Scope and types of activities

Scope

Proposals must address the development and evaluation of software systems for modelling structures from multisource imagery and other relevant available data, and for accurately predicting the effects of weapons on these structures. This includes the collection of relevant databases for training and testing the systems.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (optional)
(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	Yes (optional)

Types of activities (art 10(3) EDF Regulation)		Eligible?
	industrial or representative environment	
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating knowledge:
  - Research on automatic and semi-automatic modelling of structures from imagery and other relevant sources of information, as well as on effect prediction models, aiming at optimising the overall accuracy of effect predictions.
- Integrating knowledge:
  - Collection and annotation of representative data enabling to train and test the systems.
  - Integration of the system processing modules into demonstrators.

In addition, the proposals may also cover the following tasks:

- Generating knowledge:
  - Participation in objective and comparative evaluation campaigns or technological challenges, notably those that may be organised in the context of the EDF call topic EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAO on *Multi-source satellite image analysis*.

The proposals should substantiate synergies and complementarities with foreseen, ongoing, or completed activities in the fields of automated structural modelling and effect prediction.

Functional requirements

The proposed product and technologies should meet the following functional requirements.

- Systems should take as input various sources of information such as satellite or aerial images (optical, IR, radar, SAR, LiDAR, etc.) and documentation if available, and estimate structural features, such as position, dimensions and composition in terms of materials of structures in specified areas. Ground and soil characteristics may also be estimated if relevant for effect prediction.
- The estimated structural models should be usable in effect prediction tools. They should enable users to estimate the degree of damage to targeted structures and their surroundings, as a function of the nature and size of the weapons used. They should also enable to estimate the potential levels of casualties depending on the nature of an attack and of the estimated human presence in a given area. Secondary effects such as window shattering should be taken into account.
- The models should lead to maximum accuracy prediction on representative databases. Reproducibility of the measurements should be ensured, by participating in existing technological challenges whenever relevant, or by organising test campaigns open to other actors if needed.
- The databases foreseen for training and testing the systems should be described in the proposals. These databases should be reusable beyond the project. The foreseen organisational and technical framework for such data sharing should be described in the proposals. In particular, the entity or entities in charge of the data production and distribution should be clearly identified in the proposals.
- Systems should allow non-expert users to evaluate effects of a certain threat over a specific target. They should also provide signatures of such targets, e.g., radar signatures. Systems should also be able to use expert user inputs in order to produce structural models in a semi-supervised manner. Demonstrators should include a user interface enabling these users to supervise the model production.
- Models and systems should be scalable and compatible with broader models supporting decision making beyond the prediction of attack effects.

Expected impact

The outcomes can not only have a positive impact on a wide range of military activities, but may also have a dual use potential. They should in particular contribute to:

- Enhanced decision-making for operational planning activities such as targeting activities, planning of indirect fires or aerial bombings over enemy positions in urban areas, while limiting the risks of collateral damages.
- Vulnerability assessment, protection, and improvement of own infrastructure and prediction of impacts on infrastructure and operations due to e.g., natural hazards such as seismic events and tsunamis.

2.1.3. EDF-2024-RA-AIR-AAM: Concept study on advanced air-to-air missiles

- **Indicative budget:** EUR 35 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several actions may be funded for this topic.

Objectives

General objective

Air-to-air combat is a challenging and interdisciplinary field in a high-threat and time-critical environment. The air-to-air missiles currently in service are generally of a good technological standard. However, the requirements for all aspects of such missiles are constantly increasing in number and complexity. Given this environment, it is conceivable that future air-to-air missiles will need to be designed and operate differently.

The key challenge is to prepare for the development of a missile that can counter future air threats on an economically viable basis.

Specific objective

The main objective is therefore to develop at European level concepts and operational requirements for a short-range air-to-air missile (SRAAM) to primarily counter modern 5th and future 6th generation combat aircraft and other airborne threats, such as UAS and cruise missiles. Opportunities and limitations are to be explored in various disciplines, such as image processing, target detection, navigation sensors, missile hardware related to kinematic properties, propulsion, warhead unit design, missile guidance, missile control, multi-sensor data fusion, missile computer architecture design, advanced materials (e.g., morphing materials), new production techniques and network integration.

The research activities performed are expected to mature relevant technologies up to TRL[4] 5-6.

Scope and types of activities

Scope

Proposals must address the definition of requirements for a Future Short-Range Missile (FSRM) to be primarily used on combat aircraft for air-to-air applications, as well as a modular interceptor concept to minimise impact on aircraft integration and maximise internal carriage capacity.

In addition, proposals must address the possibility to use the FSRM or its components for a ground-based air defence application.

The proposals may also explore combined mode operations (i.e., air-to-air and air-to-ground) for the FSRM.

Types of activities

The following types of activities are eligible for this topic:

[4] Technology readiness level

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**)	Yes (optional)
(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)
I	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of the Studies mandatory activities:

- Analyse the operational requirements for future FSRM, using IR with extended visual range or RF or combining both technologies, to primarily counter modern 5th and future 6th generation combat aircraft and other airborne threats such as UAS and cruise missiles.

- Analyse readiness and accessibility of relevant technologies in the European market, in particular in the field of target detection, acquisition and tracking, as well as, but not limited to, image processing, infrared imaging seeker, navigation sensors, guidance laws, missile hardware structure, propulsion, war head unit design, fusing, guidance and control, multi-sensor data fusion, missile computer architecture.

- Define missile concepts and evaluate them against the identified operational requirements, including the use of a standardised missile simulation.

- Analyse the extent to which the FSRM can be economically viable in terms of low development, maintenance, integration and production costs, with a consistent European supply chain, including during a prolonged active conflict.

- Analyse the operational and technical requirements for the FSRM or its components to be used for a ground-based air defence application.

- Analyse the possibility of using a close loop follow on support based on a state-of-the-art prognostics and health management methodology of the FSRM.

In addition, proposals may also analyse any operational and technical requirements in view of possible combined (i.e., air-to-air and air-to-ground) operations for the FSRM.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- The envisioned FSRM should achieve a high kill probability against a variety of airborne threats, primarily against modern 5th and future 6th generation combat aircraft as well as UAS and cruise missiles, but other airborne threats may also be considered (e.g., large aircraft, light attack aircraft, helicopters, medium-range air defence missiles, air-to-air missiles and similar threats/objects, etc.);

- It should include High Off-Boresight (HOBS) abilities and lock-on after launch capabilities;

- It should be resilient to countermeasures, depending on the technologies foreseen for the FRSM and for the targeted aerial threats;

- Model assessment should be performed in a simulation-driven environment with digital-twin missile concept.

Expected impact

The outcome should contribute to enhancing the readiness of the EU Member States and the European Technological and Industrial Base (EDTIB) for any further development of state-of-the-art future air-to-air missiles, by:

- Boosting missile technology within the EDTIB.
- Improving the Member States' and EDF Associated Countries' understanding of operational requirements for a FSRM, including benefits from key technologies.

2.1.4. EDF-2024-RA-AIR-UCCAS-STEP: Unmanned collaborative combat aircraft (U-CCA) systems

- **Indicative budget:** EUR 15 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several actions may be funded for this topic.

Objectives

General objective

It is an overarching challenge for the EU and EDF Associated Countries to develop a consolidated common perspective on the long-term applications, requirements, solution concepts and technology needs for an advanced EU Unmanned Collaborative Combat Aircraft (U-CCA) system to support the 5th and 6th generation fighter in a highly contested A2/AD[5] environment, also in regards to interoperability with NATO.

U-CCA systems could be conceived as unmanned aerial multirole systems, part of a System of System (SoS), aimed at combined air operations, which are able to act in teaming with lower autonomy levels agents and manned platforms in order to execute tasks in various operational scenarios, while revealing extended survivability capability.

Although development studies have been underway for some time in the main European aeronautical companies, with the financial support of the respective EU Member States and EDF Associated Countries, the added value of this topic lies in the development of a common vision for a U-CCA system and its related high-level requirements.

Specific objective

This topic aims to explore technologies, concepts, products, processes and services related to U-CCA systems in different possible configurations. These U-CCA systems are expected to be combat ready, hence highly manoeuvrable and, depending on the mission assigned, they should also be able to collect multispectral information from large areas, while identifying and countering potential threats in a wide range of missions including, but not limited to, defensive and offensive counter air, anti-surface warfare (ASuW) and suppression/destruction of enemy air defences (SEAD/DEAD), in a highly contested environment.

The U-CCA system should therefore be characterised by a high degree of autonomy and operational effectiveness, a large reconfigurable payload capacity and a flight envelope that allows teaming with fighters, including, but not limited to, with 5th and 6th generation, and support to other future aerial platforms in the context of a SoS approach for future combined air operations, including its expendability in specific imputable scenarios.

Scope and types of activities

Scope

Proposals must address feasibility studies and preliminary design to explore new/improved concepts, configurations, mission architectures, flight and mission functions, disruptive technologies related to U-CCA systems, and trusted autonomy levels for effective networked operations including manned-unmanned teaming (MUM-T) in demanding denied/contested environments.

Types of activities

The following types of activities are eligible for this topic:

[5] Anti-Access/Area Denial

	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**)	Yes (optional)
(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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of the mandatory activities:

- Studies:
  - Define potential use cases, scenarios and applications in a wide range of operations, in particular in terms of natural environment, type of targets and air defence capabilities, levels of autonomy, rules of engagement with other cooperative and non-cooperative platforms, allocation of roles, interoperability and cyber protection;
  - Define technical requirements in line with high level operational requirements to be provided by the supporting Member States and EDF Associated Countries;

- Define U-CCA concepts to be evaluated in view of operational effectiveness against identified metrics;
- Explore current and foreseen technologies in the EU supply chain with regard to U-CCA and respective technological enablers, and identify roadmaps leading to feasible architectures and configurations through a complete and integrated approach, with a view to:
  - Identify, for each possible U-CCA configuration, a structural concept with assessed and consolidated aerodynamic, stability, controllability, launch and recovery and disassembly characteristics;
  - Identify and analyse advanced flight technologies and navigation concepts, propulsion logics and systems, including smart thermal/energy management and related AI-driven solutions;
  - Increase knowledge on advanced autonomy logics and algorithms (such as those related to autonomous emergency behaviour management system, trusted autonomy, cooperative autonomy, accelerated decision making), with reference to existing autonomy taxonomy, e.g., from NATO;
  - Enhance aircraft flight technology, logics and systems, including smart actuation and related AI-driven solutions;
  - Identify a suitable Open System Architecture for U-CCA;
  - Increase knowledge on advanced systems in terms of sensors, communication systems and effectors, to be evaluated through installation surveys;
  - Define interoperability requirements so as to be operated together with multiple assets including fighter aircraft, motherships and other UAS[6];
  - Identify the enablers for connectivity with future manned and unmanned combat aircraft (e.g., remote carriers and smart weapons including the cruise missiles) for supporting the more demanding operational scenarios (including sea and ground combat operations in contested and highly contested environments);
  - Carry out parametric studies, for instance, but not limited to, structured MBSE (Model-Based System Engineering) work methodology, to identify the critical parameters and merit criteria that could later be useful to assess the goodness of each configuration;
  - Identify the requirements for the development of integrated training systems to enable the training path and associated assets to mature, in line with the evolution of military pilot training concepts and the

[6] Unmanned aerial systems

highest levels of interoperability between future manned and unmanned aerial platforms;

- Suggest considerations to Member States and EDF Associated Countries regarding development, procurement, impact on training, basing and/or storage of platforms, spares, raw materials and operations, as well as hybrid warfare.

- Design:
  - Develop a Trusted Autonomy Methods & Validation;
  - Design and implement a digital twin methodology for requirement refinement and validation, concept optimisation and assessment supported by modelling of operational scenarios and reference missions and by simulation tools at mission and system / sub-system levels.

The proposals should also address the design of a preliminary demonstrator of U-CCA to prove the feasibility of the proposed concept.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of training systems, notably those described in the call topics EDIDP-ACC-CJTP-2019[7] related to *Combat jet training platforms* and EDF-2021-AIR-D-CAC[8] related to *European interoperability standard for collaborative air combat*.

Functional requirements

Depending on each configuration to be explored, the proposed product and technologies should meet the following functional requirements:

- The U-CCA system should be able to operate in the foreseen future combined air operations as part of a System of Systems, including in joint missions and operations, within a fleet of mixed air systems and platforms, hence able to:
  - Autonomously take-off and land, with means depending on its final configuration.
  - Automatically plan the mission task;
  - Carry a multitude of mission configurable payloads, depending on the mission and role of the U-CCA in the SoS;
  - Execute tasks (based on priorities and high-level control of the C2[9] and other SoS assets) to perform the mission assigned;
  - Dynamically re-plan the mission to minimise exposure to threats, react to unpredicted events, cope with task changes, replace other unavailable SoS components;

[7] Funding & tenders (europa.eu)
[8] Funding & tenders (europa.eu)
[9] Command and Control

- Sense, detect, deconflict and engage with collaborative and non-collaborative aerial assets;

- Autonomously fly in formation, including route following and re-joining with other manned and unmanned SoS components.

- The U-CCA system should include:

    - Flight & Mission Autonomy;

    - Improved survivability allowing to operate in highly contested and spectrum denied scenarios;

    - Cooperative Autonomy – Swarming and MUM-T allowing human to take control in an efficient way, whenever needed, while reaching the overall mission objectives;

    - Connectivity/interoperability management principles to set up secure, resilient, agile communication infrastructure and architecture and to provide connectivity services.

Expected impact

The outcome should contribute to:

- The emergence of a consolidated EU perspective for U-CCA systems in EU Member States and EDF Associated Countries and for the EDTIB[10].
- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- More effective multi-role and networked operations, including MUM-T, collaborative operations in spectrum-constrained environments and swarming formation.
- Improvement of the degree of autonomy of unmanned systems, while still allowing humans to take control whenever needed.
- To increase operational capability by identifying new concepts and options for dispersed basing of U-CCAs.
- The identification of potential "quick-wins" in the context of U-CCA solutions.
- The generation of prerequisites and inputs for the long-term development of future EU/NATO U-CCA perspective, with a view to reduce the fragmentation in EU UAS fleets.
- Air combat solutions able to reduce the exposure of risk to humans, with a more precise effectiveness to reduce the collateral effects.
- The interoperability between EU armed forces and with NATO Allies.

[10] European Defence Technological and Industrial Base

2.1.5. EDF-2024-RA-GROUND-IWAS: Intelligent weaponry and ammunition systems

- **Indicative budget:** EUR 30 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several actions may be funded for this topic.

Objectives

General objective

In the context of future armed conflicts, greater focus is likely to be placed on the precision, the effectiveness and the affordability of ammunition and missiles in order to increase the capacity to neutralise adversary forces while avoiding unintended casualties and collateral damages among friendly units and non-combatant third parties.

Research activities to develop for next generation of European intelligent ammunition is required to enhance Member States precision strike capabilities.

Specific objective

There is a request to extend the range of ground artillery, rockets and missiles, while increasing their precision. Currently, existing solutions to correct the course of gun launched ammunition are either ITAR or do not fully achieve the required precision. European related research efforts have been modest in the past years. A few concepts have matured to become commercialised products, though with limited performance.

This topic aims to pave the way for the development of an autonomous European state-of-the-art capability in the field of high precision weaponry, such as guided mortar and artillery ammunition (shells and rockets), missiles, and other munitions with loitering capabilities. Such systems should aim to increase precision in Global Navigation Satellite System (GNSS)-contested/denied environments, reduce dependency on non-EU satellite navigation, and improve terminal guidance and effects on targets at extended ranges, as well as providing more affordable solutions. The use of data fusion techniques and high accuracy Micro-Electro-Mechanical Systems for Inertial Measurement Units (MEMS IMU) should be considered.

Scope and types of activities

Scope

Proposals must address:

- Technologies for increasing ammunition precision guidance, navigation and control, particularly in GNSS-contested/denied environments.
- Technologies for improving terminal guidance of ammunition, in particular for engaging moving targets at speed and concealed targets.
- Technologies for maximising effects on targets at extended ranges, with the possibility of scaling effects, abort mission or re-targeting during flight.

In addition, proposals should address:

- High accuracy, MEMS IMU and data fusion techniques.

- Navigation solution based on GNSS should have Galileo PRS as main source of positioning and timing.
- Terminal guidance capabilities (e.g., based on Semi-active laser (SAL) or image guidance systems like Imaging infrared (IIR)).

Furthermore, proposals may address:

- Concepts for introducing guidance or course correction to legacy munitions by using existing interfaces, such as the fuze-well in artillery shells.
- Technologies for loitering capability.
- Technologies for collaborating/swarm with other munition capability.
- AI algorithms applied to guidance, navigation and control, even to moving targets and target detection.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No

Types of activities (art 10(3) EDF Regulation)		Eligible?
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating and Integrating Knowledge:
  - Perform a threat assessment, taking into account the modern battlefield, lessons learned from current peer-to-peer conflicts, and deployed or about to be deployed advanced technologies.
  - Develop research activities for maturing identified technologies.
- Studies:
  - Feasibility studies concerning proposed technologies.
- Design:
  - Develop technologies suite to TRL 6.
  - Preliminary definition and design of the proposed components and technologies.
  - Detailed definition of the proposed components and technologies.

The proposals should substantiate synergies and complementarities with foreseen, ongoing, or completed activities in the field of ammunitions, notably those described in the context of previous EDF calls for proposals (e.g., EDF-2023-DA-GROUND-IFS[11] related to *Indirect fire support*) and its precursor programmes (e.g., EDIDP-NGPSC-PGA-2020[12] related to *A Platform for long range indirect fire support capabilities* and EDIDP-NGPSC-LRIF-2020[13] related to *Programmable and guided ammunition*).

<u>Functional requirements</u>

The proposed product and technologies should meet the following functional requirements:

- Defeat semi-hard and hard targets, via the delivery of a heavy payload, with the possibility to tune the effect according to the mission.
- Terminal precision below 10 meters (CEP[14]50), proven either by system in the loop simulation or live firing.

[11] Funding & tenders (europa.eu)
[12] Funding & tenders (europa.eu)
[13] Funding & tenders (europa.eu)
[14] Circular error probable

- Integrated target detection and terminal guidance capability, be based on Semi-active laser (SAL) and/or Imaging infrared (IIR), other imagery systems or any other solutions, such as enabling technologies for Multi-Mode seeker systems (e.g., EO, IR, RF). Such systems should be effective against both moving and stationary targets.

- Flight-guided by GNSS and/or inertial measurement unit and/or any other cost-effective means. If GNSS guidance, the system should be compatible with both GPS and Galileo.

- Resistance to GNSS jamming and spoofing and operable in GNSS contested environments.

- Concepts for mortars and artillery ammunition should prove gun-firing capability.

- Concepts for 155 mm artillery ammunition should be compliant with the Artillery JB MoU[15] and be tested in a proven 155 mm 52-calibre artillery gun.

- The ammunition should be programmable before firing, with minimum interference with the weapon system.

- The setting of the artillery fuze should be able to be conducted at least through inductive settings according to commonly applicable standards in order to allow its use in platforms with embedded inductive fuze systems.

- In-flight re-targeting capability (including mission change and/or a mission abort when needed) should be assessed for the different categories of ammunition.

- Resilient communications to ensure a human-in-the-loop capability (avoiding target control and/or designation by unauthorised actions) in case the concept is not based on a fire-and-forget approach. The system should be Cyber resilient.

- Performances should be achieved without modifying the requirement of existing European launchers.

- In case of a concept based on course-correction fuze, it should be aimed at replacing traditional fuzes on standard artillery ammunition with a combined fusing and guidance kit and preferably shallow fuze-well compatibility.

- Ammunition safety of use should be as high as possible, as per the best standards related to life duration and insensitiveness to aggressions. Compliance with NATO STANAG 4439[16] (related to insensitive munition) and STANAG 4187[17] (related to safety) should be ensured as far as possible.

- Open architecture and modularity should be applied on smart guided ammunition families, allowing different software versions (algorithms / libraries) to be loaded in the same hardware version.

[15] Joint Ballistics Memorandum of Understanding - 220870.pdf (state.gov)
[16] https://nso.nato.int/nso/nsdd/main/standards?search=4439
[17] https://nso.nato.int/nso/nsdd/main/standards?search=4187

- ITAR-free in all components. All components of the concept for later integrative components (SAD, additional Ignition chains, et.al.) should also be investigated and ITAR-free and fulfil European requirements (REACH).

Expected impact

The outcome should contribute to:

- 2023 EU CDP[18] on Land Based Precision Engagement.
- High Precision effects and minimum collateral damage for engaging selected difficult-to-identify/acquire targets.
- Engage critical and time sensitive areas and point targets including threat air defence, missile launchers, tactical operation centres and assembly areas.
- European tangible capabilities in intelligent weaponry and ammunition systems for different missions.
- EU mastery of technological building blocks and strategic autonomy on smart ammunition.
- Ensure EU capability in smart guided/precision ammunition for different applications.

2.1.6. EDF-2024-RA-PROTMOB-FMTC: Future mid-size tactical cargo aircraft

- **Indicative budget:** EUR 30 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

Tactical transport aircrafts are the workhorses of battlefields, fulfilling missions like airdrop delivery, parachutist drop, logistics, medical evacuation (MEDEVAC), air to air refuelling, special missions under harsh and adverse conditions, which are critical for the success of military operations. Operations in hostile environments demand e.g., built in electronic warfare self-protection systems, and set requirements on the platform performance/build up in order to be suitable for the task, and furthermore to operate with limited ground infrastructure (e.g., unprepared runways).

Beyond their pure military role, tactical transport aircrafts are also key assets for a better civil defence/protection and EU-internal needs, with critical contribution to disaster relief, search-and-rescue, and sanitary crises response.

Besides the A400M, which is on the high-performance side of the capacity, the initial conception of the majority of currently operating tactical aircraft (C130) is now 40 years old, and there is a need for a new medium tactical European aircraft, lighter than the A400M that could provide a complementary capacity for tactical transport.

[18] qu-03-23-421-en-n-web.pdf (europa.eu)

Currently, some EU Member States are operating medium payload tactical military transport - aircrafts within their fleet, which can be replaced with growing capabilities, able to cope with the envisaged operational challenges.

Specific objective

This topic is an opportunity for Europe to federate efforts by providing the EU defence community (EU Members States, EDF Associated Countries and industry) with robust elements to decide what the 2035+ future of EU military tactical transport could be.

By maturation of the required technologies and innovations, this topic aims to lower the risks for the Future Mid-size Tactical Cargo aircraft (FMTC) capability development and therefore the costs for further potential development phases, with a view to possibly enabling first flight of prototype early 2030's.

Scope and types of activities

Scope

Proposal must address the maturation of technologies and the implementation of a state-of-the-art data management system, in two main areas:

- Technology and Concept maturation:
    - Progress on Technology Readiness (TRL) process (objective: achieve TRL5-6 in 2027 benefiting as much as possible on dual-use technology) and technologies selection for FMTC;
    - Mature Aircraft Architecture and Concepts, as selected by the supporting Member States and EDF Associated Countries.
- Implementation of new trends in Data management and In-Service support.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities along the following two main areas:

A- Technology and Concept maturation:

- Multidisciplinary Aircraft optimisation and Flight Physics streams: Develop external layout and overall aircraft performance validation through Digital Twin capabilities complemented by preliminary Wind Tunnel Tests (atmospheric) by using the most appropriate wind tunnel capabilities on low cost scaled and modular Aircraft model.
- Smart Systems stream:
  - Mature and implement Integrated Modular Avionics technology with reconfiguration capabilities, also exploiting the use of civilian technologies for aircraft functions and military missions' systems in order to maximise shared computing resources, return of investments, portability and maintenance throughout the life cycle, operational effectiveness and military standards compliance at lower life cycle cost;
  - Mature and implement wireless interfaces technology for interconnection of avionics equipment.
  - Smart Aircraft flight control for enabling eco-friendly wing functions:
    - Optimising fuel consumption, e.g., with improved electrically powered actuator system, but not limited to them.
    - Optimising tactical capabilities through aerodynamics optimisation.

        - Loads alleviation functions to reduce aircraft structure weight.

- Propulsion and Energy streams:

    - Assess propulsion architectures, including new concepts (e.g., open rotor, low speed propeller);

    - Mature 100% Sustainable Aviation Fuel propulsion compatible technologies;

    - Assess the portability of less bleed and more electrical Aircraft and alternative Propulsion System technologies to military applications, complying with the peculiar missions and requirements;

    - Implement Propulsion contemplated technology, fulfilling the flight and mission performance requirements, while meeting Life Cycle Cost sustainability and affordability criteria;

    - As an option to refine the identification of boundaries between low and high voltage architectures to optimise energy needs, considering design constraints, certification and maintenance aspects;

    - The solution for the engine should be tested in simulation independently of the platform.

- Aerostructure stream:

    - Mature material technologies (light materials and based on full life cycle environment impact analysis), meeting sustainability and affordability criteria;

    - Improve Virtual Structure Testing capabilities to limit physical testing of new technologies to minimise waste for required physical tests.

- Eco friendly Cockpit & Cargo streams:

    - Develop virtual mock-ups for Cockpit and Cargo;

    - Implement Enhanced Human Machine Interface concepts.

- Multi-mission and Connectivity streams:

    - Mature technologies and product architecture enabling flexible and quick aircraft reconfiguration for multi-mission capabilities beyond pure Cargo mission (according to the multi-mission capabilities requirements provided by the supporting Member States, for example, but not limited to: Self Protection, Air-to-Air Refuelling, Medevac, Signal Intelligence, Maritime Patrol, Antisubmarine warfare, Intelligence, Surveillance and Reconnaissance, Airborne Early Warning and Control, Command and Control Centre) and connectivity and interoperability of FMTC in a sovereign and multinational network, preparing it for collaborative and cloud based operations.

B- Implementation of new trends in Data management and In-Service support:

- Implement New Data Management Technology (Combat Cloud readiness to improve interoperability, Improved Data Analytics, Digital Twin for design and manufacturing or other equivalent technologies).

- Implement New In-Service Support Technology (Advance maintenance, Fleet monitoring and Availability enhancement).

- Autonomy, Digitisation and Artificial Intelligence streams:

    - Collaborative Autonomy. Mature technologies for an enhanced flight control, management autonomy and crew decision making (for instance Manned-Unmanned Teaming and Increased Tactical situation awareness, Single Pilot Operation, Automatic Take-off and Landing);

    - Enhanced Autonomy in aircraft subsystems. Improve the use of AI/ML in mission critical and safety critical systems; as well as during the flight checks and fault-detection procedures for instances; in order to increase the overall effectiveness.

In order to ensure no duplication of efforts, the proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of transport aircraft, notably those described in the call topic EDF-2022-RA-PROTMOB-FMTC[19] related to *Future mid-size tactical cargo aircraft*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- Main missions:

    - Should provide tactical air mobility for armed forces by tactical airlift or aerial delivery;

    - Should perform medical evacuation, refuelling on ground (ALARP[20]and FARP[21]) and air-to-air refuelling.

- Additional missions:

    a. May be able to perform (with modifications/additions) some additional missions.

- Main specifications:

    - Should be able to fly at a very low level, in both visual and instrument meteorological conditions, day and night, through hostile or contested environment in semi or non-permissive environment, worldwide;

[19] Funding & tenders (europa.eu)
[20] As Low As Reasonably Practicable
[21] Forward arming and refuelling point

- Should use a wide spectrum of airfields, non-prepared and unpaved runways without significant runway damage and short take-off and landings qualities;
- Should have performances not significantly altered in severe environment: dust, sand, humidity, maritime environment, extreme temperature conditions (arctic and desert environment) and mountainous areas, hot and high, CBRN[22].

- Main qualities:
  - Should have Economic favourable operating costs;
  - Should promote interoperability with other strategic and tactical transports that are operated by the supporting Member States and EDF Associated Countries at the time the FMTC enters into service;
  - Should allow incremental and frequent updates including cockpit interface and connectivity, and offer growth potential with Modular Open System Architecture (MOSA) type;
  - Should have a maintenance-oriented design to favour a high level of serviceability.
- Cargo specifications:
  - Should be able to load and unload freight with a maximum autonomy on ground, including engine running on/offload operations (ERO);
  - Should have the ability to perform a large variety of drop (material and personal).
- Support and deployment ability:
  - Should have maintenance scheduled and unscheduled inspections reduced to a minimum in order to optimise the fleet availability;
  - Military operations in any environment should not significantly increase the maintenance burden or accelerate the ageing of parts.
- Airspace management compliance:
  - Must be compliant with all current regulations to operate worldwide according to general and operational air traffic rules and allow easy adaptation to upcoming regulations.
- Environmental protection and sustainability:
  - Should implement state-of-the-art solution in terms of environmental protection and sustainability and keep carbon dioxide emissions as low as possible.

[22] Chemical, Biological, Radiological, and Nuclear

Expected impact

The outcome should contribute to:

- Foster a multi-national European footprint.
- The European Technological growth, connecting FMTC to existing Air Systems and future civil programmes.
- Close capability gaps in line with the EU Member States and EDF Associated Countries’ operational needs, providing an alternative to aged fleets.
- Ensure technology maturity and insertion for a mid-2030’s tactical mid-sized cargo aircraft solution.
- Reinforce the European strategic autonomy in the military transport segment.
- Develop vital military capabilities in highly contested environments (e.g., tactical transport, airdrop, air assault) against technologically advanced adversaries.
- Develop EU MEDEVAC capabilities and EU disaster relief, and sanitary crisis response capabilities.
- Promote and secure the European technological and industrial ecosystem, based on a potential new aircraft development.
- Enhance cross-border collaboration (from large industrial groups to SMEs) through the opportunities offered by the several elements of the platform and its architecture.

2.1.7. EDF-2024-RA-UWW-SACOM-STEP: Secured and adaptive underwater communications for UUSs

- **Indicative budget:** EUR 24 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several proposal can be funded for this topic.

Objectives

Efficient, robust, and secured underwater communication is a key enabler for maritime uncrewed systems (MUS), including the use of uncrewed underwater systems (UUS). There is a need for exchange of classified information in MUS. Identification, authentication and authorisation are important functionalities in the field of digital trusted gateways. Further research needs to be done to overcome the physical characteristics of the underwater environment that limits the possibility of having wireless communication systems with sufficient robustness and bandwidth required by many underwater warfare functions.

The specific objective is to design and demonstrate feasibility of secured (communications security COMSEC and transmission security TRANSEC) underwater (network) communication solutions (acoustic, optical, or other modalities) for UUSs designed for military needs.

Scope and types of activities

Scope

The proposals must address research of secure underwater communication, with focus on **acoustic** technologies, including networked solutions, that contribute to the improvement of current performance, through the creation of new low-distortion modulation techniques, interference avoidance/suppression mechanisms, recovery from fading, etc. This requires the communication to be highly adaptive and self-reconfigurable. To improve the performance of the acoustic underwater communication channel, the environmental conditions in situ, such as noise, depth, sound velocity profile, etc., must be considered.

Furthermore, research in underwater communication, with focus on **optical** technologies, must be addressed, with the aim of improving bandwidth and transmission distance, reducing signal distortion, in order to improve communication within and between platforms, networks and infrastructures.

The security aspects should be included in the underwater communication systems. The challenging communication conditions (low data rate, long latency, delay and Doppler spread effects, highly varying channel conditions and high noise levels, etc), which may result in unreliable and low-bandwidth communication links, also give special challenges for security mechanisms. This should be taken into account in the design of the complete communication system (modulations, network protocols, etc), carefully balancing modular/layered approaches and cross-layer approaches[23]. During the design, performance metrics describing efficiency and robustness should always be assessed, to avoid that this gets too much compromised by the security measures. Also, encryption methods should be considered in order to obtain metrics about its efficiency. Different encryption methods can be used depending on the mission state, data classification level, etc.

The suggested design solutions should be tested in a realistic environment in salt water.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (optional)
(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 (mandatory)

[23] The proposed solutions and design should have a view of inclusion of communication security in (candidate) military standards, e.g., future updates of NATO STANAG 4748 (JANUS) and upcoming NATO STANAG 4817 (MDCS/CATL), where NATO STANAG 4748 is planned to be extended with the EDA-SALSA stack for robust adaptive underwater acoustic network communication.

Types of activities (art 10(3) EDF Regulation)		Eligible?
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks:

- Integrating knowledge on:
  - Security techniques integrated or working in tandem with the underwater communication systems, through encryption and/or other methods. The techniques must take into consideration specific challenges in underwater communications, including short block lengths in many scenarios.
  - Integrate knowledge on suitable key distribution techniques, which may include quantum key distribution and resilience to quantum computer enhanced counterparts (post-quantum cryptography).
  - Authentication and integrity protection for autonomous underwater communication systems (including tampering).
  - Application interfaces between MUSs and their embedded secured underwater communication systems.
  - Definition and assessment of suitable performance metrics for secured underwater communication systems.
  - A simulator-based benchmark test to certify that the given concepts of this proposal are realistic and feasible.

- Studies on:
    - In-depth research that addresses the most critical technology gaps to enable capabilities for efficient, robust, and secured underwater communication.
    - The research must be supported by experimentation.
    - Studies must address methods, systems and devices for efficient, robust, and secured underwater communications for MUS.
    - The communication architecture, design and solution-space must include networking capabilities. Gateway to allow links between underwater communication networks and surface/terrestrial and satellite networks.
    - Studies must include wireless underwater communication systems (including modulations and network protocols) suitable for MUS, based on at least acoustic and optical modalities (using e.g., generic propagation models).

  Studies must include suggestions for optimal technologies for different underwater environmental conditions (taking into account features such as noise, depth, sound velocity, etc.).

- Design of:
    - Integration of secured underwater communication systems on MUS.
    - A final comprehensive System-of-systems (SoS) demonstration involving MUS with embedded secured underwater communication.
    - The design must respect an open (non-proprietary) architecture approach and interoperability standards.

In addition, the proposals should cover at least the following tasks:

- Studies:
    - A supply chain analysis addressing critical dependencies for the EDTIB.
- Design:
    - Security multilevel mechanisms, designed specifically for underwater communication systems and their challenging communication conditions, including analysis of the possible hurdles for obtaining official accreditation for handling classified information.
    - The proposals should address secure underwater communications for areas with a wide variety of conditions, such as deep water, harbours and fjords.
    - The proposals should address both LPI (low probability of intercept) and LPD (low probability of detections) communications.
    - The proposals should include solutions suitable for vehicle-to-vehicle communications in a heterogeneous system-of-systems, including MUS-MUS, MUS-nodes and C2[24]-nodes.

[24] Command and control

- The proposals should explore solutions for high bandwidth and short-range acoustic communication, low bandwidth and long-range acoustic communication, covert acoustic communication and very short range and very high bandwidth optical communication.
- The proposals should explore solutions for both horizontal, slant, and vertical communications.
- The solutions should be tested in a realistic environment in salt water.

A final test should demonstrate results of the research activities, present potential military value and identify technology shortfalls that need to be addressed in subsequent activities in the EU.

Functional requirements

The proposed design and technologies should meet the following functional requirements in support of secured underwater communication, including TRANSEC and COMSEC:

- Monitoring the network with intuitive and ergonomic graphical user interface (GUI) while the UxVs are performing the mission.
- Sending of tasks and commands, either inter-vehicle or from an operator through an ad hoc underwater communication network consisting of USVs, UUVs and sensor nodes.
- Exchange of data such as:
  - Lists of targets or anomalies detected by a survey UUV, sent to an UUV with equipment for identification in e.g., mine countermeasures (MCM) or seabed warfare (SBW) operations,
  - Target, tracks or data packets from active or passive sonars, to improve the performance in an unmanned system-of-systems ASW operation[25],
  - Recorded data from stationary sensor nodes on the sea floor to UUVs,
  - Recorded data from specific sensor mounted on board the UUVs (for instance, conductivity temperature and depth, CTD, probe),
  - UxV critical data (such as battery level, mission status, speed).
- Multi-sensor data fusion for underwater positioning.
- Adaptivity of the system depending on the number of nodes in the network and the conditions of the underwater channel(s).
- Key distribution for the applied security mechanisms.

[25] Complementarity with the call EDF-2023-DA-UWW-ASW could be considered in the scope of exchange of data.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Strategic autonomy of EDTIB in the area of secured underwater communication.
- Interoperability of EU Member States' and EDF Associated Countries' Armed Forces.
- Improvement of protocols and standardisation of underwater communications.
- Improvement of range and bandwidth of underwater communications.
- Improvement of command-and-control systems for unmanned platforms.
- Improvement the safety and security of underwater communications.

2.1.8. EDF-2024-RA-SIMTRAIN-BRG-STEP: Methods for bridging reality gaps

- **Indicative budget:** EUR 15 000 000 for this topic under the call EDF-2024-RA.

  Beneficiaries should provide Financial Support to Third Parties (FSTP)[26] in accordance with the conditions provided below. The support to third parties can only be provided in the form of lump sum grants. The maximum amount to be granted to each third party is EUR 60 000. Up to EUR 2 400 000 of the total call topic budget may be allocated as FSTP. The FSTP in the proposals should target but not exceed 16% of the requested EU contribution.

- **Number of actions to be funded:** Several proposals may be funded for this topic.

- **Conditions related to FSTP:** conditions for selection of third parties receiving financial support[27]:

  - Third parties must be established in the EU or in EDF Associated Countries;
  - Third parties must not be subject to control by non-associated third countries or non-associated third-country entities;
  - FSTP must target in priority SMEs, including start-ups. Applicants for FSTP must have self-assessed their SME status. The consortium should perform checks on the basis of random sampling in accordance with the criteria as defined in Article 2 of the Annex to Commission Recommendation 2003/361/EC. Participation of entities other than SMEs can only be accepted where no SMEs are available to demonstrate the capacity or expertise needed for the project during its lifetime.

[26] The cascade funding, formally known as financial support to third parties (FSTP), is an agile instrument that allows small and medium enterprises (SMEs), including start-ups, receive support and guidance to advance in their product and/or technology development.

[27] The support to third parties cannot be provided through services offered by the consortium directly.

- Should include a range of entities from different Member States and EDF Associated Countries and different sectors, including those not active in the defence sector;

- Certification at company level or approval as production organisation is not mandatory, but specific business coaching should be provided to non-certified companies. FSTP calls should aim to ensure a balance between experienced SMEs and newcomers;

- Financial support to third parties should be issued in up to two distinct calls with a target from minimum 10 and up to 20 beneficiaries per call, with a view to:

  - Give the third parties the opportunity to demonstrate their knowledge, technologies, capabilities and products;

  - Foster the possibilities for future involvement of these third parties in the European defence community.

- The following activities, but not limited to this list, may be considered for cascade funding:

  - Boot camps; customised trainings; coaching; technical and business mentoring;

  - Investor pitching events; matchmaking;

  - Hackathons; peer-to-peer evaluation by entrepreneurs;

  - Dedicated business mentors with public and private capital expertise;

  - Organising online training courses, webinars, virtual matchmaking platforms and marketplaces;

  - Technology showcase; internationalisation;

  - Customised support for specific challenges; proof of concept; validation; first client search; innovation management support.

- The beneficiaries may be involved in any type of task within the proposal. Possible tasks at the level of the call for third parties may include, but not limited to:

  - Feasibility studies on alternative solutions;
  - Preparation of sample technologies to be tested;
  - Analysis support;
  - Support the testing or the sample preparation;
  - The use of metaverse for defence applications;
  - Synthetic population in the area of operation / missions; Scenarios for area evacuation;
  - UxVs swarms and/or simulation of remoted pilot/ammunition ;

- Future scenarios and tactics;
- Algorithms;
- The weather effect on the area of operations (flooding, fires etc).

Objectives

General objective

Mission planning and execution in the present and future multi-domain operation environment (MDO) employing manned and unmanned force elements demand that the human decision makers are very well supported to be able to handle the complexity and dynamics of the battlespace and make decisions faster and better than the adversary.

In mission planning different types of operational capabilities need to be carefully coordinated in time and space to achieve mission goals and counter expected threats. Labour intensive manual planning is infeasible within the constraints of available time and resources. The general objective is to develop advanced automated support tools for the generation and evaluation of courses of action (COAs) in an MDO context. The toolset is expected to support wargaming[28] of the candidate COAs to ensure that commanders and staff can assess the plan and options in detail before final decision making.

Specific objective

This call aims to explore technologies, concepts, products, processes and services towards a common simulation framework for wargames/combat simulations with the potential to facilitate reinforcement learning for mission planning and execution support.

Re-planning and decision-making during mission execution are likely to be challenged in the interconnected, manned-unmanned, automated and high-speed battlespace. In the future, the clear distinction between mission planning and execution is expected to be challenged by exploiting battlespace information and predictive capabilities. Proper support is needed to speed up the OODA[29]-loop to outpace the adversary in the planning phase as well as in the execution phase.

The development and use of a computer-based decision support system that leverages AI, machine learning, wargames/combat simulations and digital twins of the battlespace has the potential to change the military planning and decision-making concept of operations (CONOPS).

Reinforcement Learning (RL) in Artificial Intelligence (AI) has shown a huge potential for solving planning problems in civilian applications. However, despite its headline success in video games, strategy games and other planning domains over the last few years, RL is not making similar progresses in the realm of wargames/combat simulations for military operations planning. Videogames leave a lot of margin when it comes to critical (life or death) simulation. Nevertheless, if access to classified data from the field is not possible, videogames data may be used for a proof of concept.

Simulation frameworks tailored to particular domains have played a major role in facilitating reinforcement learning in those domains, as witnessed by the impact of e.g., OpenAI Gym and the Arcade Learning Environment (ALE).

[28] In digital format
[29] Observe, Orient, Decide, Act

A common simulation framework for wargames/combat simulations has the potential of similarly facilitating reinforcement learning–support in mission planning and execution.

As it is related to EUDIS[30], this topic aims to support, in addition to the research activities, the creation of an innovation test hub in the field of simulation and training. To achieve this objective, financial support to third parties (cascade funding) (FSTP) is included as part of the grant. This should increase the opportunities for various smaller actors, including those not previously active in the defence sector, to adapt innovative simulation technologies for defence applications and to identify potential business opportunities in the defence sector.

<u>Scope and types of activities</u>

Scope

Proposals must address studies and design of a reinforcement learning environment/testbed or framework for training of AI agents to develop courses of actions in mission planning, including a flexible and open combat simulation framework fit for RL. It must address the need for rapid and user-friendly creation of scenarios, considering commander's objectives and intent, rules of engagement and other mission constraints (e.g., speed, resources, attrition). It must also include studies and design of a combat simulation system (not necessarily the same used for AI agent training) including trained AI agents to support mission planning. For the support to mission execution the scope includes studies and design of a digital twin of the ongoing mission for prediction and decision-making support. The proposal must establish a proof-of-concept demonstrator for verification, validation and demonstration.

The learning environment, including the combat simulation framework must be flexible and adaptive for different scenarios and domains. It must take advantage of open standards and open-source frameworks both within AI, simulation technologies (including C2[31]-Simulation interoperability) and mission sensor and mission data to the digital twin.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (optional)
(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 (mandatory)

[30] EU Defense Innovation Scheme, https://eudis.europa.eu/

[31] Command and control

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Studies:
    - Define scenarios and use cases.
    - Identify general operational needs and requirements, and more specifically, needs and requirements for simulation support in COA development, evaluation and wargaming. Needs and requirements for simulation support during mission execution, such as calibration[32] of simulation models[33] and the combination of the extensive flow of battlespace information in the future and the simulation results.
    - Describe how to use knowledge as constraints for AI models and how to (quickly) update/retrain models for specific missions.
    - Include research and identification of an appropriate Simulation Framework for wargames/combat simulations for mission planning and execution.
    - Explore the availability of data; real and/or synthetic data; validation of data.

[32] Calibration of models so these models will "copy" the operational reality / status (like a Digital Twin of the ongoing operation)

[33] Calibration of models in relation to the mission-context: knowledge of friendly forces behaviour (operating procedures, mission planning information) and of enemy forces (expected doctrine behaviour reduced or given by intelligence information)

- Contribute to the definition of a concept of operations (CONOPS) for the mission planning and execution support framework, with special emphasis on the human-machine collaboration between the AI-enabled planning and decision-making support functions and the operators. Explore how the CONOPS could change the military decision-making process (MDMP).

- Further explore existing open standards (e.g., NATO, NATO Modelling and Simulation Group (NMSG)[34], SISO[35]) and the need for new standards for simulation support in defence mission planning and execution applications.

- Explore means of verification, validation and acceptance (i.e., trust building) of the AI models for mission planning and execution support.

- Explore how the planning and decision-making support can explain proposed COAs and changes of plans during mission execution.

- Prepare activities for FSTP in the field of simulation and training and in accordance with guidance described previously in the call text under "Conditions related to FSTP".

- Design:

  - Propose an architecture design, comprising of both a Reference Architecture and proposed Solution Architecture.

  - Fulfil the requirements for simulation situations at least at the level of EU ambition (concerning number of battlegroups, concurrent operations and missions, potential opponents, etc.).

  - Design AI agents with analytics and predictive capabilities, by studying the three framework components (a testbed of simulation environments from a particular domain, a base line of general-purpose agents for that domain, and, finally, a generic interface between agents and simulation environments) to the level of a proof-of-concept, with particular emphasis on the first component, simulation environments.

  - Propose a design for a baseline of general-purpose agents. AI/RL-enabled modelling of battlespace agent behaviour, by designing and employing simulation approaches to comply with the requirements for AI-supported mission planning and execution, including Modelling and Simulation as a Service (MSaaS), simulation control, speed and parallelism.

  - Provide a clear design for verification, validation and acceptance of the AI models.

  - Organise at least one hackathon through an innovation test hub in the field of simulation and training (cascade funding).

[34] NATO M&S | NATO Simulation Standards
[35] Simulation Interoperability Standards Organization (sisostandards.org)

- Establish a proof-of-concept demonstrator, including a use-case identified in the studies, addressing its operational needs and requirements.
- Design and execute activities for FSTP in the field of simulation and training and in accordance with guidance described previously in the call text under "Conditions related to FSTP".

In addition, proposals should address at least the following study tasks:

- Explore current and foreseen technologies, for future needs;
- Study how the AI agents capabilities can be enhanced by a hybrid AI approach combining the symbolic and non-symbolic AI methods and possibly data farming.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- Frameworks for reinforcement learning, containing three main components:
  - A testbed of (fast executing) simulation environments from a particular domain (here: battlespace simulations for wargames);
  - A base line of general-purpose agents (in the form of reinforcement learning algorithms) for that domain;
  - A generic interface between agents and simulation environments;
- Simulate support for synthetic and realistic data generation for the development of AI models/agent behaviours.
- Collect realistic data and explore potential data sources from the field, pending availability and classification.
- Role for generative AI: Generate simulation environments, models and agent behaviour(s).
- Use MSaaS.
- Support for multi-domain simulation (and as a minimum land, air, maritime).
- Address electronic warfare as a domain.
- Include the weather element.
- The AI agents interface must be agnostic with respect to combat simulations/computer generated forces.

- Use open, commonly applicable standards (as recommended by NMSG, that could include IEEE[36], SISO, etc.).
- Include an easy-to-use human-machine interface.
- Meet the representation of mission and operations for example as the number of EU battle groups in accordance with the EU level of ambition, at the time of implementation.
- Include in the scenarios the role of UxVs.
- Have the capability for counter play.
- Be tailored for simulation for military operations.
- Consider a decentralised, service-based, architecture for military planning and decision-making support.
- Consider the need for human in the loop for the relevant cases of AI.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Faster and better planning and decision making (with less personnel) during mission planning and execution, resulting in higher mission success.
- Leverage Reinforcement Learning towards largely automating the modelling and implementation of expert-level (or beyond) competent battlespace agents, thereby greatly reducing the time and cost of course of action (COA) development and wargaming.
- Deliver a proof-of-concept demonstrator at least of TRL 5.
- Increase the opportunities for various smaller actors, including those not previously active in the defence sector, to adapt and apply innovative simulation technologies for defence applications.
- Increase business opportunities in the defence sector for EU and Associated Countries companies and promote technological edge in the field.
- Increasing the interoperability between EU armed forces and with NATO Allies.
- Increase opportunities and future involvement for third parties participating in FSTP in the field of simulation and training within tasks described previously in the call text under “Conditions related to FSTP”.

[36] IEEE - IEEE Standards

2.2. Call EDF-2024-RA-SI

- **Targeted type of actions:** Research actions
- **Form of funding:** Actual costs grants following the call for proposals
- **Targeted type of applicants:** Any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation.
- **Specific provisions for the call:**

  The proposals need to build upon or integrate results that have been achieved within one or several projects that had been funded under an EU R&D programme call with a focus on civil applications. The proposals must demonstrate the value added of bringing in the civil research (technologies or concepts previously not applied in defence sector) and the positive effect for the EDTIB. This previous project(s) may be completed or may still be active. The submitting consortium does not need to be constituted or even to include a participant or result owner of the previous project(s). However, applicants must provide a confirmation that they have or will have the necessary rights to use and commercialise the results of the previous project(s).

- **Indicative budget for the call:** EUR 25 000 000 to support the following call topic addressing one category of actions:

2.2.1. EDF-2024-RA-SI-MATCOMP-EC-STEP: Electronic components

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2024-RA-SI.
- **Number of actions to be funded:** Several proposals may be funded for this topic.

Objectives

General objective

European competitiveness is increasingly dependent on the development of electronics. In recent years, the opportunities offered by Systems-On-a-Chip have become very apparent in many different technology sectors such as telecommunications, military, automotive, financial, medical research, and others.

Fundamental to this development is the integration of processing hardware, embedded programming software and firmware and high-speed digital-to-analogue and analogue-to-digital technology with low power consumption technology into a single component.

There is a need to invest in a European RF-CMOS[37] supply chain and measures to mitigate the risk of export limitations connected to military applications. Building on the learnings from the GaN[38]-supply chain cooperation, and based on the growing demand for integrated circuits, a European supply chain initiative, catalysed by military needs, is likely to become a very important tool for future European prosperity and for ensuring a long-term strategy of non-dependence for critical defence technologies.

[37] Radio Frequency Complementary Metal-Oxide-Semiconductor
[38] Gallium Nitride

Specific objective

This topic aims to increase interoperability and resilience, including secured production and exchange of data, to master critical defence technologies, to strengthen the security of supply and to enable the effective exploitation of results for defence products and technologies. The action should define strategies for development and ownership of advanced RF-CMOS supply chain in Europe, possibly a European Silicon foundry base aiming for advanced technology nodes for analog (RF) and digital circuits, as well as technologies or methodologies that enable use of other foundries without compromising assurance, where assurance pertains to both availability of the supply chain and its security.

<u>Scope and types of activities</u>

Scope

The scope consists of two interacting parts:

- The development of RF-CMOS components and modules connected to current and future military applications, including the requirements for a production supply chain.

- How a non-dependent RF-CMOS European supply chain could be gained, or at least how measures to mitigate the risk of export limitations, high cost for low volume production or other limiting factor for a European supply chain can be implemented. A European supply chain must, but is not limited to, include one or more RF-CMOS fabrication site(s), mask generation, supply of wafers and other important raw materials necessary for advanced RF-CMOS processing. It may also include packaging and testing facilities.

Proposals must include studies, such as feasibility studies to explore new or upgraded products, technologies, processes, services and solutions.

Proposals should identify which components and modules are relevant for future systems and which manufacturing facilities are needed for such components and modules.

The action should develop a strategy for a European RF-CMOS fine pitch supply chain for manufacturing of high-speed and high-performance functional building blocks (data converters and FPGA[39]) in the next generations of digital AESA[40] Radar, wideband multifunctional RF systems. The nodes for each circuit (analog and digital) could be different to optimise the performance and be assembled with a system in package technology.

Taking in account the existing European manufacturing facilities and the civil programs such as CHIP JU, proposals should propose a design with a view to ensure:

- The non-dependence for defence systems integrating this RF-CMOS solution.

- The cost efficiency of the solution for low volume quantities (including NRE[41]).

The proposals must avoid unnecessary duplications with other EU, intergovernmental or NATO initiatives.

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[39] Field-Programmable Gate Array
[40] Active electronically scanned array
[41] Non-recurring engineering

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating Knowledge:
  - Describe the current European RF-CMOS supply chain and identify shortfalls and possible risks for military needs.
- Integrating knowledge:
  - Define functions and architectures for RF CMOS components.

  - Define typical specifications for RF CMOS components for the next generations of digital AESA Radars and wideband multifunctional RF systems from S to Ka Band.
  - Suggest silicon foundries for specified RF-CMOS components taking into account the following:
    - European foundries for sensitive components (sensitive means subject to export control from countries or industry)
    - The constraint of low volume.
- Studies:
  - Explore the feasibility of new or upgraded products, technologies, processes, services, solutions and production facilities.
    - Power efficient FPGA[42] technology and how IP-blocks could be integrated.
    - Firmware and software development environments.
    - High sampling speed high dynamic range and power efficient ADC[43] and DAC[44] technology.
    - Power efficient data transmission technology (within and between chip communication).
  - Develop strategies for ownership of supplier base including a silicon supply chain.
  - Develop strategies for development and ownership of a European foundry base aiming for advanced technology nodes for analog (RF) and digital circuits.
  - Develop strategy on how the military and civil community could interact to secure low-volume production.
- Design:
  - Design chip(s) and package for military RF CMOS components and modules for digital AESA Radars and wideband multifunctional RF systems from S to Ka Band.
  - Realisation and test of RF CMOS demonstrator for two applications: Digital AESA[45] Radars and wideband multifunctional RF systems from S to Ka Band.

[42] Field-Programmable Gate Array
[43] Analog-to-digital converters
[44] Digital-to-analog converters
[45] Active Electronically Scanned Array

The proposals may also cover the realisation and test of RF-CMOS demonstrator for more than these two applications.

Functional requirements

The proposed products and technologies should meet the following functional requirements:

- Proposed relevant components and modules for the requirements for the supply chain.
- Defined advanced technology nodes needed for realisation of e.g., high-speed and high-performance data converters and FPGA.
- Components encapsulated in order to withstand military harsh environment.
- Applicability for several defence applications such as avionics, radar, electronic warfare, communications, data security, ammunition and missiles.
- Compliance with REACH[46] and ROHS[47] regulations.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Future establishment of a European RF-CMOS fine pitch supply chain for defence.
- Secure the autonomy and non-dependent availability of critical analogue and digital functional building blocks in the next generations of digital wideband AESA RF systems.
- Gained knowledge regarding design and manufacturing of RF-CMOS as required for defence applications.
- Shared awareness on the need for RF-CMOS at European level as a basis for increased production volume for fine pitch chips in line with defence needs.

[46] Registration, Evaluation, Authorisation and Restriction of Chemicals - REACH Regulation - European Commission (europa.eu)

[47] Restriction of Hazardous Substances - RoHS Directive - European Commission (europa.eu)

2.3. Call EDF-2024-LS-RA-DIS

- **Targeted type of actions:** Research actions (dedicated to disruptive technologies for defence)
- **Form of funding:** Lump sum grants following the call for proposals
- **Targeted type of applicants:** Any consortium of eligible entities as defined in Article 9 of the EDF Regulation and involving at least two legal entities established in at least two different Member States or EDF Associated Countries (Norway). At least two of the eligible legal entities established in at least two Member States or EDF Associated Countries shall not, during the entire period in which the action is carried out, be controlled, directly or indirectly, by the same legal entity, and shall not control each other.
- **Indicative budget for the call:** EUR 40 000 000 to support the following two call topics:

2.3.1. EDF-2024-LS-RA-DIS-QUANT-STEP: Quantum technologies

- **Indicative budget:** EUR 24 000 000 for this topic under the call EDF-2024-RA.
- **Number of actions to be funded:** Several proposals may be funded for this topic.

Objectives

Quantum technologies count amongst the main emerging and disruptive technologies for defence capabilities. Within these quantum technologies, Quantum Sensing (QS) is one of the most mature domains and has the potential to notably impact defence operations. Nevertheless, significant technical challenges remain before operational systems can be developed. Further research is therefore needed in a range of QS domains such as quantum sensors for Positioning, Navigation and Timing (PNT), optronics and RF sensing. Besides, with the possible emergence of quantum computers, current technologies for secure communications face a risk of becoming compromised and need to be upgraded. There is therefore a need for research on technologies future-proof communication technologies such as quantum communication or quantum-resistant cryptography.

Scope and types of activities

Scope

The proposals must address at least one of the following technological domains:

a. Quantum sensing technologies for PNT

   The proposals should address quantum sensing technologies with the potential to improve PNT capabilities, such as high performances atomic clocks, quantum inertial sensors and gravimeters, and solid-state quantum vector magnetometers. Specific enabling technologies for improving size, weight and power (SWaP), to increase efficiency and/or ruggedness while lowering the overall footprint, should be addressed.

b. Quantum technologies for optronics and RF sensing

The proposals should address quantum technologies with a potential to improve imaging and optronic sensors by exploiting quantum properties such as superposition, tunnelling and entanglement. In particular, technologies exploiting single photon detection and its processing for seeing behind obstacles in non-line-of-sight configuration and/or in degraded visual environment, such as smoke and dust fog, should be addressed.

The proposals should also address quantum technologies with a potential to improve RF sensing and electronic warfare, such as ensembles of atoms in Rydberg state or superconducting quantum devices exploiting interference effects as well as colour centres in crystals or other quantum approaches.

c. Quantum technologies and/or quantum-resistant cryptography for secure communications

The proposals should address technologies with a potential to improve secure communications (including for multi-domain operations), such as quantum information networks, quantum cryptography and quantum random number generators, and/or quantum-resistant cryptography (post-quantum cryptography, PQC).

- For quantum information networks, techniques for using different transmission media such as fibre optics, free-space or water, including interface between different networks, may be addressed. Technologies to enable long-distance communication, such as quantum memories and entanglement swapping capabilities for quantum repeaters or high-precision pointing and optics for free-space quantum communications, should be covered.

- For quantum cryptography, a number of challenges remain to be addressed, such as Quantum Key Distribution (QKD) as cryptographic solutions, standardisation of quantum cryptographic protocols and interfaces, interoperability with other technologies (e.g., PQC), security certification of physical hardware border-node between quantum network domains, better SWaP and cost (SWaP-C) properties of the different quantum components (photodetectors, lasers, attenuators, modulators, etc.), connectivity and interfaces with classical devices needed for encryption/decryption of the sensitive data and for the management of the keys once generated such as Key Management Systems (KMS) and encryptors and development of photonic materials platforms for large scale integration.

- For quantum random number generators, challenges to be addressed include the need to increase the bit rate, the improvement of the form factor, miniaturise the devices, and extend the operational range.

- For quantum-resistant cryptography, several algorithms and approaches such as lattice-based, multivariate, hash-based and code-based cryptography may be addressed, as well as crypto-agility mechanisms. Challenges to be addressed include standardisation and integration or hybridisation between quantum and non-quantum algorithms. The combination with quantum cryptography and quantum networks may be covered.

The proposals must identify defence use cases and justify the relevance of the technologies proposed to be addressed with respect to these use cases, taking into account the wider landscape of potential solutions for these use cases and the deployment costs.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (mandatory)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating Knowledge:
  - Research on quantum technologies for PNT, optronics and RF sensing, and/or secure communications, as well as their possible combination or interoperability aspects.
- Studies:
  - Development and experimental performance evaluation of demonstrators addressing the identified defence use cases.
  - Analysis of technology maturation and industrialisation needs for defence applications, and drafting of future development roadmaps including supply chain, standardisation, certification, etc.

Moreover, the proposals may cover the following tasks as part of the optional activities:

- Integrating knowledge:
  - Standardisation activities.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of quantum technologies, notably those that may be performed in the context of the Quantum Flagship[48] and of space programmes, such as IRIS² [49].

Functional requirements

The proposed technologies should meet the following functional requirements where applicable for the domains addressed:

- Enhanced GNSS[50]-free navigation and high-precision timing;
- Enhanced accuracy, sensitivity and detection ranges for defence applications with respect to conventional sensors technologies;
- Enhanced sensor time response and signal bandwidth with respect to conventional sensors technologies and to constrains imposed by defence scenarios;
- Future-proof security of communication networks, including for long-range communications;
- Optimised SWaP-C and ruggedisation with respect to military environments and scenarios.

[48] https://qt.eu/
[49] IRIS² - European Commission (europa.eu)
[50] Global Navigation Satellite System.

Expected impact

The outcome should contribute to provide:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- An enhanced operational superiority in terms of PNT and sensing, and secure communications in the long term at optimal cost;
- An enhanced EU technological autonomy for quantum technologies for defence.

2.3.2. EDF-2024-LS-RA-DIS-NT: Non-thematic research actions targeting disruptive technologies for defence

- **Indicative budget:** EUR 16 000 000 for this topic under the call EDF-2022-LS-RA-DIS.
- **Number of proposals to be funded:** Several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** The requested funding should match the ambition of the proposed action and be duly justified. In any case, The requested funding cannot exceed EUR 4 000 000.

Objectives

The specific challenge is to lay the foundations for radically new future technologies of any kind with unexpected impact that aims to bring radical technological superiority over potential adversaries. This topic also encourages the driving role of new actors in defence research and innovation, including excellent researchers, ambitious high-tech SMEs and visionary research centres of big companies, universities or research and technology organisations.

Scope and types of activities

Scope

The proposals are sought for cutting-edge, high-risk/high-impact research leading to game-changing impact in a defence context. They must have the following essential characteristics:

- A disruptive impact in a defence context: the proposals need to clearly address how the proposed solutions would create a disruptive effect when integrated in a realistic military operation;
- Radical vision: the proposals must address a clear and radical vision, enabled by a new technology concept that challenges current paradigms. In particular, research to advance on the roadmap of a well-established technological paradigm, even if high-risk, will not be funded;
- Breakthrough technological target: the proposals must target novel and ambitious scientific or technological breakthroughs that can be experimentally assessed, and the suitability of the concept for new defence applications must be duly demonstrated.

Basic research without a clear technological objective targeting defence applications will not be funded.

The inherently high risks of the research proposed must be mitigated by a flexible methodology to deal with the considerable science-and-technology uncertainties and for choosing alternative directions and options.

The proposals must address disruptive technologies and should include clear descriptions of the proposed criteria to assess work package completion.

The proposals may address any area of interest for defence, such as, but not limited to, the following ones:

- Measurement and monitoring of physiological and cognitive state.
- Optimisation of cognitive performance in human-machine interaction, including for human-robot teaming.
- Blockchain applications (e.g., for Identification of Friend or Foe).
- Tools and applications improving cybersecurity talents screening.
- Artificial intelligence and robotic autonomous systems.
- System health monitoring and through life-cycle interoperability.
- Solutions for mechanical and “green” chemical recycling of waste of soldier individual equipment (uniforms, helmets, boots, rucksacks, plastic elements, harness, etc.)
- Concepts and corresponding technologies to ensure a safe water reuse throughout the entire water cycle of a deployable camp or a deployed combat group, including with microbial safety and hygiene considerations.
- Synthetic fuel production from waste and biomass for military use.
- High Power Microwave (HPM) Electronic Waveform Technology countering electronic systems.
- Technologies for advanced Printed Circuit Boards (PCB) for defence electronics.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Functional requirements

This call topic is open to any technology with a high disruption potential. The proposals should describe the targeted functionalities and the foreseen means to measure progress toward the achievements of these functionalities.

Expected impact

- Scientific and technological contributions to the foundation of a future technology with disruptive applications in the area of defence.
- Enhanced innovation capacity of the European defence industry by identifying and exploring ground-breaking concepts and approaches or by applying technologies and concepts previously not applied in the defence sector.
- Enhanced competitiveness of the European defence industry and creation of new defence markets.
- Enhanced defence research and innovation capacity across Europe by involvement of actors that can make a difference in the future, such as excellent researchers, ambitious

high-tech SMEs or visionary departments of large companies, universities or research and technology organisations.

2.4. Call EDF-2024-LS-RA-CHALLENGE

- **Targeted type of actions:** Research actions (technological challenges)
- **Form of funding:** Lump sum grants following the call for proposals
- **Targeted type of applicants:** Any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation
- **Indicative budget for the call:** EUR 52 000 000 to support two technological challenges.

This call aims at progressing technologies through the organisation of technological challenges, whereby different research teams address a given technological objective using a common testing environment set up for that purpose.

Such an organisation is needed to measure the performances of systems involving artificial intelligence (AI) and machine learning in an objective and comparative way, by relying on independent third parties and on the following processes:

- For each AI-based information processing task, common evaluation protocols are defined and agreed upon by all stakeholders, enabling the organising third party to produce a test dataset while the participating teams develop their systems, that will be run on this dataset. The system outputs are then scored using the agreed evaluation metrics. In order to foster progress, the data remain available to the participating teams for a full analysis of the results, and a debriefing workshop is organised to share this analysis.

- For robotic and autonomous systems, in addition to such data-based tests, field tests are organised to evaluate the complete systems. Such field tests offer the opportunity to collect sensor data that can feed further data-based tests. This creates a virtuous circle where enhanced information processing modules lead to more realistic behaviours during field tests, which enables to collect more representative data that can be used to develop enhanced processing modules.

Such test campaigns typically last about a year. They are generally repeated over several years to compare results and thus measure progress between successive campaigns.

Such an organisation requires careful planning and a tight coordination among stakeholders but is instrumental in steering R&D and fostering progress of AI-based technologies.

This call addresses two technological challenges:

- <u>EDF technological challenge on **robust autonomous drone navigation (RADN)**</u>: This challenge aims at progressing the autonomous navigation capabilities of unmanned aerial vehicles and systems in non-permissive environments.

- <u>EDF technological challenge on **multi-source satellite image analysis (MSIA)**</u>: This challenge aims at progressing satellite image analysis technologies for defence applications, in particular by exploiting the complementary of optical and radar imagery. It addresses multisource image analysis technologies for which progress is needed. These technologies should be integrated into demonstrators that can be tested by representative defence users on their own data.

Technological challenges involve database creation and technology evaluation activities that require specific support. Under the EDF, this leads to two topics per technological challenge, one to support the research teams participating in the challenge, and one to support the challenge organisers.

The call therefore covers the following four **topics**:

- **EDF-2024-LS-RA-CHALLENGE-SENS-RADNP:** Multi-sensor integration for robust autonomous drone navigation – Participation in a technological challenge
- **EDF-2024-LS-RA-CHALLENGE-SENS-RADNO:** Multi-sensor integration for robust autonomous drone navigation – Organisation of a technological challenge
- **EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAP:** Multi-sensor satellite imagery analysis – Participation in a technological challenge
- **EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAO:** Multi-sensor satellite imagery analysis – Organisation of a technological challenge

For each technological challenge, a preliminary evaluation plan common to the two topics is provided as part of the call document (see Appendix 1). It is an integral part of the topic description for each of these two topics.

A project submission can address only one topic. However, **it is highly recommended that applicants read both topics and the preliminary evaluation plan related to a given technological challenge before preparing their application** in order to fully understand the overall set-up.

The two topics of a technological challenge are linked. Actions selected for the participation in a challenge will be linked to the action selected for its organisation, via the 'linked action' mechanism described in the Model Grant Agreement.

2.4.1. EDF-2024-LS-RA-CHALLENGE-SENS-RADNP: Multi-sensor integration for robust autonomous drone navigation – Participation in a technological challenge

- **Indicative budget:** EUR 20 000 000 for this topic under the call EDF-2024-LS-RA-CHALLENGE.
- **Number of actions to be funded:** Several actions may be funded for this topic.
- **Range of financial contribution of the European Union per proposal:** The requested funding cannot exceed EUR 5 000 000.

Objectives

To fulfil their missions, the next generation of unmanned aerial systems (UAS) are expected to offer an increased level of autonomy. Their effective deployment necessitates key features of swarming and navigation to target positions when GNSS availability is contested or lost and more generally in non-permissive environments. The use of various types of sensors (e.g., inertial, optical, infrared, hyperspectral, radar, LIDAR, acoustic, etc.) and intelligent information fusion are needed to provide the necessary capabilities to tackle these technical and operational challenges. Such intelligent navigation payloads should be usable on a wide range of unmanned assets, including in swarm formations, while having a low SWaPC (Size, Weight, Power and Costs). Their performances should be measured in a quantitative, objective and comparable way.

<u>Scope and types of activities</u>

Scope

Proposals must address technological solutions for autonomous aerial drone navigation in non-permissive environments. These solutions must be evaluated through the testing environment set up in the framework of the technological challenge.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating knowledge:
    - Research on new approaches for robust autonomous navigation of unmanned aerial vehicles and systems in non-permissive environments
    - Participation to the evaluation campaigns organised in the framework of the technological challenge, including:
        - Contribution to the exchanges with the other stakeholders for elaborating the evaluation plans.
        - Participation of the unmanned aerial systems and software modules in experimental field and data-based test campaigns managed by the challenge organisers, whereby performance measurements are conducted to assess navigation capabilities.
        - Collection and sharing of sensor data.
        - Participation to debriefing workshops.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of autonomous drone navigation.

Functional requirements

The proposed technologies should meet the following functional requirements:

- The unmanned aerial vehicles and systems should be able to accurately estimate their positions and to go to a designated target area with high reliability in non-permissive environments, where GNSS signals and communications may be degraded or lost.
- The performances for these abilities should be measured through the test campaigns conducted in the framework of the technological challenge, using protocols and metrics based on those described in the preliminary evaluation plan provided as part of the call documents. Details about how the proposed approaches and systems will address the tasks outlined in the preliminary evaluation plan should be described in the proposals. Any relevant system performances measured in the context of previous technological challenges should be mentioned in the proposals.
- Systems should be able to record the data acquired through their sensors to enable full replay of flights and reproduction of experiments in a software environment. The types of data that can be shared with other teams should be described in the proposals.
- The proposed approaches should be relevant for future integration and operational missions, especially in terms of SWaP and costs. The user interfaces should help users and in particular pilots to understand and anticipate the system behaviours.

Expected impact

The outcome should contribute to:

- enhanced UAS capabilities with highly autonomous operation modes for EU Member States armed forces, contributing to collaborative combat and tactical cloud capabilities;
- competitiveness, efficiency, and innovation capacity of the European defence technological and industrial base, which contributes to the Union strategic autonomy and its freedom of action.

2.4.2. EDF-2024-LS-RA-CHALLENGE-SENS-RADNO: Multi-sensor integration for robust autonomous drone navigation – Organisation of a technological challenge

- **Indicative budget:** EUR 7 000 000 for this topic under the call EDF-2024-LS-RA-CHALLENGE.
- **Number of actions to be funded:** One proposal is to be funded for this topic.

Objectives

The objective evaluation of artificial intelligence (AI) technologies such as those underpinning autonomous navigation requires a specific organisation whereby systems are tested in a blind manner on data that are representative of the tasks under study, using common protocols. This scheme is commonly referred to as a "technological challenge". One objective of the call is to organise a technological challenge driving research toward autonomous drone navigation in non-permissive environments.

Scope and types of activities

Scope

Proposals must address the organisation of a technological challenge on autonomous drone navigation in non-permissive environments based on the preliminary evaluation plan provided as part of the call documents (see Appendix 1A). This includes the collection of data recorded by the participating teams during field tests, the annotation of this data, and the sharing of the resulting databases.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (optional)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Integrating knowledge:
  - Setting up of the hardware and software infrastructures for testing autonomous navigation technologies in the framework of the technological challenge.
  - Collection of sensor data from the participating teams, labelling/annotation of the data with the expected outputs against which the system outputs will be evaluated ("ground truth") or establishment of such expected outputs as needed, and quality assessment, distribution, and curation of databases.
  - Organisation of the evaluation campaigns, and in particular
    - Coordination of the exchanges with the other stakeholders on the evaluation plans and elaboration of these plans.
    - Management of the field and data-based test campaigns and of the objective measurements of the performances of the systems submitted

to the tests by the participating teams according to the protocols and metrics described in the evaluation plans.

- Organisation of the debriefing workshops.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities for the objective and comparative evaluation of the performances of autonomous navigation technologies.

Functional requirements

The proposed solutions should enable to measure the performances of the tested systems according to detailed evaluation plans based on the preliminary evaluation plan provided as part of the call documents (see Appendix 1A). Key aspects of the foreseen detailed evaluation plans and associated data management should be described in the proposals. Proposals should in particular describe:

- Scenarios, nature and size of test ranges, and environmental conditions,
- Set up for establishing the reference positions of drones during field tests and expected positioning accuracy,
- Nature and volume of data annotation,
- Quality control of the annotations,
- The framework for trusted sharing of data,
- The detailed programme of the data-based and field test campaigns,
- Evaluation procedures (rules and tools to implement the metrics) and significance tests performed on measurements.

The proposed scenarios should be representative of a wide range of situations encountered in military operations, including communications and GNSS loss, possibly due to jamming and spoofing attacks.

Trust should be ensured in the quality of the data annotation. Part of the data should be subject to double annotation by two independent annotators and the inter-annotator agreement should be analysed. The statistical significance of the measured results should be estimated.

The detailed programme of the field test campaigns should be based on the hypothesis that at least four teams will participate. The possibility to accommodate for additional participants beyond this baseline and the impact on the field test programme should be described in the proposals.

During the challenge, drafts of the detailed evaluation plans should be submitted for discussion to the participating teams and to any stakeholder designated by the funding authority, early enough to take into account the feedback for the actual evaluation campaigns. Any evolution of the evaluation plans should take into account several factors: technical possibilities and costs, scientific relevance of the measurement, and representativeness of the metrics and protocols with respect to military needs. The justification of any change that is not subject to a consensus should be documented.

Expected impact

The outcome should contribute to:

- collaboration, knowledge sharing, and new partnerships that drive collective progress in autonomous drone navigation at the EU level;
- improved knowledge and understanding on the capabilities of European industry to integrate sensors in UAS;
- improved technologies for autonomous navigation of drone swarms, and more generally improved performance of combat drones;
- certification of technologies for autonomous drone navigation;
- improved capabilities of the European Member State armed forces to prepare the use of drones in difficult environments involving GNSS jamming, communications jamming, and various obstacles.

2.4.3. EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAP: Multi-source satellite imagery analysis – Participation in a technological challenge

- **Indicative budget:** EUR 15 000 000 for this topic under the call EDF-2024-LS-RA-CHALLENGE.
- **Number of actions to be funded:** Several actions may be funded for this topic.
- **Range of financial contribution of the European Union per proposal:** The requested funding cannot exceed EUR 5 000 000.

Objectives

General objective

Imagery analysis and in particular satellite image analysis is an important component of defence intelligence. It enables to gather strategic and operational information on facilities, vehicles and forces on the ground and on the seas with a good geographic coverage across the Earth, and to assess the status of suspicious or hostile activities.

Satellite imagery analysis has long relied on traditional techniques, but the ever-increasing amounts of available satellite images has led to a need for automated analysis technologies. These technologies have been the subject of much research over several decades, and the steady progress of artificial intelligence (AI) and in particular of AI-based image recognition has led to new tools appearing on the market. However, much of the development work and technological challenges in this field have focused on image types other than satellite images, and there is a need to foster the progress of satellite image analysis technologies. In this context, the general objective of this call topic is to enhance these technologies by giving research teams the opportunity to benefit from the organisation of a technological challenge dedicated to them.

Specific objective

Optical and radar images of a given geographic area contain complementary information. While these different types of images result from very different physical principles, which make their combination quite challenging, such a combination can lead to improved information extraction and capabilities. This call topic therefore aims at progressing information fusion approaches towards this objective.

Scope and types of activities

Scope

Proposals must address technological solutions to detect, identify and characterise relevant information from multi-source satellite images, in particular by taking advantage of the complementarity of optical and radar images. These technological solutions must be evaluated in the framework of the technological challenge organised under this call. Technologies should be integrated into demonstrators that can be tested by representative defence users on their own data.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (mandatory)
(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 (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Generating knowledge:
    - Research on satellite image analysis technologies.
    - Participation to the evaluation campaigns organised in the framework of the technological challenge, including:
        - Exchanges with other stakeholders on the evaluation plans.
        - Participation to the test campaigns whereby the performances of the technological modules are measured on the test data provided by the challenge organisers.
        - Participation to debriefing workshops.

In addition, the proposals should cover the following tasks:

- Integrating knowledge:
    - Integration of technological modules into demonstrators that can be tested by representative defence users.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of satellite imagery analysis, notably those that may be performed in the context of the EDIDP (e.g., under the call topic EDIDP-ISR-PEO-2019[51]), the EDF (e.g., under the call topics EDF-2021-DIGIT-R-FL[52] on *Frugal learning for rapid adaptation of AI systems*, EDF-2022-RA-DIGIT-DBIR[53] on *Shared databases and integrated systems for image recognition*, EDF-2022-DA-SPACE-ISR[54] on *Innovative multi-sensor space-based Earth observation capabilities towards persistent and reactive ISR*, or EDF-2024-RA-DIGIT-ASMEP on *Automated Structural Modelling for Effect Prediction*), the EU Space programme (e.g., feasibility studies on potential EU Earth-observation services for governmental use[55]), Horizon Europe or within the European Defence Agency (EDA) (e.g., the Capability Technology Group on Space activities[56]).

The proposals should include clear descriptions of the proposed criteria to assess work package completion. Criteria should include the completion of the tests performed in each evaluation campaign.

Functional requirements

The proposed solutions should meet the following functional requirements:

- Technological modules addressing the tasks defined in the framework of the challenge should be developed and submitted for evaluation (cf. preliminary evaluation plan).

[51] Funding & tenders (europa.eu)
[52] Funding & tenders (europa.eu)
[53] Funding & tenders (europa.eu)
[54] Funding & tenders (europa.eu)
[55] https://etendering.ted.europa.eu/cft/cft-display.html?cftId=13224
[56] https://eda.europa.eu/what-we-do/all-activities/activities-search/ad-hoc-working-group-space

- These technological modules should be integrated into demonstrators with a user-friendly interface. Any difference between the version evaluated through the challenge and a version integrated in the demonstrator should be documented.
- The demonstrators should be able to run locally, without a connection to a wide area network, and with reasonable resources in term of hardware size, weight, price, and energy consumption.
- The technological modules should be easy to configure and integrate into defence systems beyond the demonstrators produced in the framework of the challenge. They should follow as much as possible the relevant standards, best practices and guidelines, including those elaborated at the challenge level, in particular for input and output formats.

Expected impact

The outcome should contribute to:

- An enhanced exploitation of satellite images, by automating the workflow of imagery intelligence production and enabling analysts to focus on value-added tasks;
- The EU technological edge and autonomy for defence-related satellite imagery analysis.

2.4.4. EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAO: Multi-source satellite imagery analysis – Organisation of a technological challenge

- **Indicative budget:** EUR 10 000 000 for this topic under the call EDF-2024-LS-RA-CHALLENGE.
- **Number of actions to be funded:** One proposal is to be funded for this topic.

Objectives

The objective evaluation of artificial intelligence (AI) technologies, such as those used for satellite image analysis, requires a specific organisation whereby systems are tested on datasets that are new to the systems (blind testing), but that arerepresentative of the tasks under study, and using common protocols. This scheme is commonly referred to as a "technological challenge". One objective of the call is to organise a technological challenge driving research toward enhanced satellite image analysis for defence applications, and in particular for the combined analysis of optical and radar images. While a few challenges on satellite image analysis are organised in other contexts, there is a need for evaluations focusing on defence use cases, and for large datasets with annotations enabling accurate performance measurements.

Scope and types of activities

Scope

The proposals must address the organisation of a technological challenge on multi-source satellite image analysis based on the preliminary evaluation plan provided as part of the call document (see Appendix 1B). This includes the collection, annotation and distribution of data, and the writing of the evaluation plans. The proposals must also address the possibility to involve representative defence users testing the demonstrators produced by the participating teams and providing feedback.

The following use cases should be considered when elaborating the evaluation plans:

- Target analysis: vehicle functional status recognition, target identification and early target detection, classification and recognition.

- Monitoring and tracking: change in detection, camps, oil tank volume estimation, non-linear tracking of targets, routes.

- Searching: disturbed terrain detection, vehicle trails or moving targets detection, camouflage and material detection, minefield detection.

- Mapping: terrain modelling (ground, water, roads, constructions), trafficability analysis and obstacle detection, coastal bathymetry for shallow waters.

- Damage assessment: battle damage assessment, detection of climate/environment disaster-affected areas impacting defence operations.

Both optical and radar images must be considered. They may include the following:

<u>Optical</u>

- Standard (i.e., in the visible part of the EM spectrum) panchromatic and/or multispectral images with various spatial resolutions below or above 1 metre depending on the selected use-cases, based on commercial, dual-use or defence systems.

- Hyperspectral images with various spatial resolutions below 50m, based on scientific, commercial, dual-use or defence systems.

- Infrared images.

This may include multi-view stereo or video modes where available.

<u>Radar</u>

- X-band SAR images (amplitude and phase, different polarisation) with various resolutions below or above 1 metre depending on the selected use-cases, based on commercial, dual-use or defence systems.

- C or S-band SAR images.

- P or L-band SAR images.

The use of optical and radar aerial imagery may also be considered, in particular to test systems on high-resolution images for certain types of images (e.g., hyperspectral or infrared, simulation of higher resolution images).

Metadata that would normally be used in operational scenarios should be provided.

The actual types of images and metadata to be used for the challenge should be described in the proposals.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes (optional)
(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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Integrating knowledge:
    - Setting up of the infrastructures for testing satellite image analysis systems in the framework of the technological challenge.
    - Production of data annotation guidelines, collection and annotation of data, quality assessment, distribution and curation of databases.

- Organisation of the evaluation campaigns, and in particular:
    - Coordination of the exchanges with other stakeholders on the data annotation guidelines and evaluation plans, and elaboration of these documents;
    - Management of the experimental test campaigns, including the objective measurements of the performances of the technological modules submitted to the tests by the participating teams according to the protocols and metrics described in the evaluation plans;
    - Organisation of the debriefing workshops.

The proposals should include clear descriptions of the proposed criteria to assess work package completion. Criteria should include the production of detailed evaluation plans agreed upon by all stakeholders, the production of the annotated databases needed for the evaluations, the production of measurements for all systems submitted to the tests by the participating teams following these plans, and the organisation of the needed events.

Functional requirements

The proposed solutions should enable the measurement of the performances of satellite image analysis systems according to detailed evaluation plans based on the preliminary evaluation plan provided as part of this call document (see Appendix 1B). Key aspects of the foreseen detailed evaluation plans and associated data management should be described in the proposals. Proposals should in particular describe:

- The detailed use cases to be addressed and the nature and size of image data to collect,
- The nature and volume of data annotation to be produced, the order of magnitude of the number of different semantic classes, object types and characteristics considered for annotations, and the granularity of these classes with examples,
- A framework for trusted sharing of data during the challenge and beyond,
- A detailed plan of the test campaigns and an overall timeline/Gantt chart of the challenge,
- The evaluation procedures (rules and tools to implement the metrics) and significance tests to be performed on measurements.

A user board consisting of representative defence users should be set up and involved in the preparation of the evaluation plans and of the data. Data should be representative of use cases of interest for defence. Proposals should describe the foreseen efforts from users to test demonstrators and provide feedback.

Data may be annotated in a semi-automatic way. Agreements may be sought with participants to use automatic tools developed by them. All annotations should be manually checked. To assess the relevance and accuracy of the data annotations, at least part of the data should be annotated by two independent annotators. The two sets of annotations should be compared to each other using the same metrics as for the evaluation of system outputs. An analysis of this inter-annotator agreement should be presented during the evaluation campaign workshops.

During the challenge, a detailed evaluation plan should be prepared for each evaluation campaign. Drafts of these detailed evaluation plans should be submitted for discussion to the participating teams, early enough to take into account feedback and leave time for system development before the actual test campaigns. Any evolution of the evaluation plans should take into account several factors: technical possibilities and cost, scientific relevance of the measurement, and representativeness of the metrics and protocols with respect to military needs. The justification of any change that is not subject to a consensus should be documented.

The user board and the participating teams should be involved in the steering of the challenge. Proposals should include a clear description of the foreseen governance and decision-making processes.

Expected impact

The outcome should contribute to:

- Collaboration, knowledge sharing, and new partnerships that drive collective progress in AI solution development for defence imagery analysis at the EU level;
- The development of policies and potential standards for AI in defence imagery analysis, enhancing interoperability across EU Member States;
- An enhanced cost-effectiveness of systems, optimising resource utilisation and reducing operational expenses.

2.5. Call EDF-2024-DA

- **Targeted type of actions:** Development actions
- **Form of funding:** Actual costs grants following the call for proposals
- **Targeted type of applicants:** Any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation
- **Indicative budget for the call:** EUR 310 000 000[57] for 14 topics addressing 9 categories of actions:

2.5.1. EDF-2024-DA-C4ISR-AIMA-STEP: AI-based multifunctional aperture and transceiver

- **Indicative budget:** EUR 45 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

To cope with multi-dimensional warfighting environments, modern militaries need relevant situational awareness across all domains. They also need to be able to both operate cross-domain capabilities, such as any-sensor-to-any-shooter networking, and prevent the enemy from doing so. This requires communications systems that can perform ad hoc networking in all domains in dynamically evolving tactical situations. Currently, this is done with mobile ad-hoc networking (MANET) data links.

As wireless solutions such as the Internet of Battlefield Things proliferate, the electromagnetic spectrum is likely to become an increasingly important source of situational awareness. Passive electronic monitoring, detection, classification and localisation of enemy radio frequency emitters is part of the recognised situational picture. Traditionally, this has been the task of electronic warfare (EW) units and their specific equipment providing electronic support (ES) to combat units.

To counter a detected threat, forces can use kinetic- (KE) and directed-energy (DE) means with their weapon systems, or electronic protection (EP) and attack (EA) if they have jamming systems, traditionally equipment carried and used by dedicated EW units. Before directing fire at detected targets, soldiers must mitigate the risk of friendly fire. At long ranges and in poor visibility, this requires radio communications with either self-positioning based Blue Force Tracking (BFT) or interrogation-based Identification Friend or Foe (IFF).

Today, MANET data links, ES receivers, jammers, BFT and IFF are separate pieces of equipment requiring decentralised control, separate installation space, power supply, cabling,

[57] The budget earmarked on 2024 appropriations for this call may be complemented by an amount of up to EUR 269 000 000 from 2025 appropriations. This 2025 complementary budget is subject to the adoption of a separate financing decision.

antennas, etc. By combining these functionalities into a single autonomously controlled equipment, it would be possible to achieve better performance, higher reliability, lower weight and lower life cycle costs.

In addition to the aforementioned technological reasons for converged aperture, there is also a need for converged systems. The electromagnetic spectrum (EMS) is expected to continue to be contested, congested and constrained. Military use of the EMS is under serious pressure from the civil community. Civilian, dual-use and military applications intermingle in the EMS currently in use, challenging the freedom and security of operation (OPSEC) of military users. With Software Defined Radio (SDR) technology, systems are likely to be able to dynamically perform mission and threat analysis, situational awareness, positioning and navigation, and jamming. This means dynamic adaptation to prevailing conditions at machine speed. This would require AI-based operation at the device and system of systems (fleet/network) level in order to coordinate actions of several systems with minimal detectability and platform losses.

Specific objective

The specific objective of this topic is to design, develop and build a system that should:

- Accelerate command and control (C2) and enhance operational effectiveness by providing cross-domain mobile ad-hoc networking capabilities to the armed forces.
- Increase lethality by enabling faster firing and reducing the risk of collateral damages, including fratricide, by providing the means to detect and target the enemy and to locate, track and identify friendly forces.
- Reduce enemy lethality and increase own protection by avoiding detection with AI-based emission control, stealthy waveforms and by jamming enemy communications.
- Provide autonomous mission management of several systems (including detection, jamming and targeting) within the network in order to improve survivability, and autonomously take actions to meet the mission objectives with the aid of AI.
- Be capable of operating in all weather conditions, in particular in the challenging Arctic environment and Global Navigation Satellite System (GNSS) denied areas.

Scope and types of activities

Scope

Proposals must address study, development and qualification of new generation scalable and cognitive (AI-controlled) multifunctional software defined (SD) transceiver for military use in manned and unmanned platforms. The ultimate objective of the proposals must be to achieve a qualified prototype for end-user demonstrations with a view to obtain end-user commitment for operational use.

Proposals may also provide a framework for the development of new standards, including proposals for intelligent and effective spectrum management, and prepare to contribute to future standards. The design approach should focus on building a system capable for series production and scalable for product families.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Studies:
    - Study different technological approaches, materials and study of end-user needs and requirement specifications including relevant applicable standards, such as NATO standards, which are eligible for all weather conditions, including for the northern and arctic environment.

- Design:
    - Design the architecture according to preferably NATO Architecture Framework (NAF) model 4.0[58],
    - Select applicable technologies,
    - Design the needed modules,
    - Integrate and provide a proof of concept.
- Prototyping:
    - Manufacture all functional modules and prototypes,
    - Ensure manufacturing ability with efficient supply chain.
- Testing:
    - Perform laboratory and field testing in relevant operational environment (e.g., HWIL[59], real spectrum), as well as functional testing, to:
        - Evaluate system functions and EW performance (e.g., ESM, anti-jamming, jamming);
        - Verify functions and properties against technical requirements;
        - Validate requirements against operational needs and mission requirements.
    - Analyse evaluation results and provide feedback for continuous design improvements.

Regarding the optional activities, proposals may also address, where applicable:

- Certification:
    - Ensure transceiver certifications by independent relevant body, such as authority or aircraft Original Equipment Manufacturer (OEM).
- Qualification:
    - Qualify the transceiver (functional, cyber, EW, environmental and electromagnetic compatibility (EMC)) for multi- and cross-domain use.
- Increasing efficiency:
    - Ensure smart power consumption, efficient transmitter power control and smart communications Radiofrequency (RF) spectrum usage.
    - Converge and integrate different functions to increase their control efficiency and maximise the operational endurance and survivability of smaller platforms.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities, notably those described in the call topics PADR-EMS-03-2019[60] related

[58] AC/322-D(2018)0002-REV1/ENG/NHQD204550 (nato.int)
[59] Hardware in the loop
[60] Funding & tenders (europa.eu)

to *Electromagnetic spectrum dominance*, as well as in EDF-2021-SENS-R-RADAR[61], EDF-2022-RA-SENS-ART[62] and EDF-2024-RA-SENS-ART related to *Advanced radar technologies.*

Functional requirements

The proposed product and technologies should meet the following functional requirements:

A- General functional requirements

- The proposals should address the development of a new multifunctional transceiver which supports the following application-based functionalities: data link, secure digital voice, BFT, electronic support measures (ESM), EP and EA.
- The proposed design should be suitable for operations in future challenging environment and conditions, including operations in GNSS denied areas and under jamming, non-stop operations in all weather conditions, including arctic ones, and operations in congested, contested and constrained spectrum environments.
- The proposed design should support cooperation across the transceiver nodes (at least in surveillance and engagement) based on swarm intelligence operating in centralised and distributed architecture and address the needs for an AI-based mission management system of autonomous transceiver fleet.
- The design and architecture should be modular, Size, Weight, Power, and Cost (SWAP-C) scalable and support miniaturisation.
- The proposals should address convergence of common design for all platforms. The miniaturisation should lead to cost-effective manufacturing resulting in an affordable solution to all EU Member States and EDF Associated Countries, using various platforms with different requirements (future platforms as well as existing legacy platforms through Mid-Life Upgrades), also in the northern countries and arctic environment.
- The proposed system should support efficient and adaptive use of wide RF spectrum, transmission power, bandwidth and waveform features based on situational and operational conditions using artificial intelligence (AI) in analysis and control.
- System and hardware design should comply with open system architecture.
- Hardware and software architectures should support integration of several different software (SW)-based applications.
- Hardware should include low-cost solutions (e.g., sector antennas) and support high-performance solutions (e.g., active electronically scanned arrays (AESA)), possibly with the following capabilities:
    - Beamforming with as high directivity as applicable;
    - Covering the RF spectrum required for the targeted functionalities;
- Antenna solutions allowing for integration in platform structures (conformally when required).The proposed system should be compatible with applicable standards, such

[61] Funding & tenders (europa.eu)
[62] Funding & tenders (europa.eu)

as NATO standards, and requirements and allow multi-domain interoperability in joint force operations.

B- Multifunctioning requirements

- Possibilities for the use of a direct conversion receiver should be included.
- Simultaneous multifunctionality of dynamic networking, secure digital voice, data link, BFT, ESM, EP/EA and transceiver control is the core feature of system requirements.
- RF and transceiver resource management and interoperability of two or more simultaneous applications (e.g., data link, ESM and EP/EA) should be controlled by a smart cognitive process, including for example:
    - Optimising the balance between unwanted RF emissions / interference between transmit-receive functions and communication requirements;
    - Continuous wideband RF sensing and application resource management.
- Transceiver should use simultaneously transmitting and receiving operation for all required tasks and functionalities.
    - The in-band full duplex (FD) mode may be utilised to improve spectrum usage efficiency.
- Proposals should include emissions control (EMCON) scheme in stealth operation conditions allowing network nodes to continue operation under restricted or no RF emission and continue active operation with acceptable delay.
- System positioning, navigation and timing and blue force tracking applications should use cognitive information fusion based on relevant sources to be provided by the proposed solution (such as GNSS, data link proportional navigation, ESM direction finding to known emitters and ground control support) and, when available, other sources (e.g., georeferencing (SAR, E/O visual and IR), stellar navigation, inertial, etc.).

C- Communication and networking requirements

- Networking should support multi- and cross-domain operations between different ground-based, airborne and naval platforms, as well as command and control entities.
- Networking should be scalable to different numbers of participants and applications, such as:
    - Real-time small-unit communications, e.g., swarming support;
    - Wide area information distribution for applications, such as blue-force tracking.
- Networking should support mesh topology with directional transmissions, providing self-configuration and self-healing capabilities.
- Networking should support smart datalink and dynamic traffic management according to user/mission policies/rules and overall situation.

- The system should be able to maintain connections to other nodes in the network in all possible directions (6 Degrees of Freedom (DOF) when using highly manoeuvrable platforms.
- The system should manage and control traditional passive antennas as well as active antenna beamforming and beam pointing (single/multiple) in 3D environment.
- Communication waveforms should provide robust Lower Probability of Intercept (LPI), Lower Probability of Detection (LPD), Lower Probability of Exploitation (LPE) and Interference/Jamming avoidance capabilities by using active, AI-based dynamic transmission control.
- Communication waveforms should use modern MIMO (Multiple-In Multiple-Out) beamforming techniques.
- The system should provide comprehensive support for Internet Protocol (IP) and commonly used networking standards.
- The system may support multiple loadable waveforms, including third party waveforms, and providing interoperability with other systems.
- The system may fulfil end-user communication and transmission security requirements, including support for Red/Black separation.

D- <u>Electronic warfare (EW) requirements</u>

- Signal detection and emitter recognition should be AI-based and should be capable of countering cognitive radars and threats with unknown waveforms.
- Signal detection, recognition and geolocation of targets and threats should support cooperative and distributed sensing to enhance detection of distant LPI/LPD targets.
- All system functions should be resilient to jamming and interference by EP, including, but not limited to:
    - Utilising selective directivity of antenna array (sector or active beamforming) which can reject (e.g., null steering) multiple jammers;
    - Adapting EP processing gain (bit rate and instantaneous bandwidth) by using cognitive spectrum management according to information transmission needs and operational situation;
    - Swarm level cognitive EP based on coordinated formation flying and use of data link (beam steering and routing);
    - By having high dynamic range receiver to allow observing and detecting signals with high dynamic in received power.
- System should be able to enable smart EA functions from single to multiple targets in coordinated manner with autonomous EA control process (e.g., AI-based), including, but not limited to:
    - Coordinated stand-in and stand-off jamming where all platforms within the jammed target’s range are using different jamming strategies in a coordinated manner (brute force or intelligent jamming, i.e., noise or equivalent method or repeating jamming or equivalent)

- o Utilising antenna directivity (sector or active beamforming) to selectively transmit EA RF waveforms to directions of the targeted platforms.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Maintain and enhance European sovereignty and information superiority for critical communication systems and capabilities.
- Decrease dependencies from non-EU technologies and products to support long-term targets of EU Member States and EDF Associated Countries.
- Enhance and support EDTIB[63]'s goals and position in global markets.
- Facilitate multi- and cross-domain operations with increased information superiority capabilities from various Member States and EDF Associated Countries.
- Comply with the joint forces' needs of manned and unmanned platforms and of command entities, at all operational levels.
- Support enhanced, safe and secure operations in friendly and hostile environment with new innovative modular, scalable, and multiuse interoperable RF transceiver technologies and adaptive use of radio frequencies assisted by Artificial Intelligence algorithms and characteristics.
- Equip troops and platforms of various sizes and domains with beyond the state-of-art interoperable and multifunctional communication and electronic warfare systems that are suitable for demanding tactical operations also in GNSS denied environment and arctic climate conditions.
- Enable the joint forces of the Member States and EDF Associated Countries for secure, timely and accurate data transfer and communication in multi- and cross-domain environments combined with efficient ESM and EP/EA capabilities.
- Expand EDTIB's capabilities to produce new highly innovative and interoperable communication and information systems based on tactical multifunctional software defined radio and networks, as well as new generation systems that enhance survivability and operations in future battlefield.

2.5.2. EDF-2024-DA-C4ISR-COMS-STEP: Defence multi-dimensional communication standard

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

[63] European defence technological and industrial base

Objectives

General objective

5G is a technology originally developed to address the ongoing rapid pace of digital transformation of the different vertical industries in the civilian world. It is continuously being developed through standardisation activities in 3GPP[64], and new releases with extended features of the standard are approved approximately every 18 to 24 months.

To ensure a technological edge in military use of 5G, it is important to capitalise on the continued momentum of new releases and associated features relevant for military operations. In 2016, resilience in civil communication systems was listed by NATO as one of seven baseline requirements that each Member State should measure their level of preparedness. In November 2019, this requirement was updated by NATO Defence Ministers, who stressed the need for reliable communications including 5G.

To address this statement and ensure a higher degree of robustness and resilience in military operations when operating in the tactical edge, the militaries should be able to exploit and seamlessly interact with civilian infrastructure to ensure uninterrupted services for tactical command and control applications.

This topic focuses on system level integration and orchestration of 5G technologies for seamless interaction of private military and public 5G networks. Hence, the overall objective is to support the need for an always connected concept enabling military applications to roam securely through a mix of private and public networks. To achieve this, there is a need to study, develop and demonstrate how the military can exploit seamless and uninterrupted transfer of secure applications and services in a coverage area served by a mix of private military and public 5G networks, including BLoS (Beyond Line of Sight) through Non-Terrestrial Network (NTN) communication systems integrated in 3GPP standard.

Specific objective

The specific challenge of this topic is to demonstrate robust and dynamic operational capabilities of 5G connectivity solutions matching the military needs for tactical command and control applications and services.

The solution should always be connected via a hybrid form of networks, while ensuring secure communications, using tactical networks, private military and public 5G networks and other federation solutions. The use of flexible reach back solutions such as 5G NTN is also necessary to reach shared centralised cloud services.

Within this context, secure integration of commercial and military hardware, software and services is a fundamental challenge that must be addressed on both a technological and a commercial level.

Scope and types of activities

Scope

Proposals must address the development of either integrated private-public 5G system architectures for military operations, or private military 5G networks, or public 5G services for military applications.

[64] 3rd Generation Partnership Project

Moreover, proposals should lead to the development and demonstration of case-agnostic technical products and services, applicable to military operations across all dimensions of warfare. The demonstrations should be performed in relevant operational environments and cover all aspects from devices, infrastructure, security, and simplified orchestration of the overall system.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of studies mandatory activities:

- Perform feasibility studies to explore the feasibility of new or improved technologies, products, processes, services, and solutions for 5G military applications.

- Study the concept of 5G Network-as-a-Sensor[65], targeting future capabilities of using a mix of private and public 5G networks for RF reconnaissance enabled by third party applications through an Open RAN[66] API[67].

- Set up simulation or emulation tools of mobile networks and/or associated applications, enabling improved understanding of current network situations (i.e., analysis) as well as of future configurations and deployments (i.e., predictions).

- Demonstrate that 5G works for private networks in different frequency bands, such as ISM[68] bands (5G, for 5G unlicensed), in NATO bands (e.g., 4400-5000 MHz, 225-400 MHz, etc.).

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of communications, notably those described in the call topic EDF-2021-C4ISR-D-COMS[69] related to *Robust defence multi-dimensional communications*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

A- Operational requirements:

- Ensure that troops and military assets are always best connected with interoperability capabilities to use multiple networks.

- Provide worldwide connectivity through the integration of 5G NTN.

- Dedicated 5G defence slices in public networks for tactical command and control applications.

- Robust, resilient, secure, and manageable roaming across private and public network.

- Robust tactical applications and services that can operate locally even when communication with central services is lost.

- Making use of existing civilian networking infrastructure in military operations.

- Allow military private mobile networks operate as extensions of public mobile networks whenever feasible with demands on roaming and interconnect.

- End-to-end military-grade SIM[70] encryption (i.e., through the GSMA[71] standard IoT SAFE[72]).

[65] 5G Network-as-a-Sensor may have the potential to serve as a sensor to detect and locate jammers, detect false base stations (based on reports from users' equipment), detect drones, etc.
[66] Radio Access Network
[67] Application programming interface
[68] Industrial, scientific, and medical
[69] Funding & tenders (europa.eu)
[70] Subscriber Identification Module
[71] Global System for Mobile Communications Association
[72] Internet of Things SIM Applet For Secure End-2-End Communication

- Access to terrestrial-based navigation services when GNSS[73] signals are subjected to jamming (e.g., through 5G positioning).

- Automated and simple network setup and operation by military personnel (e.g., through self-organising networks).

- Handling federation and interconnection of private and public 5G networks according to the framework of Federated Mission Networking (FMN).

- Ensure transmission security (LPI[74]/LPD[75]) to protect from interception and exploitation in the spectrum (e.g., spread spectrum, frequency hopping).

- Support of civil-military communication via interworking of military 5G solutions and public solutions, as required for defence operations.

- Leveraging interoperability with LTE[76]/5G support.

B- Technical requirements:

- Utilising 3GPP 5G standards (5G RAN, 5GC[77]) and connected applications (e.g., NR[78], network slicing, FWA[79], NTN).

- 5G Stand-alone solution for tactical network.

- Redundancy and security for critical solutions, especially solutions considering the needs in terms of confidentiality, integrity, and availability, when facing threats (including cyber threats) corresponding to the military use cases for active cyber defence.

- Interoperability and integration with existing military infrastructure, including through usage of military frequencies for private military 5G applications.

- Leveraging commercial 5G networks and technologies (e.g., network slicing, edge computing, 5G NTN, Open RAN, D2D[80], IoT SAFE[81], etc.).

- Compatible with different frequency bands (e.g., ISM, NATO, etc.), including with Dynamic Spectrum Sharing.

Expected impact

The outcome should contribute to:

[73] Global Navigation Satellite System
[74] Low probability of interception
[75] Low probability of detection
[76] Long term evolution
[77] 5G Core network
[78] New Radio
[79] Fixed wireless access
[80] Device to device
[81] Internet of things SIM Applet For Secure End-to-End Communication

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Create a European ecosystem for secured 5G devices and infrastructures, including hybrid networks (utilising both civilian and military radio technologies), configuration and management tools and cyber security fit for military use.
- Prepare the ground for the use in defence operations of next generation communication standards (e.g., 6G).
- Demonstrate the adaption of an appropriate industry standard to military needs.
- Orchestrate services across multiple administrative domains through the concept of federation.
- Provide worldwide 5G connectivity for operations through the integration of NTN.

2.5.3. EDF-2024-DA-C4ISR-SEEU-STEP: Small enhanced European UAS

- **Indicative budget:** EUR 11 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

<u>Objectives</u>

General objective

Despite the extensive use of COTS[82] UAS[83] in recent conflicts and continued technological development, these systems serve the purpose of rapid and relatively low-cost deployment of assets and effectors in times of extreme need. As with all such systems, there is a lack of key requirements and an overall development and sustainability frameworks that meets the real needs of defence users at the tactical level in the EU Member States and EDF Associated Countries. It should be noted, however, that large UAS are always challenging to operate due to their specific needs, e.g., regarding facilities, maintenance and support.

Anticipated advances in miniaturisation and communication protocols are likely to provide sufficient ground for improvements in the area of small UAS[84] for defence applications and their associated payloads, including weapons, without the stringent need for large UAS. Such activities are embedded in very promising prospects for further industrial and operational development.

Against this background, this topic aims to have a direct impact on the tactical operational effectiveness of armed forces in multi-domain operations (air, land and maritime). In addition, the outcome of this topic is also expected to improve the intervention capacity of relevant national or European agencies.

[82] Commercially available off-the-shelf
[83] Unmanned Aerial Systems, including Remotely Piloted Aircraft Systems
[84] i.e., Class I RPAS (>15 kg and <150 kg) according to NATO STANAG 7232, Ed. 1, 13 Jan 2020, ATP 3.3.8.1. Training of unmanned aircraft systems (UAS) operators

Specific objective

In particular, this topic intends to contribute to address the following specific challenges that small UAS are prone to:

- Low UAS signatures and extended operational ranges;
- Operate autonomously and automatic, including with assisted piloting considerations;
- Miniaturisation of sensors and payloads, including potential weapons and communication systems;
- Operational capability and survivability in contested, congested and challenging (e.g., weather) airspace.

<u>Scope and types of activities</u>

Scope

Proposals must address the development of a small UAS with advanced ISTAR[85] capabilities, such as real-time imagery intelligence, and possibly kinetic capabilities, capable of operating in support of the widest possible range of military operations.

In addition, proposals should address the development of a multi-role approach that explores compatibility between different payloads and configurations, in particular through an Interoperable Modular and Scalable Architecture (IMOSA) approach to allow interchangeability of components and interoperability between different solutions, including a "plug and play" capability for sensors and possible effectors.

As the small UAS cannot support sets of different sensors due to weight, space and power limitations, the possibility of standard interfaces should be explored to allow the selection and integration of a variety of specific sensors to be used in different configurations depending on the mission, and to facilitate the use in defence, civil and dual-use configurations.

In addition, proposals may also address the potential synergy for use by law enforcement and other governmental use.

Types of activities

The following types of activities are eligible for this topic:

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	Yes (optional)

[85] Intelligence, surveillance, target acquisition, and reconnaissance

Types of activities (art 10(3) EDF Regulation)		Eligible?
	defence products and technologies (**integrating knowledge**)	
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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/No (optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes/No (optional)

Accordingly, the proposals must cover at least the following tasks as part of mandatory studies activities:

- Develop integration with Combat Management System (CMS) in line with a common standard protocols (e.g. foreseen NATO STANAG 4817).
- Study electromagnetic compatibility in order to integrate the system in a combat system without interferences

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of small and tactical RPAS, notably those described in the call topic EDIDP-ISR-TRPAS-2019[86] related to *Development of a low-observable tactical RPAS with the capability to provide near real time information and with modern self-protection* and in the call topic EDF-2023-DA-C4ISR-TRPAS[87] related to *Tactical RPAS*.

[86] Funding & tenders (europa.eu)
[87] Funding & tenders (europa.eu)

Functional requirements

The proposed product and technologies may elaborate on mature and already proven solutions, when available and applicable, and should meet the following functional requirements:

- **Performance requirements**: The prototyped new small UAS platform should:
  - Be of Vertical Take-Off and Landing (VTOL) type, while being:
    - Able to take-off and land automatically in a conscripted area with its own means (i.e., without using external equipment such as net or catapult), e.g., from and to a ship single spot flight deck;
    - Compatible with the performance characteristics of a fixed-wing aircraft, especially regarding speed, range, and endurance, during cruise phases and in over-target flight, meaning:
      - An operational autonomy of at least 10 hours;
      - An operational range of at least 200 km Line Of Sight (LOS);
      - A cruising speed of at least 50 kts.
  - Be equipped with sustainable propulsion system/powertrain, possibly using alternative fuel (e.g., electric propulsion, heavy fuel (JP5) engine, multi fuel engine);
  - Have a reduced acoustic signature to limit detection, recognition and direction finding of the small UAS;
  - Sustain steady winds ≥25 knots with gust of 30 kts;
  - Fly in moderate rain conditions ≥ 5 mm/h;
  - Be able to operate in a temperature range between -20°C and +49°C;
  - Be able to carry a payload of up to 20kg with structural mounting points by design;
  - Be compliant with IP[88] 66 standard;
  - Include a plug and play capability in order to provide flexibility to users.
- **Airspace integration:** The system should be designed and equipped to enable safe deconfliction, transit and operations BLoS[89] in non-segregated airspace.
- **Airworthiness:** The system, including its design, development and construction, should be compliant with applicable standards with a view to future certification.

[88] According to International Electronical Commission (IEC - https://www.iec.ch/) standard 60529 on Degrees of protection provided by enclosures (IP Code)

[89] Beyond the Line-of-Sight

- **Operational requirements:** The system should:
  - Have an automated mission profile, configured in real-time, before and during flight;
  - Have an autonomous flight mode, where the UA[90] could adapt its flight path and take decisions based on the sensing of the environment/scenario;
  - Have a fly-by-wire assisted flight mode where a human pilot can intervene using a pilot console;
  - Be capable of automatically taking-off and landing, using its own means;
  - Include a Manned-Unmanned Teaming (MUM-T) capability;
  - Be able to operate in swarming formations;
  - Be resilient to cyber-attacks;
  - Be operated via a control station with the smallest footprint possible;
  - Be aero transportable by and launched from e.g., light transport aircraft;
  - Have a very reduced logistic footprint;
  - Have the smallest crew for operation possible, considering the remote crew (i.e., remote pilots, systems, cameras and datalink operators), take-off and landing support crew, assistance crew;
  - Control and monitoring unit software should allow e.g., but not limited to, geofencing, automatic NOTAM[91] creation based on requested flight area, input/upload of areas of interest or limitation (e.g., NOTAM or area of operation), PoI in the MAP, the map layers should be always updated and allow for military and civil maps and charts, the waypoint type navigation should draw the actual flight path of the UAS.
- **Survivability:** The developed small UAS should be able to operate in a contested environment with enemy anti-access/area denial (A2/AD) capabilities, in particular UAS with return and pickup considerations, e.g., via increased protection on the UAS, redundancy and low signatures.
- **Optical gyro-stabilised spread spectrum multi-sensor**: A multi-spectrum sensor suite for small UAS should be capable of visualising, geo-referencing, and tracking multiple moving points of interest (POIs) in adverse weather and visibility conditions.
- **Improved sensing and ISR[92] and targeting systems**:

[90] Unmanned Aircraft
[91] Notice to airmen
[92] Intelligence, surveillance and reconnaissance

- The system should include radar sensors SAR (Synthetic Aperture Radar) and LIDAR (Laser Imaging Detection and Ranging);
- The development of smaller and more precise systems for ISR and targeting, as well as direction of indirect fires, should be addressed;
- The system should include electro-optical, infrared (IR) sensors and target illumination (e.g., laser pointer, buddy lasing) capabilities;
- The system should be able to auto-track fixed and moving targets and support the overall targeting cycle;
- The system should provide IMINT[93] support to land forces.

- **Communications:**
  - The development of wideband BLoS communications for Small UAS (WB[94] BLOS LEO[95]) combined with Advanced Beamforming LoS with Direction Finding Capabilities, based on the new constellations for LEO satellite communications, should be addressed;
  - The system should be equipped with:
    - Radio receiver and transmitter;
    - An integral Communications sub-system for BLoS UAS C4I[96] datalinks and telemetry transmission;
    - An aerial communications relay and mesh network node payload to enhance or facilitate communications between other ground-based users;
    - An IFF[97] Mode 5/S and ADS-B[98] transponder aerial identification device that can be switched according to operational needs.

- **Artificial Intelligence / machine learning for autonomous and assisted piloting**:
  - The development of an intelligent module on the ground station / control and monitoring unit to process big amounts of data into actionable intelligent information should be addressed, as small UAS can incorporate a limited processing capacity.
  - The system should be capable of flying in manual and automatic modes for flight plans and waypoints, with an autopilot capable of maintaining orbital

[93] Imagery intelligence
[94] Wideband
[95] Low Earth orbit
[96] Command, Control, Communications, Computers, & Intelligence
[97] Identification Friend and Foe
[98] Automatic dependent surveillance-broadcast

trajectories while observing points, and automatic take-off and landing capability (including safe landing in case of emergency situations).

- The solution developed should be capable of **swarming operations**, acting in a coordinated way and controlled by a single control and monitoring unit.
- **Interoperability**: The developed solution should be interoperable with common standards in force, such as JISR[99] standards (e.g., NATO STANAG 4559[100]), UAV[101] interoperability standards (e.g., NATO STANAG 4586[102]) and C4I[103] interoperability standards.
- The proposed solution should be **affordable by design**, in terms of acquisition and lifecycle costs, including the overall operating, logistics and maintenance costs.
- **Electronic warfare:** The system may include:
    - VHF/UHF jammer capability;
    - Small jammer disposal capability;
    - Automated hold and track of an electromagnetic source.
- **Supply carrier and precision delivery:** The system may include the following capabilities:
    - Airborne launched capability;
    - Automated delivery of cargo;
    - Beacon capability for discoverability.
- **Miniaturised weaponry**: The development of miniaturised weapons may be considered to eventually get weapon-capable small UAS, hence paving the way for a solution to develop small kinetic capability against e.g., lightly armoured targets, including e.g., loitering munitions, small calibre guided missiles and small calibre torpedoes.
- **CBRN[104] surveillance**: The developed small UAS may be able to have a standoff or remote CBRN detector as a payload to allow remote detection of CBRN threats, alerting the unit to the proximity of a contaminated threat and allowing time to take protective action.

[99] Joint Intelligence, Surveillance and Reconnaissance (https://www.nato.int/cps/en/natohq/topics_111830.htm)
[100] NATO NSO NSDD (nato.int) https://nso.nato.int/nso/nsdd/main/standards?search=4559
[101] Unmanned aerial vehicle
[102] Standard Interfaces of UA Control System (UCS) for NATO UA Interoperability - AEP-84 Edition A https://nso.nato.int/nso/nsdd/main/standards?search=4586
[103] Command, Control, Communications, Computers, & Intelligence
[104] Chemical, biological, radiological and nuclear

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- The emergence of a commonly agreed EU standard for small UAS to allow a wider European application, interchangeability of sensors and modules, together with adaptability to various types of missions.
- Define commonly agreed EU defence requirements for small UAS.
- Reduce the current dependencies on non-European UAS suppliers.
- Reduce the fragmentation of UAS fleets in European armed forces and reduce the procurement and maintenance costs through economies of scale.
- Promote the interoperability between European armed forces.
- Foster an active European market for the development of interoperable and interchangeable sensors.
- Exploit the synergy with other than defence applications.

2.5.4. EDF-2024-DA-C4ISR-MALE: Medium altitude long endurance RPAS

- **Indicative budget:** EUR 100 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The ‘Medium Altitude Long Endurance Remotely Piloted Aircraft System’ (MALE RPAS) is an indispensable capability to facilitate international conflict prevention and crisis management in all phases of operations – especially in the field of Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR). Member States and EDF Associated Countries (MS) have already used various types of MALE RPAS in recent operations to provide detection, identification and communication. MALE RPAS could also have a dual use potential.

The EU commonly agreed priorities underline the permanent need to track ships, aircraft and other systems across a wide area of airspace by means of interoperable unmanned surveillance systems capable of operating in all and adverse weather conditions and all types of environments, with assured data integrity. To operate in all types of operational environments, RPAS must be integrated into air traffic management (ATM).

As part of a versatile and robust MALE RPAS, the system should consider the option to incorporate the means for an effective neutralisation of targets that posed a threat to the mission being carried out.

Today, most of the ISR capabilities of the MS rely on non-EU manufacturers in order to carry out their missions. However, due to the sensitive nature of military operations and the restrictions on technology transfer that prevent MS and EDF Associated Countries from fully benefiting from platform adaptation, the development of a fully European MALE RPAS is key to reduce dependency on non-EU solutions and to ensure sovereignty in this area of ISTAR.

It is an overarching objective to strengthen European sovereignty in this strategically relevant area. Hence, this topic is expected to result in a step-changing programme in line with the commonly agreed EU defence objectives and ensuring European strategic autonomy and technological competitiveness in a broad sense.

Specific objective

MALE RPAS reconnaissance includes optical, infrared, radar and signal intelligence sensors and generates geoinformation data. The sensors for optical, infrared and radar reconnaissance are usual configuration parts of a MALE system. As signal intelligence is often classified for national eyes only, it would be preferable to develop a common pod design, which is suitable to contain the national electronics. The integration effort into the MALE system can be shared with a common pod design. This pod design is also a suitable baseline for additional future sensors.

The ultimate objective is to develop, produce and sustain a system that provides this critical defence capability to respond to future security challenges.

In addition, a strong European supply chain is intended to be developed at all levels to promote the European Defence Technological and Industrial Base (EDTIB) in the long term. The supply chain should not be a pre-determined black box, but is expected to be open to competitive suppliers in a largely open tendering process, with the suppliers for mission-critical or security-relevant systems intended to be EU-based.

Scope and types of activities

Scope

Proposals must address a prototype of a fully European MALE RPAS with an innovative ISTAR and armed ISTAR capability to exceed the capabilities of comparable current systems and the capabilities of systems available at the entry into service time or, at least, be comparable with them. The prototype must be tested with a view to further qualification and certification activities.

Proposals must also address the design and prototype of a common sensor pod for the European MALE RPAS, without affecting the timeline of ongoing activities related to the development of MALE RPAS.

In addition, proposals should address the enhancement of a multi-role approach for the MALE RPAS available with different sensor pod configurations.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Studies:
    - Set up the configurations to be recognised in the design.
    - Define a set of requirements considering the whole products cycle, to be assessed and accepted by supporting MS and EDF Associated Countries.

- Provide an overview on a suitable configuration for signal intelligence pods for MALE RPAS.
- Identify, analyse and mitigate critical technical risks especially regarding integration and certification considerations.
- Perform a life-cycle-cost-analysis and management.

- Design:
  - Cover detailed design activities after the Preliminary Design Review (PDR) until the System Test Readiness Review (STRR) of the MALE RPAS.
  - Complete a full design process for a common sensor pod to be used with the MALE RPAS.
- Prototyping:
  - Prototype the MALE RPAS.
  - Prototype a common sensor pod to be used with the MALE RPAS.
- Testing:
  - A flight test campaign must assess certification and qualification considerations for the European MALE RPAS including the common sensor pod.

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of MALE RPAS, notably those described in the EDIDP Work Programme for 2019 and 2020 with reference to the *development of European Medium-Altitude Long-Endurance Remotely Piloted Air System (MALE RPAS)*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

A- Regarding the detailed design of the MALE RPAS, the solution should**:**

- Include innovative ISTAR and armed ISTAR capabilities.
- Include widespread types of sensors:
  - Electro-Optical/Infrared;
  - SAR (Synthetic Aperture Radar) with GMTI (Ground Moving Target Indicator) capability;
  - Automatic Identification System function;
  - Personal Locator System.
- Include state-of-the-art means of communications:

- Secured V/UHF;
- Air Data Terminal;
- Tactical datalinks, e.g., L16/JREAP[105] and VMF (Variable Message Format) functionalities;
- Provision for future ATM and Aeronautical Telecommunication Network (ATN).

- Include reliable and high-bandwidth C2[106]-/Data-links:
  - Wideband Beyond Line-of-Sight Data Link;
  - Wideband Line of Sight Data Link;
  - Narrowband Beyond Line-of-Sight Data Link;
  - Narrowband Line of Sight Data Link.
- Address armament integration considerations.
- Include an automatic Take-Off and Landing System.
- Address growth potential considerations:
  - For ATI equipment (Air Traffic Integration in non-cooperative traffic);
  - Provisions for future payloads within the scope of ISTAR and armed ISTAR.
- Ensure long-endurance ISTAR operations (no less than 26 hours).
- Be certifiable (acc. to STANAG 4671 Ed. 3, Draft Sept 2014[107]).
- Include a ground Control Station taking latest HMI-related scientific expertise into account.
- Be transportable by air, land and sea standard means.

B- **Regarding the development of a pod for the European MALE RPAS**, the solution should**:**

- Study signal intelligence configurations for MALE RPAS, specific for European MALE RPAS for a common pod design for European MALE RPAS supporting MS and EDF Associated Countries.
- Analyse possible other sensor configurations, like geoinformation data generation for a common pod design.

[105] Joint Range Extension Applications Protocol
[106] Command and control
[107] NSO NSDD (nato.int)

- Perform risk management for the development of a common pod, especially for integration, certification and qualification issues.
- Create a set of requirements to be assessed and accepted by supporting MS and EDF Associated Countries.
- Design a common pod shell according to the set of requirements with a Critical Design Review.
- Produce a system prototype for flight test campaign with the European MALE RPAS.
- Define and perform a flight test campaign to prepare for further qualification and certification of the European MALE RPAS, and report the outcome in a flight test report.

Expected impact

The outcome should contribute to:

- European sovereignty for ISR platforms.
- The emergence of a certifiable and air traffic integrated European MALE RPAS.
- Improve interoperability of EU Member States Armed Forces.

2.5.5. EDF-2024-DA-CYBER-NGCR-STEP: Next-Generation Cooperative Cyber Range

- **Indicative budget:** EUR 48 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

Cyber range technologies have seen notable uptake over the last decade. They form a cornerstone of cyber defence training and testing. The objective of this topic is to take further the ongoing cyber range technology roadmap by designing and implementing next-generation solutions. The key consideration is on the cooperative approach in developing and using those cyber range technologies, thereby facilitating joint capability development.

Technological investments and developments have so far mostly focused on various fundamental needs such as visualisation, scoring, realistic scenarios, and federation. Separate mature technological building blocks exist in modern cyber and IT solutions. However, these developments have yet to be consolidated into the context of cyber ranges for defence purposes, in a manner such as the PESCO project *Cyber Ranges Federation*.

Specific objective

This topic aims to address the remaining challenge on design and development of solutions that deliver notable progress vis-à-vis the current state-of-the-art, including in view of wider technology landscape. This means that focus has to shift from creating cyber ranges that fulfil basic needs to cyber ranges that target next-level capability requirements. Therefore, the specific objective is about the use of cyber ranges for trainings and exercises. The proposed solutions, however, can benefit also other cyber range use-cases such as product development and penetration testing. Therefore, considerations of such use-cases may be taken into account for developing the solutions.

Scope and types of activities

Scope

The next-generation cooperative cyber range capability must address at least the following issues:

1. **Set up of trainings and exercises with classified information, especially for cross-border exercises by EU Member States and EDF Associated Countries.**

Although the use of classified information in national exercises and trainings is not a new phenomenon, it is, firstly, still absent from the capabilities of many nations and, secondly, there is no existing solution that offers an EU-wide, cross-border classified capability. Such a capability could help various countries in using this functionality which they otherwise would not be able to use and it would provide a currently unavailable solution to conducting exercises across nations, including for topics such as information sharing and ensuring confidentiality of related data. This would also benefit the EU's military structure, e.g., EU Military Staff, European Defence Agency and others.

Moreover, such a capability can be used by nations internally, e.g., for its different security agencies both in defence and national security to increase interoperability.

2. **Set up of trainings and exercises covering the entire chain of cyber defence operations from planning through conduct up to review, including by utilising realistic mission networks.**

Most large-scale technical cyber exercises that are currently conducted do not sufficiently cover all relevant aspects of cyberspace operations. While such aspects are sometimes covered in non-technical exercises, these tend to not sufficiently well incorporate technical cyber defence teams. As a result, truly comprehensive and effective exercises are difficult to deliver.

The aspects that surround these technical activities (e.g., operation planning, legal considerations) and which complement incident management (e.g., intelligence activities) require different scenarios and different technical exercise environments in comparison to existing capabilities. The latter also includes the challenge of creating realistic federated mission networks for training purposes.

Key aspects in this entire chain are also the analysis of the performance of the cyber operators and the scoring of cyber security situational awareness.

3. **Leveraging Artificial Intelligence throughout the delivery of trainings and exercises (e.g., for Blue, Red, White and Green Teams)**

The use of AI in different phases and parts of cyber exercises and trainings has been researched and developed to an extent. This includes, for example, AI-based scenario generation[108], and AI-based Red/Blue Teams with hybrid skills (human + AI-based attack/defend strategies (developed in different private companies). AI also plays a pivotal role in generating comprehensive situational awareness for the development of realistic federated missions.

In the area of federated missions, which employ multiple teams operating from different locations, AI technologies could help to identify the operational deficiencies within each team member, informing subsequent training customisation and generating tailored scenarios.

It is clear that AI can assist in these and in other parts of cyber capability development. The proposals are expected to provide AI-based solutions that target all major parts of cyber exercise and training delivery, as well as AI-based solutions for the performance evaluation of the trainees using the hybrid skills.

4. Set up of trainings and exercises that leverage the concept of digital twins.

Digital twins [109] as a concept has a long history. The use of such solutions in cyber exercises has also been targeted previously but not with results that have been sufficiently persistent or useful. Therefore, the challenge remains on developing digital twins or other high-fidelity simulations that have a reasonable cost-effectiveness – given that a common dilemma in such simulations is finding a balance between cost of creating such digital copies and the learning impact that those simulations can offer on top of more standardised ways for IT/OT system and network simulations. One possible avenue for successful balancing of these requirements may be witnessed in the space domain, given its increased need for simulations and testing.

5. Develop or facilitate a framework for accreditation of training centres and personnel skill levels.

The solutions should include a proposal on how to establish certified practices for accreditation of training centres (cyber ranges) and skill levels (personal and team certificates). The solution should take into account EU-wide accreditation schemes. However, these should allow for national specificities. Where possible, existing standards, such as relevant NATO practices, should be used.

6. Cross-cutting items

All solutions must address the **challenge of sharing and pooling cyber range capabilities** in a coordinated manner between cyber range providers. This challenge may be best addressed by using and enhancing existing initiatives and projects. Moreover, this sharing and pooling can be demonstrated, for example, via the implementation of the project’s solutions in different cyber ranges through federation. If federation as an approach is used, it is expected that the proposals also cover the business and management side of the federation. This could, for example, formalise in the development of model cooperation agreements that mimic actual needs and have been developed with processes similar to actual processes (twin environments).

Where existing or new cyber range and cyber exercise standards (e.g., for scenario development and game net creation) are covered, the proposal must address the challenge of

[108] Such as ENISA November 2021: Foresight challenges: A study to enable foresight on emerging and future cybersecurity challenges.

[109] A Digital Twin is a virtual representation of a connected physical asset, American Institute of Aeronautics and Astronautics (AIAA), “Digital Twin Definition & Value,” 2020.

achieving a wide user-based of the standard. Proposing the use of any such standards without clearly addressing the way forward may invalidate the whole part of the proposal related to such standards because the success of a standard is as much dependent on the community as the standard's actual content.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks:

- Studies:
    - Identification of additional challenge(s) with a comparable level of complexity as those specifically listed above (scope, items 1-6).

  - Definition of capability statements for the solutions to all of the items in the scope (1-6).
  - Assessment of the feasibility of achieving the capability as per the capability statements.
  - Based on the feasibility assessment, definition of the most appropriate technical requirements for the solutions.
- Design:
  - Design of the solutions for each of the listed items in the scope (1-6).
- Prototyping:
  - Development of one or more system prototypes for each of the solution that target the items in the scope (1-6).
- Testing:
  - Testing of all of the prototypes developed under system prototyping.
  - Testing of one or more system prototypes at least in:
    - One new live-fire cyber demonstration with 3 or more EU Member states/EDF Associated Countries, organised by the consortium
    - One existing live-fire cyber demonstration with 3 or more EU Member states/EDF Associated Countries (e.g., in an exercise that is part of a series where at least one exercise has been held and where the exercises are held irrespective of the current topic)
- Qualification:
  - Qualification of the system, systems or system components for one or more of the system prototypes.

In addition, the proposals should cover at least the following tasks:

- Studies: A supply chain analysis in the area of cooperative cyber range technologies, addressing critical dependencies for the EDTIB.
- Design: Design of the solutions to items relevant for future cyber ranges beyond the mandatory items stated in the scope and in the mandatory tasks.
- Prototyping: One or more prototypes of the designs to items relevant for future cyber ranges beyond the mandatory tasks.
- Testing: Testing of the prototypes beyond the mandatory tasks in at least one live-fire cyber exercise.
- Certification
  - Certification of the system, systems or system components which are used for the purpose of using classified information.
  - Certification of the system, systems or system components which are used for the purpose of delivering complete cyber operations trainings and exercises.

Also, a proposal for accreditation schemes both for training centres and personal certificates (on skill) should be included.

The proposals may cover at least the following tasks:

- Qualification: Qualification of any systems beyond the mandatory tasks.
- Certification, with the meaning of Validation, Verification & Evaluation (VV&E):
    - VV&E of the system, systems or system components which are used for the purpose of leveraging the concept of digital twins.
    - VV&E of the system, systems or system components which are used for the purpose of leveraging AI.
    - VV&E of system prototypes designed and delivered beyond the mandatory tasks.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities, notably those described in the call topic EDF-2021-CYBER-D-IECTE[110] on *Improved efficiency of cyber trainings and exercises*, as well as with activities conducted under Horizon Europe (e.g., DIGITAL-ECCC-2022-CYBER-03-CYBER-RESILIENCE[111]).

Functional requirements

The proposed solutions and technologies should meet the following functional requirements in support of cyber ranges capabilities:

- The proposal should meet the common requirements for next generation cooperative cyber range as defined by supporting armed forces.
- The proposal should enable use of classified information.
- The proposal should provide a complete cyber operations trainings and exercises environment.
- The proposal should be able to measure the performance of the cyber operators, as well as to allow for the scoring of cyber security situational awareness.
- The proposal should, by leveraging AI enabled technologies:
    - Be able to identify operational lacks within each team member before the organisation of the training exercise.
    - Be able to enrich the training environment by the use of Green/White/Blue/Red teams with features such as hybrid skills (human + AI), game net components, environment enriching user simulation, dynamic amendments of training deliveries, etc.
    - Be able to provide performance evaluation of the trainees using the hybrid skills

[110] Funding & tenders (europa.eu)
[111] Funding & tenders (europa.eu)

- The proposal should leverage digital twins (may include cyber physical elements), as part of the realistic federated missions to be defined in the different trainings, enabling red teams with AI-based tools to attack the digital asset and blue teams with AI-based tools to defend the digital asset.

- The proposal should enable federating cyber ranges through:

  - Standard solutions to all challenges, which should contain functionalities for sharing and pooling of resources and federation of cyber ranges. For example, through concepts methods, tools, and standards such as HLA[112], or as developed in the context of the call EDF-2021-CYBER-D-IECTE.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Strategic autonomy of EDTIB in the area of cooperative cyber ranges.
  - Fostering the technological cooperation of industries in the field of cooperative cyber ranges.
- Interoperability of EU Member States and EDF Associated Countries Armed Forces:
  - In the area of cyber defence for cyber mission planning and execution, including through the use of classified information and high-fidelity simulations such as digital twins within the training process;
  - Between civil and military actors;
  - Common requirements and harmonisation of capability development.

2.5.6. EDF-2024-DA-SPACE-EPW-STEP: Secure waveform for satellite communications

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

In today's military applications supported by satellite communications, security, information assurance and link efficiency are inextricably linked. Military operations are becoming more complex as conflict areas grow more dispersed on a global scale, with a growing need to support a diversity of on-the-move, on-the-pause and fixed platforms. At the same time,

[112] SISO standard: High Level Architecture for distributed simulation, training and exercises.

security threats are becoming more apparent, raising concerns that nations, terrorist groups, criminals and individual hackers can jam, interrupt and endanger military operations.

In satellite communications, most individual nations cannot generate significant capabilities by themselves. Instead, European nations can generate increased capabilities through cooperation and collaboration. Several pooling and sharing initiatives have already been kicked off in the European defence context to face challenges related to the fragmentation of supply and demand, the assured secure access to satellite communications and the changing environment.

The complexity of dispersed military operations translates into requirements to have access to complex global satellite communication networks with a mix of different satellite constellations, networks and services to support a wide variety of military applications. Security and resilience are key features of today's military satellite networks and are paired with efficiency to cope with the increased data demand of bandwidth hungry services such as ISR and situational awareness, the growing use of on-the-move applications, and the need for seamless end-user experience during operations. However, military satellite communication networks with these wide-ranging requirements face an increased risk of ill-intentioned acts and cyber-attacks such as jamming, signal spoofing and interception attempts.

A key element to tackle this security challenge is the implementation of a protected, resilient and secure satellite communication waveform for fully transparent[113], processed transparent[114] and the new generation processed interactive transponders[115], which at the same time responds to the operational requirements and allows for interoperability during joint operations with allies.

The great majority of Member States do not have independent access to secure satellite communication waveforms, although they also engage in military operations in a national or multinational (EU, NATO, UN peacekeeping, etc.) context. The investment for developing a protected waveform cannot be carried out by a single nation alone and requires a multinational development approach in a European context with the aim to establish a European Protected Waveform (EPW).

Specific objectives

This topic aims specifically at further developing a European interoperable protected waveform for satellite military communications that can be used by different EU nations

[113] Transparent transponder: a satellite transponder performing fully analogue handling of the received signals. It re-transmits (repeats) the signals without modifying the received waveforms. A transparent transponder is also known as a bent pipe transponder.

[114] Processed transparent transponder: a satellite transponder performing digital processing of the received signals. It re-transmits (repeats) the signals without modifying the received waveforms. It includes a Digital Transparent Transponder (DTP). Signal processing allows to manage the apportionment and switching of the transponder bandwidth resources.

[115] Interactive Transponder: a satellite transponder, based on digital Software Defined Radio (SDR) technology On Board Processor (OBP), capable of dynamic/adaptive signals regeneration by demodulation and re-modulation of received signals. Signal processing allows to manage the apportionment and switching of the transponder bandwidth resources. The interactive functionalities hosted on-board can provides dynamic routing of data traffic between satellites via inter-satellite links and/or inter-beams/inter-channels, according to a dynamic on-board generated control plane. Furthermore, it could be able to host higher level functions devoted to assist satellite network control and management (i.e., network control centre and/or Traffic Resource Management (TRM)). Interactive transponder is also capable to downlink in regenerative and transparent modes.

individually or together in a joint operational context (EU, NATO, multi-nation missions). Such European Protected Waveform (EPW) should in particular target efficiency, security, affordability and interoperability of satellite communications. The EPW should be license-based and flexibly adapted according to the application, service or platform (fixed, on-the-move or on-the-pause) during peacetime or in operations.

Next to the waveform, related technologies should be developed to increase the security and resilience (via integrated multi-layered approach) and adopt the EPW on on-board processing satellites as well as to cater for next-generation technologies.

The targeted development should therefore be undertaken with five key considerations in mind:

1/ European autonomy and cooperation between Member States

The EPW should be capable of increasing the autonomy of Europe and of reducing the dependence on non-European satellite communication technologies for military operations with mission critical and sensitive information. At the same time, it should allow for interoperability between EU nations in a joint operational context to support the exchange of mission critical information and improve the efficiency of the operations.

2/ Affordable and efficient satellite services

The EPW should be affordable and include the latest efficiency satellite communication waveform, networking and equipment technologies to save OPEX (reduce bandwidth costs, require less resources for planning) and CAPEX (reduce equipment cost) compared to current existing expensive (proprietary) military satellite modems. The EPW should include already available innovative Commercial Off-The-Shelf (COTS) satellite communication technologies (e.g., DVB-S2X waveform standard) in combination with the latest security and resilience technologies. There should no longer be a trade-off between the efficiency of the waveform and security. As such, high throughput demands should be achieved even with small satellite terminals using a limited amount of satellite bandwidth.

3/ Flexibility and scalability

The EPW should be portable on different modems with different form factors (board, modem, terminal), different platforms (fixed, on-the-move, on-the-pause) and be used across multiple types of satellite communication networks, different types of satellite constellations (LEO, MEO, GEO, HEO, high-throughput satellites, spot beams, regional and global beams), transponders (fully transparent-, processed transparent- and processed interactive, including software defined radio ones) and different network architectures (VSAT, point-to-point, mesh). At the same time, the EPW should be operational in different satellite frequency bands (at least C-band, X-band, Ku-band and Ka-band) and exchange, broadcast, multicast, unicast or relay a large range of satellite services and applications, including those requiring low latency, from low to very high data rates.

4/ Innovation

The EPW development should not just be a copy and paste of existing waveform solutions, licenses and technologies. The EPW proposal should be ambitious and innovative, combining the individual strengths of different nations and different members in the European satellite communication industry. The EPW programme should be open to support future requirements and capabilities needed.

5/ Security and resilience

The main feature of the EPW should be the increase in protection and resilience of the waveform to ensure secure information exchange over satellite for mission critical communications. Based on different threat analysis and Concept of Operations (CONOPS) definitions, the EPW development should focus on building satellite links that are resistant to electronic- and cyber-attacks, such as jamming, signal spoofing, eavesdropping and interception attempts. In addition, satellite link outages caused by rain fade, atmospheric and extra-atmospheric (relevant space weather events) conditions, or on-the-move communication challenges should be reduced to a minimum. The EPW activity should investigate how different security levels can be offered towards different military end users depending on their security requirements, their daily operations and the budgets available.

Scope and types of activities

Scope

Proposals must address system prototyping of the baseband equipment (satellite modem), the on-board satellite active transponder and ancillary systems, as well as the testing of all prototypes (modems, on board active transponders and ancillary systems) operating the EPW in a controlled and operational military environment.

Types of activities

The following types of activities are eligible for this topic:

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 (optional)
(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 (optional)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- System prototyping:
  - Develop a breadboard of an SDR Interactive Transponder implementing the EPW enhanced secure mechanisms that includes some of the components and electrical and functional (including digital) performances in order to reach TRL 6;
  - Implement the EPW in SDR/ground-based equipment.
- Testing:
  - Verify the SDR Interactive Transponder prototype in an end-to-end representative laboratory environment, including anti-jamming capability, user access control (authorised user admission and unauthorised user rejection), signals activity masking, ability to operate in GNSS-degraded or denied environment;
  - Test end-to-end service in laboratory environment;
  - Demonstrate end-to-end service in satellite environment (TRL 6).

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of satellite communication for defence applications, notably those described in the call topic EDF-2021-SPACE-D-EPW related to *a European protected waveform and accompanying technologies for resilient satellite communications against jamming*[116], as well as with those described in the European Defence Industrial Development Programme (EDIDP) work programme 2019-2020 relating to the European Secure Software defined Radio (ESSOR)[117] and those targeted by the new EU Secure Satellite Constellation[118] IRIS².

[116] Funding & tenders (europa.eu)
[117] See section 4.5.2 of EDIDP work programme https://ec.europa.eu/docsroom/documents/34515/attachments/3/translations/en/renditions/native
[118] IRIS² (europa.eu)

Functional requirements

The proposed product and technologies should meet the following functional requirements:

System requirements:

- The EPW should be accessible to small, mid-sized and large Member States and EDF Associated Countries seeking to embrace today's and future challenges related to increased throughput demand over satellite, dispersed theatres, joint operations, mobility and new security threats;

- In accordance with this integrated multi-layered security and resiliency approach for military satellite networks, the EPW development should fulfil requirements at the level of the waveform, the baseband equipment (terminals, modems, hubs, networks) and end-to-end satellite network level including multi-band/multi-frequency terminals, anti-jamming technologies, interference mitigation, network diversity, network security and cyber technologies. The demarcation point is the edge router of the satellite network which connects the hubs, gateways and modems with outside networks or the internet.

- Additionally, it should be feasible to implement the EPW also on existing and operational telecommunication satellites;

- The EPW should be resilient and maximise service availability to ensure continuity of seamless operations;

- The EPW should have performances considering the throughput demands of today and the future;

- The EPW should support pooling and sharing service models of both waveform and equipment that can be implemented for different operations;

- The EPW should apply to the best extent possible the set of applicable standards of 5G non-terrestrial network (5G NTN) within 3GPP[119] and take into account the new use cases and technologies linked to Machine-to-Machine (M2M), Internet-of-Things (IoT), orchestration, cloud-services, the connected soldier and smart defence.

Protected Waveform Requirements:

- The EPW should be defined as a standard to enable interoperability in joint operations.

- Terminals from multiple vendors should be able to support the EPW and be compatible with it;

- The EPW should be affordable, based on the best practices of COTS and government or military-grade waveforms;

- The EPW should implement the most efficient SATCOM technologies to obtain the best performance out of a satellite link;

[119] See 3GPP TS 38.101-5 v18.3 (for user end equipment) and 3GPP TS 38.108 v18.0 (for satellite access node) available here www.3gpp.org/ftp/Specs/archive/38_series/.

- The EPW should support a range of different multi-orbit satellite constellations ((V)HTS, wideband, military, commercial, government, HEO, GEO, MEO, LEO), satellite architectures (pure transponder, partially or fully processed) and frequency bands (C-band, X-band, Ku-band, [mil- and civ-] Ka-band) with extension to Q-/V-band to support future SATCOM constellations) and have the capability to roam across the different satellite networks in a seamless manner;

- The EPW should be easy to port on other software defined modems or hubs;

- The EPW should be flexible to support multiple governmental and defence applications that require different levels of security and latency;

- The EPW should implement functionality to support (a growing amount of) on-the-move and on-the-pause platforms connected over the satellite with a need for mobility features (Doppler compensations, spreading modulation, small and flat antenna support, beam switching, beam hopping, etc.);

- The EPW should be able to operate in GNSS-denied environments;

- The EPW should provide adequate protection against intrusion, hacking, jamming, traffic monitoring and eavesdropping;

- The EPW should mask and obscure traffic patterns across the satellite link that could give away activity-related information on ongoing operations and assets;

- The EPW should consider a wide range of throughput requirements and satellite bandwidth sizes (symbol rates) and automatically adapt to changing environments and service requirements;

- The EPW should offer seamless services over resilient satellite links against fading and shadowing effects, unintentional and intentional interference such as jamming (fixed and sweeping);

<u>Multi-layered security & resilience requirements (extended capabilities):</u>

The EPW should be embedded in an integrated multi-layered security and resilience approach to increase the protection of mission critical military or governmental satellite networks. As such, an overall approach needs to be envisaged to align the EPW development with the complementary security and resiliency technologies for ground and space segments, leading to the following additional requirements:

The EPW should be integrated into a larger multi-layered security & resilience architecture that:

- Contains anti-jamming technologies that allow to detect, mitigate, prevent and predict jamming efforts by 3rd party adversaries. This could be tackled through spectrum monitoring, geolocation and network management technologies working together with nulling or interference excision technologies as well as Anti-Jam waveform capabilities as Direct Sequence Spread Spectrum, Frequency Hopping Spread Spectrum and beam forming technologies;

- Allows for network diversity, redundancy and geo-redundancy technologies to increase the resilience of the satellite network as well as for multi-access capabilities (hybrid LTE/5G/etc.) with intelligent routing;

- Can dynamically steer its radiation pattern accordingly to connect to another satellite in a different frequency and satellite orbit to increase network resiliency. Fixed, on-the-move and on-the-pause land-based and maritime terminals, man packs and antenna systems, including airborne terminals and antenna systems installed on rotatory wings (RW), need to be considered as well as different types of antenna technologies (e.g., parabolic, electronically steered, phased array, flat antennas, etc.). The secure connection and interface between antenna system and baseband needs to be taken into account as well;

- Includes network and ground segment technologies that improve the cyber hardening of all satellite vulnerable subsystems including protection against possible hacking, network intrusion, etc.

- Includes protection technologies against hostile action (e.g., jammers, intrusion and eavesdropping) for critical satellite datalinks, improving signals protection and integrity;

- Provides future proof interfaces and complementarity to upcoming disruptive security technologies such as quantum-safe encryption, self-healing networks, etc.;

- Is open towards upcoming and existing EU-based pooling and sharing programs (e.g., GovSatCom) and satellite constellations (EU Secure Space Connectivity System initiative currently under study) and ready to be integrated in these concepts.

<u>Baseband equipment requirements (hubs, modems):</u>

The right implementation of the terminal is likely to determine the success of the EPW. The flexibility and the affordability of the terminal are key considerations.

- A Software Defined Mode type of baseband equipment should be pursued;

- The baseband infrastructure (hubs and modems) should cover multiple architecture types of networks (point-to-point, point-to-multipoint, mesh) and satellite (wideband, spot beam, mix of both, transparent, processed) architectures;

- The EPW should operate on Software Defined hardware from different vendors to be selected by nations, government and defence agencies or institutions, depending on their preference or acquisition processes;

- The EPW should include the ability to receive and transmit various modulation methods using a common set of hardware;

- The EPW should be future-proof, easy to upgrade and change configurations (over-the-air) and offer the ability to alter functionality by downloading and running new software at will, in order to repurpose the modem for new applications;

- The EPW should be affordable and include the latest efficiency satellite waveform, networking and equipment technologies to save OPEX (reduce bandwidth costs, save resources for planning) and CAPEX (save on equipment cost) compared to existing expensive military satellite modems;

- The EPW should consider Size, Weight and Power (SWaP) constraints for on-the-pause and on-the-move platforms and unmanned systems. Modems and terminals should be easy to transport and deployed and use a minimum amount of power;

- The EPW should be deployable in different environment conditions and on different platforms (land, sea or air);

- The EPW should be available in different form factors (OEM cards, rack units or rugged terminals);

- The EPW should be transparent for national encryption standards and externally encrypted data, and capable of integrating on-board modules for encryption technology.

<u>On-board Transponder requirements:</u>

- The EPW should consider different transponder technologies including next generation ones (i.e., fully transparent transponder; processed transparent transponder; new generation processed interactive transponder).

- The EPW processed transponder should contribute to improve link performance; adoption of (individual) gain adjustment mechanism for dynamic power level control needs to be considered.

- The EPW interactive transponder should be able to support operation in GNSS-denied environments by implementing enhanced mechanisms dedicated to the network elements synchronisation and aided fast signal acquisition.

- The EPW interactive transponder should improve the Low Probability of Detection – LPD / Low Probability of Interception LPI – factors .

- The EPW interactive transponder must provide protection against intrusion and jamming.

- The EPW interactive transponder must deny connectivity for unauthorised transmission attempts by guaranteeing exclusive access to the satellite resource.

- The EPW interactive transponder should be able to implement enhanced mechanism, addressed in the EPW project, devoted to decoupling the transmission schemes between downlink and uplink signals in order to de-correlate uplink and downlink signals activity and prevent eavesdropping and activity monitoring for ongoing operations and assets.

- The EPW interactive transponder architecture should be designed maximising the employment of Software Defined solutions in order to perform future upgrade/changes of configuration.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- The availability of a critical enabler for CSDP operations and missions in providing scalable secure and resilient communications in peacetime and during operations with protection against intrusion, hacking, jamming, traffic monitoring and eavesdropping;
- Full interoperability between different demanders and suppliers of satellite communication in support of military operations and missions;
- Secure, guaranteed and affordable access to satellite communications for all Member States and EDF Associated Countries;
- Strongly increase European autonomy in satellite communication for defence users and remove dependency on support from outside the EU for the transmission and exchange of mission critical and sensitive information;
- State-of-the-art technological solution in line with the latest satellite innovations and initiatives such as 5G, small LEO/MEO satellites, connected vehicles and Internet of things.

2.5.7. EDF-2024-DA-ENERENV-EEMC-STEP: Energy-independent and energy-efficient systems for military camps

- **Indicative budget:** EUR 40 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The future battlefield is likely to be dominated by weapon systems, platforms and devices that require electric energy. This type of battlefield, previously purely oil-based from cradle to grave, to integrate energy management technologies, buffer storage resources and a camp/weapon system interface in a constrained and contested tactical environment, is in need of a comprehensive review of its energy production and distribution. It requires the implementation of a coherent and efficient energy network, from the energy production systems at operational level to the soldiers at tactical level, through all the layers of the distribution systems.

In parallel, the EU defence sector has to start its digital and green energy transition to contribute to the EU net-zero greenhouse gas emissions target by 2050 and to anticipate growing energy costs linked to the vulnerability of fossil fuel supplies becoming increasingly scarce and disputed.

This development entails major risks for military activities. The multiplication of low-carbon energy sources and the risk of more complex logistics are an additional challenge for manoeuvres. It is also an opportunity to meet the growing demand for future weapons systems, platforms and devices.

An energy-independent and energy efficient deployable military camp, as part of the future electric battlefield, is the first step towards an operational and tactical integrated energy supply chain. It serves as a starting point, hub for innovative electric energy generation and efficient distribution throughout all levels. This includes initial definitions of interface between the stationary components (operational level) and the mobile components (tactical level) of the electric battlefield.

As the role of the military camps, as an energy provider has been emphasised, scaling-up of its technological bricks (energy generation, storage and distribution) needs to be amplified while covering a wide range of operational scenarios.

Specific objective

The specific objective of this topic is to substitute the fossil fuel dependency reduction in military deployable camps (support and mobility) without any drop of operational performances, in a context of increasing electrical energy demand in the battlefield. Moreover, investigation on the return of experience of the demonstration stage, should include specifications of a whole concept of energy independent and efficient deployable camps. Furthermore, the ability to support the diminution of their fossil fuel consumptions while maintaining operational performances, avoiding logistics, security burden and reducing logistics footprint should be validated.

Scope and types of activities

Scope

Proposals must address a full-scale operational demonstrator of a deployable camp fulfilling interoperability between inter-allied armies and NATO, with a modular and easily deployable energy system and adaptable energy mix.

Proposals must pursue the feasibility study of different technologies to answer to the identified needs of the Member States and EDF Associated Countries while ensuring the interoperability of systems and taking into consideration opportunities such as autonomy or resilience. As innovative solutions evolve rapidly, the proposals should update results generated through the latest research in this domain. In addition, proposals should demonstrate the effectiveness of logistics and maintenance in different scenarios (e.g., Host Nation Support, Contractor Support to Operations or by military themselves).

Proposals must design and produce the solutions (production, storage and management modules, including control and command interfaces, communication protocols, and operational simulation and planning systems). In order to ensure their safe use, functional tests must be performed before the demonstration stage.

Proposals must address physical experiment of the most critical technological modules deployed in military camps, especially the most vulnerable ones toward harsh environmental conditions and demanding operational scenarios, including resilience against electronic warfare, cyber-attacks and electromagnetic pulse.

Proposals must split the demonstration of the technological modules in different locations hosted by several Member States in different representative environment (cold/warm weather, dust, number of occupants, deployment duration, type of mission, etc.). In addition, the proposals must validate a wide range of operational use cases and assess the adaptability of the technology for the deployment in different scenarios. Adding up, they should ensure testing, validation and qualification of the overall concept through simulation activities in real military context including in harsh conditions. Furthermore, the ability of the energy architectures and protocols endorsed to operate in civil-based (non-rugged) solutions should be demonstrated. The demonstration should cover the simulation and planning tools.

The focus must be on military use-cases, taking into account specific harsh military environment (cold/heat/dust), different deployments and conflict intensities (including the shift from low-intensity conflict to high-intensity warfare), different deployed infrastructures, different life-time phases of the camp (storage, building, operation and redeployment phase) and military heavy constraints (logistic, maintenance, training, risk management, unmanned).

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes

Types of activities (art 10(3) EDF Regulation)		Eligible?
		(mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Studies:

  Study activities must build on ongoing, completed civil-based and military research and follow as well new solutions available on the market (hydrogen/synthetic fuels, non-fossil fuels from renewable sources, smart grid, microgrids, self-healing power systems, etc.) to validate the feasibility of deploying such solutions in operations areas. Some specific areas must be covered:

  - Study the emerging technological solutions becoming available on the market;
  - Analyse hydrogen or hydrogen based synthetic fuels to include recent development on substances identified as storage medium for hydrogen as ammonia, toluene, salt and solid matter, and assess the possibility to be employed in overseas camp (UxV, soldiers wearables, etc.);
  - Analyse smart grid integrating hybrid and electric vehicles in the camp scope, including fast charging systems, vehicle to grid concepts, wireless and fast charging docking for UxV;
  - Analyse heat recovery systems for increasing energy efficiency of power generators, thermal energy storages, i.e., water or phase change material (PCM)/ latent heat storages and waste treatment systems, including wastewater;
  - Analyse data monitoring tools (including meters) and management technologies, interface with tactical management systems as battlefield management and situational awareness tools;
  - Perform an accurate energy performance diagnosis;
  - Identify and select key technological solutions for a demonstration action: existing industrial solutions and adapting civilian products identified that are part of the energy independent and efficient deployable camps concept;

- Study of the added value of Artificial Intelligence (AI) for the camp's energy management system and to prevent, detect and to respond to cyberattacks;
- Study and implement up to date technological solutions in order to allow the forces to reduce fossil fuel consumption in military deployable camps;
- Study the ability for such technological solutions to operate in a military context by integrating the logistics and financial aspect, and collateral benefits;
- Study and update the risk assessment from demonstration actions: vulnerability, electromagnetic compatibility, detections of such systems, spare parts needs, possible collateral damages in case of destruction, cyberattacks, training;
- Identify the needs of the interested Member States and EDF Associated Countries for demonstration actions;
- Define aspects of standardisation of hardware and software interfaces (i.e., through the use of middleware or other) to allow the creation of a military camp in which different modules can be integrated through standard interfaces in accordance with Operational Energy Concept milestones (e.g., the draft available on the NATO Energy Security Centre of Excellence website) and the environmental protection for military camps (e.g., the NATO operations environmental protection best practices).

- Design:
  - Design and define energy efficient deployable camp architectures following preliminary existing research concepts in this area and covering the complete energy chain too;
  - Design and production of the energy modules (production, storage, management modules, as well as electrical and control/command equipment, communication protocols, operational simulation and planning tools);
  - Design a camp energy simulation and planning platform and validate its capacity to represent operational situations. The simulation and planning platform must be designed in a way that it can be updated and provide the ability to add new modules/characteristics of power sources, energy storages and consumers;
  - Design and set-up a full-scale operational demonstrator of a deployable military camp as the starting point of an energy supply chain, to validate the concept in operational conditions, and to support the development of a new advanced European capability for supplying electric energy on the battlefield;
  - Design should ensure that the outcomes of the proposals must include the definition of an EU energy efficient deployable camp standard, with a special interest on standardisation of hybrid and electric heavy vehicles supply and

powering systems at the camp. Proposals must also pursue the development of the tool to predict and simulate energy production/consumption and determinate the most efficient camp architectures for planning activities;

  - Design should safeguard specifically the capacity to on-site produce, transport, store, distribute and use green hydrogen or green hydrogen based synthetic fuels in military context and to power supply in field operations;

  - Integrate individual tests at component/equipment level to ensure safety.

- System prototyping:

  - Functional testing of the energy modules at real power levels (test bench at full size) in order to confirm the global safety of the solutions, test the interoperability and connectivity of each module and test non-nominal electrical scenario (stress tests, breakdown, network resilience and reconfiguration).

- Testing:

  - The testing activities must involve the identification of key players in this domain, to ensure the inclusion of the European armies need addressing specific operational scenarios and different hypothesis of engagement. A special attention must be given to the technological modules which show vulnerability towards harsh environment or carrying potential risk to be operated in fields operations.

  - The testing must include the design of the appropriate experimental approach to demonstrate the capacity of the technological solutions to be operated in military context covering different deployment scenarios, with at least:

    - Geographic and climatic regions including at least an Arctic region, a continental climate region, an arid climate region and a tropical region;

    - Validate requirements against operational needs and mission requirements;

    - Perform the tests in specific harsh environments: extreme heat and cold, dust, high humidity.

  - Test the use of hybrid and full electric vehicles, including military, logistic and construction vehicles (e.g., forklifts, excavators, cranes, ground moving equipment, etc.) that are used in the build-up phase, the operational phase, and the redeployment phase of a deployable military camp, including the evaluation and simulation of the use and possible impact on fuel reduction of those machines as part of the camp microgrid system (e.g., as extra energy storage and/or grid balancing).

- Test the capacity to power hybrid and electric vehicles, including construction equipment (e.g., forklifts, excavators, cranes, ground moving equipment, etc.) and military platforms (e.g., UxV, robots, DEW, soldiers, etc) in operations.

- Test the capacity to produce, transport, store, distribute and use alternate non-fossil fuels from renewable sources to explore the convenience of integrating fossil fuels with zero or low impact on the carbon footprint in the military environment.

- Different existing concepts of deployment for overseas operations, at least including deployed force infrastructure.e.g.,

- Three scenarios reflecting different number of camps occupants: 50 personnels, 250 personnels and 2000 personnels;

- A peacetime and low-intensity scenario and a high-intensity war scenario demonstrating the energy network's capacity for reconfiguration;

- A test preparation and coordination between industrial partners and hosting Member States, by defining an adequate Data Collection Plan. In addition, ensure security and proper analysis of the data collected;

- Demonstrator testing, both tactics and logistics (including maintenance);

- Individual tests at component and equipment level to ensure safety (e.g., CE certification).

- To prove the performance of the capacity, the testing must be performed following realistic operational conditions, for a representative period for each demonstrator module. Physical testing must be completed with simulation activities (e.g., SIMEX - Simulation Exercise) through the digital model elaborated. The testing must be organised in collaboration with the supporting Member states and EDF Associated Countries (e.g., in collaboration with NATO “Capable logisticians” exercise and with the Permanent Structured Cooperation (PESCO) and Energy Operational Function EOF[120] partners) to articulate the interoperability of the solutions with the allies.

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of energy-efficient systems for military camps, notably those described in the call topic EDF-2021-ENERENV-D-EEMC[121] related to *Energy independent and efficient systems for military camps.*

[120] https://www.pesco.europa.eu/project/energy-operational-function/
[121] Funding & tenders (europa.eu)

Functional requirements

The proposed product and technologies must meet the following functional requirements:

- Lower the fossil fuel dependency of deployable camps and foster their energy autonomy and improve the use of an extensive energy mix, including a growing share of renewable energy;
- Improve the energy autonomy of the camp: use of renewable sources, production and storage of its own electricity or sustainable fuel, integration of smart electricity grid and energy management system, implementation of cogeneration of power and heat from different non-fossil sources, including renewable sources (i.e., combination of solar panels and heat pumps), with a minimum of maintenance and cost-efficient solutions;
- Improve the deployment of hydrogen solutions in operational areas particularly in terms of onsite production (from renewable sources) transportation and storage;
- Improve the operational capacity of the camp: reducing the noise and detection/signature, reducing the logistical convoys in fossil fuels and integration of the energy awareness inside battle management systems;
- Improve the energy supply of current, future weapon systems, operational energy planification with digital twins, machine learning, and AI technologies;
- Promote plug-and-play and easy-to-use solutions in order to limit human resources burden and be effective maintainable,
- Be modular and be integrated in extensive military operational configurations, from foreground infrastructure to equipment deployed close to the threats,
- Be protected against military risks and natural disasters, taking into account climate change effects;
- Be easily and rapidly transportable (even air-transportable), deployable and removable without involving a lot of labour force, in different geographic and climatic regions from arctic to tropical regions, housed in ISO containers (e.g., an ISO 20 feet container type "1C" or under);
- Be compliant with cyber-defence and cyber-security requirements;
- Be agile and easily reconfigurable with open interfaces and communication protocols allowing the integration of future solutions and use of civil-based (non-robust) solutions deployed in harsh operational circumstances (e.g., in a downgraded mode);
- Be based on components developed and manufactured in Europe in order to foster the European autonomy and sovereignty;
- Be interoperable between allied armies and NATO and be tested in a representative military environment;

- Be compliant with relevant national, European and global regulations and standards.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Improving the armed forces autonomy, resilience, interoperability and capabilities in operations to support the growing needs of electrical energy for the weapons systems in the battlefield,
- A decrease in the total costs of ownership of deployed capacities and supporting the growing needs of electrical energy for the weapons systems in the battlefield,
- Enhancing the competitiveness and innovation capacity of the EU defence industry in the area of new energies,
- Completing the global European strategy for renewable and sustainable energy, hence tackling the climate change,
- Adapting to civilian sustainable energy technology, military requirements and develop European standards,
- Improving the logistics processes and the ability to perform effective maintenance.

2.5.8. EDF-2024-DA-AIR-NGRT: Next generation rotorcraft

- **Indicative budget:** EUR 100 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The importance of rotorcraft in military operations is widely recognised as one of the most important VTOL[122] assets/systems. Military rotorcraft act like workhorses of the battlefield, performing a variety of missions such as armed reconnaissance, strike, combat, combat and ordinary search-and-rescue (SAR), MEDical EVACuation (MEDEVAC), CASualty EVACuation (CASEVAC), utility, air assault and close aerial support, all of which are critical to the success of military operations.

After decades of European involvement in counter-insurgency type of operations, recent conflicts have marked the return of high-intensity confrontations very close to European Union territory, recalling that although military helicopters are key assets, they require careful mission planning and operations to be efficient and survivable.

[122] Vertical Take-Off and Landing

On the longer term, rotorcraft is foreseen to be even more critical as future combat theatres are likely to take place in congested urban environment, mostly in littoral regions, and to involve a wide range of long-range strike capabilities (artillery, short range ballistic missiles) combined with a shortened OODA[123] loop made possible by the massive global deployment of networked C4ISR[124] assets.

Current capability forecast assessments at European and NATO levels show that the helicopter fleets will have to be renewed as of 2035-2040. The main objective is therefore to provide the EU Member States and EDF Associated Countries with a European solution that meets the European market and military needs in the field of rotorcraft.

Specific objective

This topic is intended to lead to a step improvement in EU VTOL capability with a view to future EU/NATO rotorcraft programmes (EIS 2035/2040+). Moreover, developed technologies should also be used for upgrades of legacy platforms, where applicable.

<u>Scope and types of activities</u>

Scope

Proposals must address future technologies and rotorcraft architectures with a view to the launch of a new European collaborative capability development programme in the field of next generation rotorcraft by 2030.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)

[123] Observe – Orient – Decide – Act
[124] Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance

	Types of activities (art 10(3) EDF Regulation)	Eligible?
(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 (mandatory)

Accordingly, the proposals must cover at least the following tasks as part of the studies and design mandatory activities:

- Assess adequate elements and criteria underpinning the convergence towards a single vehicle architecture and assess the related operational concepts for high performance military VTOL platforms, including:
  - Fundamental work on EU defence community needs as provided by EU Member States and EDF Associated Countries, with a special focus on logistics, serviceability and training;
  - Assessment of the preliminary technical specifications, concept studies and sizing for major sub-systems (including, but not limited to, propulsion, core avionics, mission system(s), role equipment and general systems);
  - Feasibility analysis and preliminary requirements review (PRR) of rotorcraft architectures to confirm the technical, programmatic, industrial and market feasibility of the solution(s), with a view to further development and industrialisation and production phases;
  - Rotorcraft design study consisting of an assessment of vehicle architectures, with a maturity target allowing a System Specification Review (SSR);
  - Coordination of technology acquisition efforts to integrate key future capability streams since early concept phase (e.g., modularity, interoperability, interchangeability, manned-unmanned teaming (MUM-T), survivability, design-to-cost).

- Address key technologies and system architectures for next generation VTOL platforms up to TRL[125] 4-6, in particular regarding:
    - o Design and manufacturing technologies to:
        - ▪ Reduce acquisition and upgrade costs, using an EU Modular and Open Rotorcraft System Architecture;
        - ▪ Reduce maintenance costs while providing a significantly higher operational and fleet availability than existing helicopters (e.g., utilising mature and already proven solutions wherever possible, harmonised maintenance programme, etc.).
    - o Technologies towards lower-emission production and operation, as well as reduced consumption of energy resources;
    - o Technologies to improve the operational capability and thus create an operational advantage in the area of:
        - ▪ Performance of the platform (e.g., range, endurance/autonomy, payload, speed, manoeuvrability, etc.);
        - ▪ Enhanced survivability in contested environments, such as technologies towards minimised signature (e.g., IR, radar, acoustic, visual, etc.);
        - ▪ Improved connectivity and interoperability;
        - ▪ Adaptability for rapid reconfiguration according to the mission requirements;
        - ▪ Improved interchangeability of components between different aircraft configurations and/or between different helicopter operators;
        - ▪ Manned-unmanned teaming and automation level to reduce crew workload;
        - ▪ Multi-domain (air, land and maritime) capability aspects;
        - ▪ Ability to conduct distributed operations to sustain potentially protracted confrontations.
- Perform ground and flight demonstrations of systems and technologies, relying on technology demonstrators and available assets, as well as on laboratory testing.
- In terms of programme activities:
    - o Prepare the required industrial activities to develop and exploit the military capacity to be selected and the interoperability requirements;

[125] Technology readiness level

- Establish the preliminary programme management and the system engineering plans;
- Establish the overall programme schedule and roadmap, including possible relationships with other projects;
- Perform a costing evaluation exercise;
- Perform a market assessment review;
- Identify risks and constraints related to implementation, costs, schedule, organisation, operations, maintenance, production and disposal;
- Identify key technological aspects and plan for their maturation within the programme plan;
- Establish methods to ensure the simplest feasible technical solution to the operational requirement and to establish methods to harmonise and optimise the maintenance programme.

- In terms of activities related to the operational environment, contribute to:
  - The refinement of a concept of operations (CONOPS) and Main Attributes List provided by the supporting EU Member States and EDF Associated Countries.
  - The definition of the sustainment model (i.e., number of planned flight hours, layout of bases, deployments), in line with guidance from the supporting EU Member States and EDF Associated Countries.
  - The definition of a baseline for aircraft logistic support, in accordance with the supporting EU Member States and EDF Associated Countries provisions.
- Provide a proposal for a best candidate solution based on a complete value analysis covering performances, costs, risks, modularity, availability, manufacturability, safety, consistency with Member States and EDF Associated Countries operational needs, with jointly defined detailed criteria and hypotheses.

In addition, the proposals must cover at least the following tasks in view of the increasing efficiency mandatory activities:

- Maximise maintenance operations to be performed at operational level and minimise depot level maintenance (with regard to aircraft components and aircraft ground equipment);
- Minimise calendar and flight hour maintenance limits while maximising on-condition maintenance;

- Minimise utilisation of components subject to limitations (e.g., REACH legislation[126] or any other import/export regulation), potentially affecting the procurement of spare parts;

- Implement as many already certified systems and maintenance metrics as possible;

- Provide targeted production and maintenance plans to be worked on at all stages of the development/design phase.

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of rotorcraft, notably those described in:

- The call topic EDF-2021-AIR-R-NGRT[127] related to Future Operating Environment (FOE) and Future Operating Concepts (FOC) for *Next generation rotorcraft technologies*.

- The call topic EDF-2021-AIR-D-CAC[128] related to *European interoperability standard for collaborative air combat* as regards to collaborative air combat and manned-unmanned teaming aspects.

- The call topic EDF-2023-DA-AIR-SPS[129] related to *Self-protection systems* as regards to survivability aspects.

<u>Functional requirements</u>

The proposed product and technologies should meet the Main Attributes List defined by the supporting EU Member States and EDF Associated Countries and the following functional requirements:

A- Ground rig test, laboratory tests and/or specimen demonstration of:

- The system architecture, based on a maximal proportion of existing system components, modified where applicable to include new interfaces, and combined in a system integration laboratory to test the architectural backbone and system interconnections.
- Critical structural and dynamic components to collect experimental data for preliminary validation activities of design concepts, in support to the rotorcraft architecture assessment.
- Technologies enhancing survivability capacities of structural elements.
- Aerodynamics performances through experimental aerodynamics campaigns to demonstrate aerodynamic effects and behaviours of the platform in various mission conditions.
- Aerodynamic tests on non-linear behaviours to collect de-risking elements on critical aero-elastic effects.
- Technologies supporting the ability to adopt dispersed operations for long time (validation of the technologies developed by simulation).

[126] Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (OJ L 396 30.12.2006, p. 1)
[127] Funding & tenders (europa.eu)
[128] Funding & tenders (europa.eu)
[129] Funding & tenders (europa.eu)

B- In-flight demonstrator of:

- Interoperability capability to support mid- and long-term compatibility of EU rotorcraft with future multi-domain and air combat collaborative systems and leverage on results from simulation;
- Collaborative combat and MUM-T[130] capacities.

C- In-flight demonstrations of technology bricks, focusing on bricks providing an operational advantage:

- Modular architecture for control system (from pilot inputs to moving surfaces) to be tested at the end of specific design activities;
- Survivability elements to reduce the risk of encounter, detection, acquisition, as well as hit, penetration and kill, such as those induced by self-protection capabilities, in coherence with hardware and/or software solutions already developed in this field, provided that they are made available for testing, even in their simplified configurations and shapes;
- Future on-board energy/power capability and related energy/power management possible architectures.

D- Simulation of technology bricks, focusing on those providing an operational advantage, such as:

- Rotors and rotating controls, in combination with ground demonstrators;
- Technologies supporting the ability to adopt dispersed operations for long time (to be validated in rig-test demonstrator);
- Survivability capabilities linked to low signature/detectability assessment (of various types, e.g., acoustic/dB, radar, IR etc.), connectivity and System of Systems (SoS) capabilities;
- Survivability capability technologies, systems and structures, such as structural protection for ballistic damage tolerance, impact/crash resistance, on-site repairing of ballistic damage, etc.;
- Maintenance, including dispersed maintenance technologies (e.g., non-destructive testing, simplified repair, etc.) and enhanced by the concept of “smart maintenance” to enable predictive maintenance approaches to replace the conventional scheduled tasks with an aircraft tailored maintenance. This new approach relies on the continuous collection and analysis of aircraft data through advanced engineering techniques, empowered by digital-twin technologies and applied-AI techniques;
- Airframe and structural components modularity to allow for fast vehicle re-configuration.
- Control laws impacting platforms manoeuvrability capabilities to be demonstrated through digital tools, such as digital-twin or available ground simulators, and as a consequence, improving survivability potential.

E- Cross-cutting requirements:

[130] Manned-UnManned Teaming

- Based on operational scenarios & threat environment 2030+ (i.e., multi-domain connectivity), to be assessed though both studies and virtual simulation as appropriate;
- Affordability, in terms of acquisition and lifecycle costs, including the overall operating costs and maintenance costs (e.g., easier and less labour-intensive maintenance in terms of methods, tools and personnel required) to remain below similar solutions available on the market;
- Operations in hostile environment (e.g., battlefield/federated battlefield simulations) and dispersed maintenance concepts;
- Multi-mission capability and flexibility for operating different kind of military missions and possibly reconfigurable for supporting civilian needs;
- Cargo capability to carry the necessary equipment for the execution of the various missions as required in the CONOPS and Main Attributes List defined by the supporting EU Member States and EDF Associated Countries;
- State-of-the-art development to ensure availability and reliability of the platform and avoid obsolescence concerns;
- Sustainability along the entire product lifecycle: from the conception / production by means of digitalisation up to the product use with reduced environmental footprint due to e.g., advanced propulsion system, low weight and more efficient flight capabilities.

Expected impact

The outcome should contribute to:

- Prepare 2035/2040+ horizon, building European capabilities for new EU/NATO rotorcraft/VTOL programmes, fully compatible to future multi-domain combat collaborative systems.
- Develop technologies and concepts usable for upgrade of legacy platforms, where applicable.
- Support the competitiveness and excellence of the EDTIB, as well as the autonomy and sovereignty of EU and EDF Associated Countries, in the field of military rotorcraft.
- Increase the effectiveness and efficiency of EU Member States and EDF Associated Countries Armed Forces.
- Enhance the strategic autonomy and competitiveness of the EU Member States and EDF Associated Countries and their DTIB willing and able to develop new technologies for inclusion in future EU/NATO rotorcraft programmes.

2.5.9. EDF-2024-DA-GROUND-UGS-STEP: Multipurpose unmanned ground systems

- **Indicative budget:** EUR 50.000.000 for this topic under the call EDF-2024-DA-GROUND-UGS.

- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The use of Unmanned x (generic) Vehicles (UxVs) in military operations represents one of the most important innovations of recent years. Undoubtedly, UxVs exploitation is likely to grow in the coming years with the massive introduction of other autonomous systems in different domains (land, air, sea, space, cyber) and the increase of capabilities to work collaboratively between systems (swarms) and people.

Indeed, intelligent and effective cooperation between military assets (UxVs, different types of vehicles and their operators, and dismounted soldiers) within Close Combat Operations is needed to increase the overall Battlespace effectiveness, while reducing loss of life, the risk of collateral damage and lowering the cognitive burden placed upon operators.

Therefore, deploying autonomous and swarm-based military assets in a framework of cooperation between manned and unmanned systems (manned-unmanned teaming) is a very important capability that can enable enhanced ISTAR, survivability, situation awareness, mobility, lethality, logistics and training, and increase the probability of battlefield combat success.

This would allow the rapid development of capacities implying an incremental approach of capabilities milestones for current and future land systems and upgrades of legacy systems.

Specific objective

The use of such UxV systems has a direct impact in reducing the exposure of human operators and soldiers to associated risks. Such systems can radically improve the efficiency and performance of the tactical unit to provide tactical/ operational superiority and offer robust and reliable solutions in very demanding conditions.

Thus, the aim of this topic is to develop an unmanned modular system of systems capable of supporting dismounted, mechanised and motorised infantry in all types of European geographic and operational land environments, including denied environments, in adverse light and weather conditions with evolving levels of autonomy and robustness.

The overarching goal of this topic is to contribute to the maturing, testing and verification of the Unmanned Ground Systems (UGS) capability, so that the technology is expected to be ready for integration into the European armed forces by 2030. Therefore, to ensure wide acceptance and efficient use of the systems, it is pertinent to study, analyse and develop:

- Detailed capability provision assessment for integration into force structures for supporting dismounted, mechanised, and motorised infantry.
- Novel concepts for Human Machine Teaming to enable closed hatch and long-range usage of system capabilities with regards to ethical and legal aspects of combat operations. These concepts should allow a significantly reduced cognitive workload for UGS operator(s) by improving the efficiency and effectiveness of the control, direction, monitoring, and supervision of unmanned systems through the development and application of artificial intelligence and assisted functions.

- Enhanced manned-unmanned and unmanned-unmanned teaming capacities of UGSs through advancements in multirobot and swarming technology.
- Modular design and open architectures (regarding platforms, autonomous functions, as well as effector, sensor and other payloads management) with standard interfaces to enable Through Life Capabilities Management (TLCM) in terms of interoperability, scalability, maintainability, availability, robustness and resilience. This should ensure transferability of technology with other manned and unmanned (including drive-by-wire legacy) platforms.
- Federated digital-twin framework would favour this TCLM management and may provide improved training environment for UGS navigation and other mission specific algorithms.
- State-of-the-art equipment and secure information availability to enable enhanced ISTAR, Survivability, Situational Awareness, Mobility, Lethality, Logistics and Training to ensure Battlefield Superiority.
- Self-air-defence (against NATO Class I UAVs), in support of dismounted soldiers, with automatic designation by on-board electro-optical sensors and related data fusion.

Additional enablers for the wide acceptance and use of the Systems are:

- Formation of UGS related R&D ecosystem/community that facilitates continuous innovation, synergies and inclusion of deep-tech start-ups, Technology and system testing, Evaluation, Verification and Validation (e.g., cross-border TEVV procedures, trust).
- Practical testing in a scenario-based exercise (48+ h) with infantry units.

Scope and types of activities

Scope

Proposals must address the development of a multipurpose Unmanned Ground System of systems with lethal effectors and solutions for systems integration and manned-unmanned teaming. This system must integrate the following abilities:

- Enhance situational awareness and force protection of ground units, their combat effectiveness, endurance, mobility, and autonomy, and enable faster deployment.
- Support dismounted, mechanised, and motorised infantry in all types of European geographic and operational land environments, including denied environments, in adverse light and weather conditions with evolving levels of autonomy and robustness.
- Significantly reduce cognitive workload for UGS operator(s) using artificial intelligence and assisted functions.
- Have a modular design and enhance interoperability with manned and unmanned platforms to ensure transferability of the relevant technology to other platforms (including existing manned vehicles) and simplify payload integration, with the aim of bringing together European industrial capabilities and define standard interfaces for the benefit of European defence.
- Enhance manned-unmanned and unmanned-unmanned teaming capacities of current UGS.
- Have the capability to analyse different weather conditions, terrain types and obstacles to increase the mobility of single UGS and UGS teams.

The proposal must also provide analysis on the following topics:

- A fully autonomous targeting process and efficient effector(s) management and use against multiple types of targets, and include mobility solutions for engagement, target delegation and other relevant aspects of effector usage.
- The ethical and legal aspects of integrating combat-UGS in the European armed forces (if needed, research to support recommendations/decisions on ethical and legal aspects related to integration of combat-UGS in the EU Armed Forces and their interaction with human beings in the land domain should be included).

Proposals should also integrate the development and TLCM support of equipment (hardware or software) designed to enable personnel to function within different manned-unmanned operational modes and environments, able to be deployed in the digitised Battlefield where all land system assets are available to operate in coherence and demonstrating the following abilities:

- To interconnect in real time within the Battlefield and in a fully secured way with an extended set of systems supported by an intelligent TLCM solution concept.
- To be integrated seamlessly in the digitised systems (e.g., power supply, situational awareness, targeting process) manned or unmanned as and when needed during combat missions.
- To adopt real-time cooperative functionality and enhance Battlefield combat superiority, adaptation and effectiveness with measurable impacts of actions.
- To cooperate within the Battlefield while being able to sustain connectivity and interact with other assets (dismounted troops, UxVs, manned vehicles, swarms, long range support).
- To enable a versatile use in order to be deployed for a large spectrum of close combat operations and provide superior and optimised operational capability in hostile and harsh environment.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (mandatory)
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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 (mandatory)

Accordingly, proposals must cover at least the following tasks:

- **Studies** to critically analyse the essence of Intelligent Behaviour and Ethics within Land Operations, while understanding the necessary coherence and integration between different enablers to provide state-of-the-art equipment and information superiority for Battlefield success:
  - Consider the ethical and legal aspects of integrating combat-UGS in the European armed forces (if needed, research to support recommendations/decisions on ethical and legal aspects related to integration of combat-UGS in the EU Armed Forces and their interaction with human beings in the land domain should be included).
  - Provide an analysis and present possible solutions for an autonomous targeting process and efficient effector(s) management and use against multiple types of targets, and include mobility solutions for engagement, target delegation and other relevant aspects of effector usage. The system must meet standing law as required, with focus on the principles of discrimination, proportionality and caution in International Humanitarian Law (IHL) – e.g., by providing the possibility to override the systems autonomous engagement by a “human in the loop” manual function in order to meet standing law as required.
  - Provide modular platforms design able to support dismounted, mechanised and motorised infantry in all types of European geographic and operational land

environments, including denied environments, in adverse light and weather conditions with evolving levels of autonomy and robustness. This implies modular design and enhance interoperability with manned and unmanned platforms in order to ensure transferability of the relevant technology to other platforms (including existing manned vehicles) and simplify payload integration, in order to bring together European industrial capabilities and define standard interfaces for the benefit of European defence. This also implies significantly reduced cognitive workload for UGS operator(s) through maximum use of artificial intelligence and assisted functions.

  - Provide manned and unmanned platforms and intelligent swarms of platforms with advanced mobility capabilities. This implies developing systems for automation with the ability to perceive the environment and location in all weather and operational conditions (e.g., unstructured environments, GNSS denied, adverse weather conditions, etc.), and resilient communications to the operating position. In critical circumstances the autonomous decision making should be supported, using local platform status (HUMS) and knowledge.

  - Consider line-of-sight (LOS) and beyond-line-of-sight (BLOS) support with Command-and-Control system that meets mission planning and management needs, being able to manage the information available before the mission and the information provided during execution (common operational picture), so that the operator can have situational awareness that allows taking operational decisions assisted by the system intelligence (information superiority).

  - Consider resilient and secure communications and high-level cyber security to work simultaneously in different security environments and handle the information.

  - Consider the definition of a predictive maintenance framework encompassing logistics (including across fleet), and in-Battlefield support, including equipment functional configuration and re-role for assets availability and capabilities resilience.

  - Consider the definition of a training framework to ensure specialist personnel availability with all areas of the Battlefield.

  - Consider the definition of digital-twin framework that provides improved TLCM support as well as training environment for UGS navigation and other mission specific algorithms.

- **Design** an interoperable modular UGS combat platforms framework to demonstrate infantry support by effective engagement, risk reduction, sustainability and mobility, enabled by computerised processing technologies as well as study of the potential early exploitation of innovative technologies, through the:

  - Definition of an interoperable modular architecture and the relevant functions in terms of autonomy, effectors management and necessary modules.

- Definition of the relevant functions for manned-unmanned and the unmanned-unmanned operation modes for balanced teaming and swarming, environment understanding and advanced decision-making support.
- Definition of the relevant implementation and integration of functions into a modular open system architecture of the targeted vehicles (hardware, software, networks) and other assets, taking into account EU/NATO existing standards.
- Definition of the relevant functions implementation within a unified, interoperable and self-sufficient adaptive command and control environment.
- Definition of the security environment.
- Definition of open solutions able to embed future sensors, effectors and their optimised systems integration.
- Proposal for a test case as a basis for demonstration, simulation and prototyping.
- System integration into the tactical cloud concept and the distributed processing that allows fostering information superiority.

- **Develop, Prototype and Demonstrate** combat UGS capabilities and technology insertion to provide Intelligent Command and Control within an optimised cooperative environment of human-machine assets, whilst conforming to ethics, legal aspects, safety and security, through:
  - Development of optimised solutions identified within the Design Framework:
    - Integration in a system of systems demonstrator of all the proposed capabilities: multipurpose ground system of systems capable of supporting dismounted, mechanised and motorised infantry in all types of geographic and operational land environments, including denied environments, with evolving levels of autonomy and robustness.
    - Risk mitigation potentially including early exploitation of dismounted troops.
  - Presentation of study results and execution of a demonstration with a test scenario.
  - A detailed plan for the subsequent project phases must be developed, including the identification of implementation priorities, according to the operational needs of the participating Member States.

- Develop technologies or assets **increasing efficiency across the life cycle** of UGS products and technologies, by substantiating synergies and complementarities with foreseen, ongoing or completed activities in the field of Unmanned Ground Systems, notably those described in the call topics EDF-2021-GROUND-D-UGVT[131] on *Unmanned ground vehicle technologies* and EDIDP-MUGS-2019[132] on *Multipurpose unmanned ground system*, as well as other activities conducted across the EU (e.g., iUGS PESCO[133], EDA Cat B Combat UGS project[134]).

The proposals may also cover:

- **Certification** and support to the definition of a Through Life Capabilities framework, enabling battlespace-ready equipment and personnel, infrastructure and organisation, maintenance and logistics, as well as the definition of a Capability Certification framework for operational deployment, encompassing hybrid functionalities within the (human-machine) system (e.g., in the case of dismounted troop providing support to operations).

Functional requirements

The development of functions that enable upgrading a set of current vehicles or to be integrated into vehicles under development or future vehicles with the ability to embed advanced multi-technology sensors networks and advanced effector networks around a common and standardised manned/unmanned teaming capability.

This set of modular components is expected to provide Armoured Fighting Vehicles programs with initial capacity to operate within connected hybrid balanced manned/unmanned Battlefield teams with the following main functional requirements around common, standardised and novel manned-unmanned teaming with a modular and robust architecture:

- Ability to manoeuvre the unmanned vehicles as needed for the relevant functions both in autonomous and remote way, taking into account that:
  - an unmanned ground system can be remotely driven from any position (manned vehicles, possibly moving, operational station, etc.);
  - the operators must have a comprehensive understanding of the environment of remote unmanned systems;
  - the operators must rely on assisted and autonomous functionalities with a special care in the reduction of collateral damage risks;
  - the unmanned systems should be able to interact in terms of manoeuvre in combat situations within a manned-unmanned swarm;
  - the unmanned systems should be able to rely on and switch between several alternative driving modes (e.g., remotely controlled driving, semi-autonomous driving and highly autonomous driving) and call humans into the loop if standing law requires it or the confidence level of the autonomous system gets below a specified level;

131 Funding & tenders (europa.eu)
132 Funding & tenders (europa.eu)
133 Integrated Unmanned Ground System (UGS) | PESCO (europa.eu)
134 10---combat-unmanned-ground-system-cugs.pdf (europa.eu)

- the unmanned systems should be able to function as part of dismounted and motorised infantry in most relevant environments and capable of manoeuvring autonomously to pre-planned positions and formations, and operating in support to dismounted and motorised infantry operation, by fielding the following abilities:
    - navigate in a GNSS signal-denied environment;
    - autonomously calculate the optimal route and plan the path between two geographical points;
    - generate trajectories for local navigation, adapting the path as needed and overcoming possible obstacles through “sense and avoid” technology;
    - autonomously detect, identify, categorise and track relevant agents and elements from the environment (e.g., targets, potential threats or enemy units, allied units and civilians);
    - autonomously follow dismounted soldiers and vehicles, moving in coordination with them.

- Ability to resort to advanced interaction modes to optimise the number of human operators depending on the interaction modes.
- Ability to understand and adapt to the operational and tactical environment to speed up the decision-making process of the operators by delivering a user-friendly and reliable decision-making support tool. This enables operators to remotely operate all payloads from any of the manned vehicles by:
    - providing good situational awareness to the system operator;
    - providing real-time trusted situational awareness information and information sharing inside a system swarm;
    - allowing to remotely cooperate the effectors of relevant systems (manned and unmanned) in order to gain a tactical advantage and generate tactical options, taking into account the tactical required effects, the collateral damage constraints and the ethical and legal aspects.
- Ability to integrate additional UxSs seamlessly and securely to drastically enhance capabilities in the following domains:
    - force protection against a large spectrum of threats by using specific individual or cooperative countermeasures provided by UxSs;
    - integration of Beyond Line Of Sight (BLOS) combat capabilities.
- Capability to enhance force protection and resilience through:

- impossibility for the enemy to visually distinguish between manned and unmanned platforms:
  - to prevent external identification of a manned or unmanned vehicle to target it as a priority (does not apply to systems designed to be only used in unmanned mode);
  - to give access to this capacity without increasing the logistic footprint.
- the improvement of short- and long-range sensors and effectors integration and real-time communication;
- the interoperability with soldier systems based on EU/NATO standards and previous EDIDP and EDF Projects.

- Use of a diversity of sensors and technical equipment to ensure:
  - the availability of information from variety of data sources;
  - the ability to predict logistic resource requirements using real time data;
  - the ability to navigate primarily with passive sensor systems.
- Use of state-of-the-art system with modern, customisable and intuitive user interfaces that support operators in all their operational, technical and training needs – with particular emphasis put on deployability as the cornerstone of system design – enabling rapid adaptation, implementation, operation and embedded training.
- Ability to operate in all relevant European climate zones and in all areas where relevant EU missions could be conducted.
- Dynamic, scalable and resilient functions, efficiently embeddable in most of the existing ground combat vehicles systems, compliant with their different programme roadmaps and the obsolescence of their modules lifecycles.
- Functions designed to be able to support specified availability requirements to contribute to an open, scalable, highly available and transparent failover architecture.
- Functions designed to be proof against diminution of environmental sensing capability, hostile countermeasures, including the application opportunity in Global Navigation Satellite System (GNSS) denied operation environment.
- Cyber security aspects to be applied along all project phases, from requirements capture to system design and implementation, in order to ensure adequate resilience, survivability and information protection.
- The system, and especially its command and control (C2), should be able to provide resilient and reliable connectivity in EW hostile environment.
- Functions designed to be able to work simultaneously in different security environments and handle the information security requirements to properly control the

information flows between these domains and with external systems. The system should be able to be integrated into environments that impose different security constraints on the exchange of information while remaining usable in an environment with low security constraints.

- Multi-level security to be applied to all systems, data and information access to enable secure multi-national cooperation.
- Functions to be designed in accordance with the modularity openness and standard interfaces principles in order to enable integration of new technological solutions and to enable maintenance, scalability, availability, resilience and obsolescence management.
- Employment of any effector should be in accordance with the requirements of IHL and other regulations with appropriate human control while sensors can potentially be employed autonomously to increase the potential capacity to gather data and increase situational awareness.
- Functions designed to comply or be able to comply with the operational procedures of the targeted vehicles, with ethical and environmental constraints as well as with logistic and defence programme efficiency requirements.
- The ability to shift a system into an unmanned configuration.
- The design to be modular and scalable for future upgrades and implementations of different autonomous functions and must ensure transferability of technology with defined interfaces with other manned and unmanned platforms.
- Digital twins to be available for integration with high-level digital training areas usable with existing simulation systems.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Develop critical enablers for Common Security and Defence Policy (CSDP) operations and develop concept of critical enablers for EU Battlegroup missions.
- Enhance UxS self-defence and cooperative force protection.
- Increase readiness and availability for equipment and personnel deployment of EU military missions.
- Reduce the possible number of casualties on friendly forces.
- Interoperability milestones for Member States’ ground capacity programs.
- Improve situational awareness, resilience and security of EU operations.

- Create a reference for manned-unmanned teaming modes and functions to improve the capabilities of the European defence industry to develop and supply state-of-the-art ground systems.

- Reinforce adaptation and interoperability of EU Member States' armed forces.

- Strengthen the EU's strategic autonomy in military capabilities.

- Optimise interoperability and synchronisation between manned and unmanned platforms, and soldier systems.

- Reduce the impact of the logistic footprint.

2.5.10. EDF-2024-DA-GROUND-BLOS: Beyond the line-of-sight close combat

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The performance of land combat systems has proved decisive in recent conflicts, since the availability of mobile (tactical and strategical mobility) precision systems able to provide the necessary high degree of accuracy, efficiency and reactivity, are becoming increasingly important to avoid widespread collateral damage and reduce exposure of friendly forces. In particular, it is essential for Member States' armed forces to provide combat units with increased engagement capabilities without being spotted and with a high level of success and survivability.

Specific objective

Beyond Line Of Sight (BLOS) engagement is the capability of firing at a target not directly seen by the effector, based on information given by a remote sensor. The Beyond Line Of Sight (BLOS) capability offers tactical advantages, as mobile units acquire an increased engagement capability with higher kill probability and without being spotted by the adversary.

To succeed in a BLOS-firing mission, reconnaissance, intelligence, and adequate preparations is likely essential. A technical system design (i.e., incorporating command and control, mobility, survivability, lethality, intelligence and endurance) for BLOS must be versatile against future alterations pending an evolving hostile threat. A BLOS system design therefore needs to be future-proof regarding robustness and security to motivate investments in resources and funds for the anticipated period of life.

In this context, some requirements are becoming increasingly important: provide the land and coastal combat units with an increased engagement capability and with a very high degree of success and survivability; discriminate between threats that are not always clearly identified and visible before firing; defeat targets that may mask or unmask at the last moment; avoid widespread collateral damage; providing conditions for a high level of survivability by low exposure as well as reachability with precision strikes over an area.

Scope and types of activities

Scope

Proposals must address:

- the development of innovative technologies of interest to improve the performance of the capability;
- the update of BLOS collaborative close combat architecture for the integration of new technologies / capabilities;
- the development of effect management functions for BLOS capability;
- the development or the integration of a BLOS battlefield training system for collaborative training indoor, outdoor and being able to use force on force;
- the development of a common interface concept for dismounted system integration in light and medium vehicles and system compatibility with, but not limited to, ring mounted version;
- the demonstration of a BLOS collaborative engagement that:
    - o should include firing from a dismounted version (possibly mounted on a light vehicle);
    - o may include firing from a BLOS system integrated into a battlefield vehicle (deployed in a tactical situation).

Types of activities

The following types of activities are eligible for this topic:

	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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

Integrating Knowledge:

- Perform a threat assessment, taking into account the modern battlefield, lessons learned from current peer-to-peer conflicts, and deployed or about to be deployed advanced technologies.
- Develop research activities for maturing identified technologies.

Studies:

- Feasibility studies concerning proposed technologies.

Design:

- Develop technologies suite to reach TRL 6.
- Preliminary definition and design of the final product and technology.
- Detailed definition of the final product and technology.
- Critical Design Review (CDR).
- Testing of product, tangible or intangible component or technology.

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities, notably those described in the call topics EDF-2021-GROUND-D-3CA[135] on *BLOS collaborative close combat architecture* and EDIDP-NGPSC-2019[136] on *Upgrade of current and development of next generation ground-based precision strike capabilities*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- The architecture should allow Collaborative Close Combat using Line of Sight (LOS) or BLOS firing modes at different ranges and using mounted, dismounted and integrated European missile systems.
- The BLOS system should be coordinated at a tactical level.
- The system should operate with cooperation means such as a communication network of participants or the European Battle Management Systems.
- The system should allow for employment within land and amphibious/littoral naval force structures, e.g., light and motorised infantry, mechanised units, and amphibious assault units.
- The system should be quick into and out of engagements (BLOS and LOS) with a short time from transport, through deployment, preparations, engagement and redeployment, allowing for use in highly dynamic manoeuvre scenarios.
- Design should consider common maintenance concepts for cost-effective solutions for availability within Europe.
- The BLOS system should be reliable and safe.
- The data links should be cyber robust, the cyber aspects being fully controlled by Member States.
- The system should be capable of operating in climate zones that are of interest to the EU Member States and EDF Associated Countries with a "one applies to all" way of usage.
- Effect management functions should be explored and possibly improved.
- The system should provide automated deployment and engagement planning support.
- The system should be able to operate in a Global navigation satellite system (GNSS)-denied environment.
- The BLOS system should have an associated battlefield training system for indoor and outdoor exercises with focus on force-to-force training.

[135] Funding & tenders (europa.eu)
[136] Funding & tenders (europa.eu)

- System design should take into account forces' limited availability of time for training to operate the capability.

- The system should allow for robust positioning, navigation and guidance.

- The system should provide automated support for target detection and acquisition.

- When doing re-design and design, concern should be taken to existing concepts to minimise the cost of ownership for future upgrades of the capability.

Expected impact

The outcome should contribute to:

- Bring a significant operational differentiator and contribute to enhanced interoperability between armed forces of Member States;
- Develop and increase the maturity of innovative technologies specifically adapted to BLOS engagement;
- Increase EU industry capabilities on BLOS architecture, components and technologies;
- Consolidate European business consortium able to offer competitive solutions for the global market;
- Decrease dependence on non-EU technologies and products.

2.5.11. EDF-2024-DA-GROUND-AIFV: Next generation armoured infantry fighting vehicle

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

The Global Strategy for the European Union's (EU) Foreign and Security Policy defines an integrated approach to conflicts "at all stages of the conflict cycle, acting promptly on prevention, responding responsibly and decisively to crises, investing in stabilisation and avoiding premature disengagement when a new crisis erupts".

In order to support and, if necessary, enforce, the above approach, a credible deterrent is required to be rebuilt in terms of land combat capability with a priority focused on armoured vehicles in general and, in particular, on Armoured Infantry Fighting Vehicles.

Specific objective

Armoured Infantry Fighting Vehicles (AIFV) remain a pivotal element of land military manoeuvre, both in a conventional warfare context as well as in the asymmetric one, thanks to the combination of protection, mobility, and firepower. Nonetheless, AIFVs currently numbered in the fleet inventories of the EU Member States are to some extent either ageing or obsolete and, therefore, the same States face the compelling need to modernise their in-service platforms and replace those of them approaching the end of their operational life. There is also a need to accelerate the acquisition and increase the size of the AIFV fleets updating some of the new requirements stemming from the war in Ukraine and the new threat scenarios. Against this background, the upgrade of the current and development of the next generation armoured infantry fighting vehicle capable of outstanding operational effectiveness and mission success in all possible future scenarios are highly necessary.

Modularity, reduced crew workload, the integration of automatic systems, Manned-Unmanned Teaming (MUM-T), and increased survivability must guide design considerations.

Scope and types of activities

Scope

Proposals must address studies and design for the upgrade of current armoured infantry fighting vehicles and the development of next generation armoured infantry fighting vehicle technologies, with desirable outputs for legacy platforms, including enabling and green technologies (eco-design or sustainable technologies), leading to a system level capable of outstanding operational effectiveness and mission success in all possible future scenarios. Furthermore, they must take into account aspects such as mobility, deployability (tactical and strategic ones), autonomy, firepower, maintainability, survivability and cyber security.

Thematic scope of the activities to be supported is preliminary studies, system analysis and early development phases. It includes considerations of the system in operational perspective and identification of specific subsystems that define the future operational environment and purpose of system within the future battlefield.

Moreover, proposals should include development efforts of a new common European “Armoured Infantry Fighting Vehicle” (AIFV), and when feasible have a high commonality with solutions in other future European combat vehicles.

Types of activities

The following types of activities are eligible for this topic:

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)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Study:
  - Concept of Operation (CONOPS) definition, feasibility study and architecture definition, including the definition of operational requirements and critical capabilities,
  - Cost-benefit analysis against technology solutions defined during the project,
  - System Specification (SSS and SSDD) providing a detailed system and sub-systems description, including the development of harmonised requirements and vehicle system architecture,
  - System Requirement Review (SRR).
- Design: Concept and Preliminary Design Review (PDR).

The proposals should substantiate synergies and complementarities with foreseen, ongoing or completed activities, notably those described in the call topics related to ground combat capabilities and possibly related to manned and unmanned platforms under EDF and EDIDP.

Functional requirements

The proposed activities should focus at least on a subset of functions for AIFV (e.g., among mobility, energy, observation, protection, human-machine interaction and/or firepower) and meet the following functional requirements:

- Be capable of performing its missions by day, night and in adverse weather conditions, in worldwide crisis/war scenarios, including asymmetric theatres, with the minimum possible degradation of performance due to extreme environmental conditions and type of terrains, as defined in the relevant standards, and in compliance with EU/NATO standards;

- Be capable of conducting operations in Chemical, Biological, Radiological and Nuclear (CBRN) environment (to be also considered in the design phase);

- Be capable of handling the specific requirements that comes from conditions in special areas context:

    - Comprising soft soil (marshland) and deep snow mobility capability;

    - Impact from heavy snow, wind and low temperatures, implying e.g., ice build-up, blocking of sensors;

    - Be able to act with own resources in low logistic support situations;

    - Be capable of handling short standoff distances (<150m) with short time to engagement of target;

    - Long shooting distance BLOS in covered terrain (e.g., forest);

    - APS functionality in covered terrain (forest);

- Be capable of handling the specific requirements coming from the MOUT (Military Operations on Urbanised Terrain) context:

    - Capability to detect threats in high elevations;

    - Capability to engage and defeat threats in high elevations and short stand-off distances;

    - APS functionality within high elevations and short stand-off distances;

    - Capability to obtain situational awareness within an urban environment;

- Have a modular design which allows different mission capabilities relying on high subcomponent commonality among different variants;

- Be designed to facilitate the possible future evolution into an "optionally manned" remotely controlled AIFV. Remote off-board control is expected to be assisted by on-board automatic functions, intended to reduce the workload for the remote operators in charge of the control so that, with the long-term goal that a single operator might control an AIFV. To be noted that the firing of any of the weapons equipping the AIFV must always remain under human control;

- Adaptive crew environment and support architectures, open and modular to enable the introduction of innovative technologies as soon as they become mature, in accordance with EU/NATO standards on Vehicle Architecture;
- Be designed with crew comfort and ergonomics in mind;
- Have decision-making assistance: advanced crew information presentation capabilities including smart synthesis, prioritisation, and filtering, to keep the most relevant items, especially in the context of reduced crews;
- The vehicle be designed for being operated by a minimal crew (maximum 3), and the crew be given the maximum possible level of protection and survivability chance;
- The vehicle should be capable of hosting a fully combat geared infantry squad of 8 members (with 6 members being the minimum admissible threshold), and they must be given the maximum possible level of protection and survivability chance;
- Ensure interoperability with unmanned ground platforms and facilitate MUM-T (Manned-Unmanned Teaming) with adequate LOI (Level of Interoperability), and interoperability with Unmanned Systems (UAS/UGV). The interoperability for unmanned ground platforms may be in accordance with EU/NATO standards.
- Integrable and interoperable with a family of similar support platforms (system of systems);
- The complete vehicle (i.e., hull and turret), in full combat order, should be transportable in an in-service aircraft. The vehicle must have the possibility to dismantle components (e.g., additional armour) for transportation in smaller aircraft;
- The weight and the overall dimensions of the complete vehicle in full combat order must guarantee lethality, mobility (both tactical and strategic) and protection factors, together with a high power/weight ratio;
- Take into account constraints due to EU Member States and EDF Associated Countries' roads, railways, tunnels and bridges in order to meet transportability requirements; air transportability/ air drop should also be considered according to commonly applicable EU/NATO standards;
- Feature a maximum speed of at least 70 km/h on paved roads, at least 50 km/h (aiming at 65 km/h) on all off-road terrain and an operational range of not less than 600 km averaged on different type of terrains;
- Feature a wading depth without preparation of at least 1.50 m, a trench crossing capability of at least 2 m and an obstacle/step crossing capability of at least 0.7 m, and a ground clearance of at least 0.4 m;

- Feature a high “Operational Availability” to be capable to perform the assigned missions;
- Provide effectors to engage modern AIFVs and MBTs with precise “fire-on-the move” capability at greater distances than current systems;
- Provide effectors to engage modern AIFV and MBT under LOS, NLOS and BLOS conditions;
- Provide capabilities to engage UAVs and perform air defence self-protection;
- Feature sophisticated C-UAS/C-SWARM/C-RAM capabilities to perform platform protection aiming at reducing the number of systems (e.g., multi mission system, or handing over some functions to other support platforms);
- Support smart/programmable ammunition;
- Ability for the vehicle of automatic threat detection, identification and tracking, including ability to handle multiple threats, and target distribution - enabling sensor-to-effector allocation (hard- and soft-kill capabilities), to support the decision-making process and ensure a rapid engagement;
- Have real-time and unified information and data presentation, provided by the sensors deployed on the platform and from external networks (including other combat support platforms) with low latency times;
- Have advanced PNT (Position Navigation and Timing) system (with inertial navigation capability) in order to ensure trusted PNT for the platform even in challenging GNSS contested and denied environment;
- Feature a low detectability and electromagnetic signature e.g.,: ultraviolet (UV), visible, infrared (IR) (from Short-Wavelength Infrared (SWIR) to Long-Wavelength Infrared (LWIR), radar, laser, and acoustic. Detection and signature recognition by multi- and hyperspectral sensors must also be considered;
- Feature an optimised trade-off between mobility, firepower, and protection;
- Provide protection against the following threats: mines and improvised explosive devices (IED), electronic warfare (EW) and cyber-attacks/offensive Cyber Electromagnetic Activities (CEMA), and at least 30 mm “Armour Piercing Fin Stabilised Discharging Sabot” (APFSDS) and other direct threats likely to become known over the whole duration of the project according to STANAG 4569 Protection Levels for Occupants of Armoured Vehicles Level;
- Feature a capability to counter direct threats, such as: Rocket Propelled Grenades (RPG) (including those with a functionality of disposable anti-tank rocket launcher like RPG-30), “High Explosive Anti-Tank” (HEAT) Munitions, “Anti-Tank Guided Missile” (ATGM; including 3rd generation ATGM with high angle of attack – e.g., NLOS and top attack), loitering ammunition and Unmanned Aerial Systems (UAS) and APFSDS (125 mm) according to STANAG 4686 DAS;

- Be capable of reducing the reliance on fossil fuel, foster reduction of dependency on combustion engines by means of electrical or alternative propulsion systems (e.g.,: hybrid engines) and take into account other aspects of green technologies (e.g.,: total life CO2 footprint, use of other materials, recycling, micro-grid management);

- Operate in silent mode for at least 10 km and extended silent watch with low thermal signature for at least 24 hours;

- Store and supply high density and power of electric energy for sensors, effectors and weapons;

- Have a range between 5% and 10% of growth potential without changing the assigned power/weight ratio;

- Be equipped with technologies to ensure enhanced Situational Awareness (SA), e.g.,: advanced display devices products, "transparent armour" concepts, allowing visualisation of the environment around the vehicle; automatic surveillance, detection, reconnaissance and identification;

- Have advanced 360 degrees SA and decision-making systems to integrate, correlate and fuse video and data from the available sensors in the platform to provide an enhanced SA augmented reality picture of the environment (including Friend or Foe, Battlefield Combat identification) of the vehicle status and support the decision-making process through multimodal human machine interfaces combining textual, vocal, acoustic, haptics, 2D and/or 3D visual information, and augmented/virtual reality devices;

- The vehicle mission system should be interoperable with other command and control systems, including the dismounted soldier command and control system, increasing the protection and effectiveness of soldiers once they get out from the vehicle in the combat zone. The interoperability may be in accordance with EU/NATO standards;

- Have a multi-sensor suite for threat detection and target acquisition (including, but not limited to: electro-optical sensors, acoustic sensors and radar), whose data should be available for Situational Awareness (SA) technologies and effectors through the fire control system, according to STANAG 4754[137] - NATO generic vehicle architecture (NGVA)s;

- Have decision-making assistance: advanced crew information presentation capabilities including smart synthesis, prioritisation, and filtering, to keep the most relevant items, especially in the context of reduced crews;

- Feature static or dynamic on-board simulation for training (embedded);

- Be able to perform battle damage assessment without compromising survivability;

[137] https://nso.nato.int/nso/nsdd/main/standards?search=4754

- Be able to monitor the health of the system and make the actual system performances data promptly available to the C2 systems, allowing to perform conditions-based maintenance.

Expected impact

The outcome should contribute to:

- Fill the majority of technology gaps as identified in the "Overarching Strategic Research Agenda" concerning the armoured vehicles domain;
- Reduce, through commonality and mass production, the acquisition and lifecycle costs and create employment in each MS;
- Remove dependency from non-EU technologies and products;
- Reinforce interoperability of EU MS Armed Forces;
- Reduce the logistic footprint and costs of EU Missions and Operations aiming at the implementation of infologistic systems;
- Competitiveness, efficiency and innovation capacity of the European defence technological and industrial base, as expected long-term effects enabled by the supported action;
- A common understanding and knowledge of technological basis as input to subsequent high level requirement analysis for next generation AIFV systems;
- Contribute to the defence and security interests of the EU and its Member States;
- Contribute to the EU strategic autonomy level of ambition;
- Contribute to Europe's resilience and European technological sovereignty;
- Contribute to European industrial autonomy;
- Contribute to excellence with the demonstration of a significant advantage over existing products or technologies.

2.5.12. EDF-2024-DA-NAVAL-FNP: Functional smart system-of-systems under an integral survivability approach for future naval platforms

- **Indicative budget:** EUR 45 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** one proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

Evolving operational environment and threats require the development of cutting-edge maritime technologies, solutions, and systems, which should be able to operate interconnected in a fully integrated way under challenging multi-domain (i.e., land, aerial, surface, subsurface, and cyber) threat conditions.

Naval platforms trends are based on technologies, standards, solutions, and systems, all designed from the start to work integrated together in a coherent manner, ensuring the survivability of the platform against emerging threats. Therefore, the main objective of this topic is to identify, define, design, and develop them, to be integrated on future European naval platforms.

The topic should act as a real enabler for both the European naval industry and the EU Navies. In that context, it should be very inclusive to be adapted to the most European Navies' needs for their future naval platforms. It will allow EU Navies to remain at the forefront of technology, to maximise interoperability and the survivability by design, to operate with technological superiority, and to increase EU strategic autonomy. At industrial level, this topic should be an instrument for the European industry to assess and reinforce its ability to develop and support emerging key technologies.

Specific objective

The specific objective of this topic is to define the common operational requirements of the System of Systems (SoS) framework and the essential elements of the next generation of European naval platforms. Such a SoS framework is expected to embrace the supporting infrastructure including interfaces, data, and common and specific services. It must identify the technological needs for the future development of European naval platforms with special attention on emerging technologies, promising solutions, and the increased resilience of naval vessels when facing the most sophisticated threats by near real-time evaluation of survivability.

In particular, the topic should contribute to solve these specific challenges:

- The capability to operate interconnected in a fully integrated way, under challenging multi-domain (i.e., land, aerial, surface, subsurface and cyber) threat conditions.
- The definition and the design of the core architecture of the future European naval platforms by a SoS approach.
- The analysis of naval vessels survivability aspects on an operational level, considering its three key aspects (i.e., susceptibility, vulnerability, and recoverability) under an integral approach, leading to a resilient ship.

This topic aims to identify and define essential elements for future European naval platforms as functional system building blocks by specifying a full set of new technologies, solutions, and systems to be fitted on board, covering the following main areas:

- Four pillars:
    - **Combat System.** New threats based on emerging technologies lead to the development of combat systems with enhanced sensors collaborating under an extended top-side concept that increase the detection capability, in time and accuracy, as well as new weapons/effectors able to face them, based on decision making algorithms to allow shorter reaction time to engage those threats. The UxVs[138] are to be integrated into the Combat System as an extension of the detection and defence

[138] Any one of the four categories of unmanned vehicle: ground, air, surface, or undersea.

capability. In terms of survivability, specific challenges to susceptibility are the required countermeasures, both hard-kill and soft-kill, and their deployment, together with the ability to predict and manage where a missile or a torpedo might impact the vessel, as an important interface between susceptibility and vulnerability. UxVs should be also analysed in relation to ship survivability.

- **Communication and Information System.** Solutions need to be sought to meet emerging challenges in this area such as the management of a big volume of data transmitted at high speed (comparable to 5G and ahead) in a very demanding operational theatre, the integrity and cybersecurity of the data, and the EU naval tactical cloud integrated in a military multidomain operations cloud. Special consideration should be made on anti-access/area denial (A2/AD) scenarios, defining embarked cloud capabilities to support the edge operation of joint forces overseas. Attention must also be paid to complete loss of connectivity due to denial or due to stealth reasons.

- **Enhanced Platform Management System**. New threats and evolving technologies should lead to redefine the current concept of naval platforms to ensure enough and adequate power generation, as well as a proper top-side compatible with new weapons and UxV launch and recovery systems (LARS) on board. In the same way, future naval platforms should address efficient platform control and management, as well as increased power supply needs for future weapons and sensors, and new energy technologies to achieve the European Green Deal objectives. In addition, ship signature management, smart damage control, and survivability aspects should be considered because countermeasures, both hard-kill and soft-kill, and their deployment, or the impact of hypersonic missile or torpedo affect the vulnerability of the platform (e.g., a successful hard-kill engagement might result in debris hitting the ship, the success soft-kill deployments strongly affect the ship signatures). The impact of such events should be studied, and technical solutions to withstand the physical and system damage should be identified.

- **Navigation System.** Solutions should be sought for increased safety during navigation, independent satellite positioning system, accurate inertial navigation system, autonomous operations and multi-manned and unmanned, underwater, surface, and aerial vehicles coordinated navigation.

– One transversal area linked to the four pillars:

- **Survivability Advisory System Foundation**. The evolving threat landscape should result in a need for an advisory capability to assist in the setting of the ship signature management system, the deployment of hard-kill and soft-kill countermeasures, the adjustment of the ship’s signature for hit-point management, the post-hit damage assessment, the remaining capability including strength and systems, and the deployment of recovery actions to regain functionality. This should also allow for future task group advisory capabilities, where high value assets should be protected by the task group, and the survivability of the task group is expected to be optimised due to advice across the task group.

Proposals should design a SoS framework: Solutions should be sought based on a service-oriented architecture or any other evolution, that might sustain the above-mentioned areas. It should include transversal capabilities like for instance, Artificial Intelligence (AI) Based Decision Making, Digital Twin, Federated Mission Networking, Through-Life Support based on virtual reality and remote systems monitoring, Cyberwarfare, or Survivability.

Scope and types of activities

Scope

Proposals must address:

- The definition of common operational requirements of the essential elements for the future European naval platforms, covering the main areas (i.e., Combat System, Communication and Information System, Enhanced Platform Management System and Navigation System) under an integral survivability approach (i.e., Survivability Advisory System Foundation);
- The development of a concept of a SoS framework, typically based on a service-oriented architecture or any other evolution that might sustain the concerned areas;
- The definition of a modular, interoperable, scalable, and flexible concept design to support an architecture that should provide a versatile solution for answering future Navies´ needs and trends;
- The identification of emerging technologies that should respond to the operational needs of the future naval platforms, including integrated operational data-, messaging-, telecom-communication systems;
- The design of a tool for the management of the ship signature while advising on the status and solutions for timely and accurate deployment of countermeasures, both active (e.g., advanced jammers, signature manipulators) and passive (e.g., flares, chaff, corner cubes), coordinated with hard-kill solutions, and including the prediction and management of the hit-point;
- The assessment of existing solutions and the consideration of new damage control systems where appropriate through automated systems, crew actions, and recovery of systems, while performing predictions of the state of the ship after incidents, likely based on AI that processes sensor readings/information and imaging;
- The design of an operational guidance system to support the Navigation System for ship operations with a damaged and undamaged ship (e.g., advice for helicopter operations, UxV deployment);
- The identification of the priorities on technologies to be further develop in the future, as well as the level of maturity to be achieved for the associated elements;
- The analysis of a tool for the European naval industry to assess and reinforce its ability to develop and support emerging key technologies;

- The operational assessment and the analysis of the technical viability, as well as the evaluation of the feasibility of the baseline concepts;
- The design of a joint technology demonstrator and to de-risk potential further activities in the future.

In addition, the proposals should substantiate synergies and complementarities, while avoiding unnecessary duplication, with activities described in previous call topics under EDIDP and EDF programmes.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Integrating knowledge:
    - Illustrate an integral overview of available and to be developed technologies fitting in a future European System of Systems.
- Studies:
    - Identification and definition of the systems and the subsystems that may be considered essential elements for the future European naval platforms, according to the main areas.
    - Development of the Concept of Operations (CONOPS) under the direction of the participating Navies.
    - Defining operational requirements including threat analysis and assumptions, under the direction of the participating Navies, and derive use-cases (vignettes) as a common basis for the project.
    - Establishing the guidelines for an integral survivability approach, leading to solutions to be applied in the design phase of a vessel.
    - Defining the guidelines for the main areas (i.e., Combat System, Communication and Information System, Enhanced Platform Management System, Navigation System, and Survivability Advisory System Foundation) and for the SoS framework.
    - Elaboration of a comprehensive roadmap, identifying technologies to be considered and developed for the future European naval platforms, and prioritising the developments on technologies and the associated elements for subsequent phases and the target TRLs[139] to be achieved.
    - Tools for analysis of the European industrial capabilities to support current and emerging key technologies.
- Design
    - Conceptual design of the essential elements and the framework to equip the future European naval platforms, considering the following aspects:
        - Identifying target architecture baseline concepts for SoS.
        - Identifying specific and common baseline services for the next generation of naval systems.
        - Assessing operational, technical, and programmatic feasibility of the baseline concepts, optimising naval vessel survivability.

[139] Technology readiness level

        - Identifying a demonstrator of the common framework with the possibility to incorporate specific elements to perform partial tests for risk reduction and technology consolidation.

    - Tools for assessment of European industrial capabilities with the elaboration of an up-to-date map on skills and knowledge, processes, facilities, and equipment needed to design, develop, manufacture, repair and support key technologies and products for next generation of European naval platforms.

In addition, the proposals should cover the following tasks:

- System prototyping:
    - A prototype for the SoS framework should be developed, including some representative pillar functionality, in addition to some capability focused on the Survivability Advisory System Foundation. It should be developed to demonstrate the proof-of-concept between participating Navies.
- Testing:
    - Testing some performances of the prototype.

Functional requirements

The proposed SoS framework should:

- Be modular, interoperable, scalable, flexible, and adaptable to the requirements of the Navies;
- Be based on a service-oriented architecture and include the common and specific services for the essential elements;
- Consider the available government developed applications;
- Cover the main challenges for the next generation of European naval platforms while allowing the incorporation of new developments to face the future needs and threats, and serving the basement for future developments.

The conceptual design should consider new and promising technologies to:

- Shorten reaction times to engage the new threats like hypersonic missiles, or small targets that may appear in swarms, using the aid of decision-making algorithms;
- Enhance integration of new types of weapons based on conventional and non-conventional reaction means, as laser and direct energy weapons, or electromagnetic rail-gun weapons;
- Incorporate an integral missile defence, ballistic missile defence capability, and an integral anti-torpedo system;
- Integrate UxVs in combat system as an extension of detection and defence capability;

- Manage a big volume of data transmitted to high speed in very demanding operational scenarios;

- Ensure the integrity and security of data;

- Enhance the platform control capabilities such as ship signature management, smart damage control, or higher survivability, while harmonising requirements across the disciplines of susceptibility, vulnerability and recoverability;

- Increase the power supply needs for future weapons and sensors;

- Provide advanced navigation processing to improve the own-ship estimated position and navigation data even in GNSS[140] denied environment, considering other positioning methods like astronomical exploration and localisation;

- Facilitate a SoS approach by identifying transversal capabilities such as AI-based decision making, digital twin, federated mission networking, through-life support based on virtual reality and remote systems monitoring or cyberwarfare, that substantiates an integral conception of the ship systems.

Expected impact

The outcome should contribute to:

- the commonality of European naval systems to increase interoperability and interchangeability among European defence naval industries and Navies;

- an integrated survivability of naval vessels, more resilient against future threats, and with a reduced size and safer crew;

- promoting the EU strategic autonomy in the naval sector, configuring naval forces that respond to national and European strategic needs and trends;

- reducing the development and maintenance cost of future systems throughout their life-cycle;

- developing innovative systems, more efficient, scalable, and adaptable to different naval platforms.

2.5.13. EDF-2024-DA-UWW-AHMS: Autonomous heavy minesweeping system

- **Indicative budget:** EUR 30 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

[140] Global navigation satellite system

Uncrewed systems are a familiar asset in naval capabilities, and they are being increasingly adopted. These types of assets and the technologies that go with them have the potential to offer a diverse mission set, minesweeping being one of them. The maritime drones and their payloads currently used and integrated by the navies operate with different levels of autonomy and endurance. This topic aims to enhance naval minesweeping capabilities by pushing the design and level of the autonomy of particularly maritime drones. Furthermore, this topic addresses sweep gear and sweep sources for minesweeping operations adjoining the higher level of autonomy. In this context the drone/platform and its payload/sweeping gear form the minesweeping system.

Minesweeping is traditionally performed using mechanical or influence sweep sources towed behind a highly specialised and expensive crewed platform (minesweeper). Evolving technologies, such as autonomous features, offer new solutions to the minesweeping systems. These solutions in concert with new operational concepts offer European navies the opportunity to maximise the benefits of common development. Typically, a distinction can be made between drones with towed signature sources and those with integrated sources installed aboard.

The size and capability of a minesweeping drone and its payload are defined by the operational needs. These needs vary in environmental aspects from inshore operations with short transit and limited operation times in sheltered areas to operations in unsheltered areas potentially exposed to heavy wind and large waves with long standoff distances. The variation in operational needs with respect to the subject of protection can be from smaller merchant vessels and military vessels with reduced underwater signatures to large civilian merchants with significant underwater signatures.

The underwater signature and the shock resistance of the minesweeping system is a crucial part of its design and a fundamental feature of minesweeping operations.

The objective of this call is to reach at least technology readiness level 6 for a minesweeping system (platform/drone and payload designed for it)[141].

Scope and types of activities

Scope

The proposals must target minesweeping systems (platform/drone and payload/sweeping gear) with autonomous features that are capable of performing influence sweeping in open-sea conditions against mines that target large merchant vessels (such as Landing Platform Dock (LPD), Ro-Ro vessels etc. up to around 200m length). The proposals must investigate and develop capable and cost-effective drone systems for influence minesweeping. This includes the interfaces to enabling systems such as launch and recovery (LARS) of the sweep system and command and control (C2) systems (including planning and evaluation tools).

The proposals may include solutions that include modified mechanical minesweeping operations.

Furthermore, the proposals must address reducing time (improved effectiveness) and risk for personnel and materiel in minesweeping operations. Development of uncrewed systems and autonomous features are seen as enablers in this regard. Improvements must address at least

[141] A functional version of the product working on a realistic environment able to draw conclusions on the technical and operational capabilities of the product (Horizon Europe)

vehicle design regarding underwater signatures, propulsion system, and shock resistance to benefit both operational quality and efficiency. Improvements should also address features such as low maintenance effort, survivability, endurance, and modularity.

The proposals should address multi-purpose functions with the aim of supporting additional Naval Warfare operations, such as, but not limited to, Anti-Submarine Warfare (ASW), Intelligence, surveillance and Reconnaissance (ISR), and Maritime Evacuation Operations. This may imply that features, such as, but not limited to, LARS, interaction with several autonomous underwater vehicles (AUVs), operation in Global Navigation Satellite System (GNSS) denied environments, towing of sonar systems, and use of mine disposal systems are incorporated.

The outcome should benefit a European interoperable and interchangeable NMCM Future Sweeping System designed with incremental capabilities to counter current and new mine threats consisting of enhanced intelligent platforms. Furthermore, the outcome should address the development of influence sweep source demonstrators for relevant underwater signatures (such as acoustic, magnetic, pressure and electric).

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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 (mandatory)
(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)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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)

Tasks

The proposals must cover at least the following tasks as part of the mandatory activities:

- Studies:
  - Research and studies on relevant signature levels, characteristic and frequencies as well as sweep tactics.
  - Defining the sweep signatures in the acoustic, magnetic, pressure and electric field. The research must be supported by simulation and experimentation.
  - Simulations must include at least mine influence sweeping, including multi sweep, in order to estimate the effectiveness against various mines.
    - Simulations must include at least the most basic mine setting and target selection features.
- Design:
  - Design, development, fabrication and integration of demonstrator signature sources, including, but not limited to, features on available energy, mechanical interface and shock requirements.
  - Design of minesweeper drone.
  - Design of uncrewed LARS of towed sweep sources if the proposed design includes towed sweep sources.
  - Design of minesweeping systems and sub-systems with attention to at least the following characteristics:
    - Shock resistance from underwater explosions.
    - Automated ship systems prepared for autonomy interfacing.
    - Non-magnetic materials and/or degaussing systems for reduced magnetic underwater signature.
    - Hybrid propulsion including battery powered electric propulsion for reduced underwater signature.
    - Resilience and robustness.
    - Autonomous detection of mine firings.
    - Environmental conditions (sea state, temperature etc.).

        - Uncrewed operations with the possibility of crewed operations in transition phases to-from operation or regulatory demand.
        - Digital infrastructure, and communication security.
        - Data and information security.
    - Design in support of autonomous features for drones including at least the following characteristics[142]:
        - Navigation including COLREGS[143] (collision avoidance) and GNSS denied situations (implies low derivation error).
        - Situational awareness.
        - Joint sweep operations with cooperating drones in formation.
        - Fault handling.
        - Mission planning, including interface to higher level operational planning tools.
        - The design of the autonomous features must be in accordance with international and national laws and regulations, including, where applicable, regulations for autonomous vessels[144] and class guidelines from international providers of classification.
    - Design of user interface for maintenance, monitoring, and information exchange for minesweep operations with drone.
    - Design verification must include technical and functional tests of key technology components (such as sweep signature sources, drone sub-systems, autonomy and command and control systems) in a representative operational environment.

The proposals should cover at least the following tasks:

- Studies:
    - A supply chain analysis in the area of minesweeping solutions with autonomous features addressing critical dependencies for the EDTIB.
- Design:
    - The design should include alternative payloads for NMCM operations:
        - AUV operations with transport and LARS, also including underwater communication with AUV and position aiding.
        - Towing of mine hunting sonar systems.
        - Remote operation of mine disposal systems from drone.

[142] The use of best practice definitions, for instance the guide for UMS handling, operations, design and regulations developed by the SARUMS (Safety and Regulations for European UMS) ad-working group of the European Defence Agency, is advisable.

[143] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) (imo.org)

[144] Including constrained manoeuvrability and towed gear

        - Support vessel role equipment for mine clearance divers.
        - Role equipment for underwater surveillance (mission module) in support of barrier operations necessary to protect ongoing mine clearance operations.
        - Supporting vessel for mine jamming operations.
    - Communication systems to operate uncrewed systems with crewed systems including interworking and interoperability of applications & data.
    - Digital infrastructure and cyber security by design.
        - The digital infrastructure and security measures depend on the configuration/architecture of the System setup (System of Systems). This needs to be tested in isolated component and subsystem tests, as well as total systems tests.
- System prototyping:
    - The proposals should include technical system prototyping for a minesweeping system, including drone and influence sweep sources for relevant underwater signatures (any, some, or all of signatures such as acoustic, magnetic, pressure and electric).

A final demonstration should serve as an instrument to show to the military community the results of the targeted development activities, present potential military value and identify technology shortfalls that need to be addressed in subsequent activities in nations and in EU.

The design and development methodology should comply with NATO Architecture Framework (NAFv4)[145].

Functional requirements

The proposed solutions for a minesweeping system should meet the following functional requirements:

- The proposals should meet the common requirements for future minesweeping systems as defined by supporting Member States.
- The solutions should be capable of minesweeping in the tactics mine setting mode (MSM) against different mine types and in target simulation mode (TSM) for the simulation of various ship types, in particular large merchant vessels (such as LPD, Ro-Ro vessels etc. up to around 200m length).
- The solutions should be capable to operate in an open sea, as well as confined and shallow environment at moderate to rough sea state.
- The solutions should be capable to operate continuously (independently without replacement, recharging, reloading) in sweeping mode for at least 36 hours and in transit mode at least 72 hours.

Expected impact

[145] NATO - NATO Architecture Framework, Version 4

The outcome should contribute to:

- Strategic autonomy of EDTIB in the area of minesweeping systems.
    - Fostering the technological cooperation of industries in the field of uncrewed sweeping drones and signature sources.
- Interoperability of EU Member States Armed Forces:
    - System definition and proof of concepts for a future European minesweeping system.
    - Common requirements and harmonisation of minesweeping concepts.

2.5.14. EDF-2024-DA-SIMTRAIN-STME-STEP: Simulation and training for medical emergencies

- **Indicative budget:** EUR 10 000 000 for this topic under the call EDF-2024-DA.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

Medical (support) personnel often have limited access to extensive Prolonged Field Care (PFC) training due to a wide variety of factors. Studies to evaluate hospital preparedness have shown that good response plans can be developed for complex medical training scenarios (such as radiation exposure response), and that medical providers can be trained to follow these plans if the given training is realistic in its delivery.

Effective military medical training and readiness for PFC require decision training, performance of individual medical procedures and excellent teamwork skills in austere conditions of fast changing battlefield conditions of large-scale symmetrical conflict or natural disaster. Military medical training based on both computer-generated, hybrid and physical teaching materials creates advantage to development of cost-effective training courses for the military and civilian medical (support) personnel population and paramedics.

European Union has already started its efforts for developing military medics' innovative training solutions, focused on Field Care and Role 1 scenarios. In order to take full advantage of military medics training simulation, additional operational scenarios and functionalities in a virtual reality environment have to be developed and integrated into a network of federated toolbox which provides interconnection and joint access to simulation systems that are supporting different but mutually complementing simulation methods like mixed, augmented, hybrid, part task trainers, logistics, manikins and medical equipement, but currently are unevenly distributed in the European market for the medical personnel and paramedic training.

Specific objective

The topic aims to address the current operational challenges facing military medical personnel in the EU Member States (MS) and EDF Associated Countries, including in and out of areas of deployment.

Scope and types of activities

Scope

Proposals must address the development of a prototyped solution for a federation of available and enhanced medical simulation systems that support military medical curriculum and are connected to a (at best AI-based) feedback system (that may include real medical and health-data as benchmarking) that enables to see integrated picture of all training related information.

Proposals must therefore address:

- **Medical Training Modules**: The Medical Training Modules are designed to impart knowledge in military medicine to trainees. At present, the guidelines are anchored in Tactical Combat Casualty Care, serving as vital training curricula for both medical and non-medical personnel in civilian and military contexts. Looking ahead to future battlefield situations, insights from Ukraine underscore the importance of updating existing guidelines with a Prolonged Casualty Care environments. This adaptation is essential in preparing Europeans to confront diverse battlefield scenarios. Training modules can provide realistic, scenario-based learning experiences covering trauma, infections, and radiation exposure. They extend across various environments, including battlefield tranches, vehicles, and aircraft, offering comprehensive multi-modal and interdisciplinary training. The integration of virtual and mixed technologies elevates the delivery of educational content and learning retention. The overarching focus is effective communication, coordination, and preparedness for non-medical professionals in dynamic settings of the battlefield.

- **Supporting elements enabling Military Medical Training Multi-Modular Simulation Federated network**: The Military Medical Training Multi-Modular Simulation Federated network employs advanced technologies to create a comprehensive and realistic training environment. This includes cloud-based solutions for simultaneous management of large casualties, integration of digital computer simulated casualties for dynamic scenarios, physical simulated patients for hands-on training, and physical manikin systems replicating human responses. Crucially, seamless data exchange between computer-generated simulations and physical systems ensures a cohesive training experience. The interconnected federated network allows collaborative exercises across different locations, with real-time monitoring and feedback enhancing the learning process. Scalability, customisation, and integration of virtual, mixed, and augmented reality technologies contribute to an immersive and adaptable training platform for military non-medical and medical professionals.

- **Integration with Real World**: The integration of 5G technology into medical education signifies a transformative approach for European Union medical training centers. This integration facilitates the delivery of educational content with high-speed, low-latency connectivity, enabling real-time and immersive learning experiences. Learning analytics tools add a data-driven dimension, offering insights into individual and collective learning patterns. Augmented reality serves as a powerful teaching aid, particularly for Definitive Surgical Trauma Care, enhancing trainees' understanding through virtual overlays in the real-world environment. This comprehensive integration fosters scalable and distributed training solutions, promotes remote collaboration, and ensures standardisation and quality assurance across diverse training centers. The result is a cutting-edge educational paradigm that leverages advanced technologies to elevate the efficiency, accessibility, and effectiveness of medical training throughout the European Union.

In addition, the proposals must address concept development for interconnectivity of Military Medical VR Training Simulation Modules to a Battle Management System's simulation[146], including interface to a MS Battle Management System's simulation.

Moreover, proposals should address how real data and AI can be used to create an as realistic as possible environment facing medical, medical logistic and C2[147] challenges and provide suggestions to improve real life scenarios.

In addition, proposals may address the analysis of trainees' stress levels and hesitations and provides feedback.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(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	Yes (mandatory)

[146] Battle Management System's simulation here is meant to address MedC2 (Medical Command and Control) features to facilitate medical regulating and patient flow management as part of Battlefield Management (simulation).
[147] Command and control

Types of activities (art 10(3) EDF Regulation)		Eligible?
	industrial or representative environment	
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (mandatory)
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

a) **Medical Training Modules**

- Studies:
  - Research analyse and define the existing military medical curriculum, focusing on identifying key areas for potential improvements and adaptations to meet the requirements of European Member States. An updated military medical curriculum framework, incorporating interactive and engaging content elements that reflect the diverse training needs and scenarios of EU Member States and EDF Associated Countries.
  - Review and assess existing MEDEVAC protocols and procedures, identifying areas for enhancement and integration into the virtual simulation environment, with a specific focus on logistics and casualty flow simulation medical regulating and MedC2.
  - Explore current practices and methodologies in Prolonged Field Care (PFC), and prolonged casualty care, focusing on understanding the necessary sustainment skills and training requirements for improving overall preparedness for armed forces medics and paramedics. Tactical Combat Casualty Care must be core of the training module.
  - Investigate and analyse various CBRNE scenarios, with a specific emphasis on burn injuries related to radiation exposure, aiming to develop comprehensive

training modules that address recognition, decontamination, and effective trauma treatment strategies.

- Design:
  - Develop a scalable and dynamic simulation model for MEDEVAC scenarios (with a focus on tactical MEDEVAC maneuver elements), incorporating operational environment complexity logistical complexities and casualty flow dynamics to provide an immersive and realistic training experience for military medical personnel.
  - Design an integrated Prolonged Field Care (PFC) and Prolonged casualty care, based on the skills and equipment[148] of the medical (support) personnel module within the virtual reality training platform, focusing on the implementation of advanced medical procedures and treatments beyond conventional planning timeframes, emphasising critical decision-making and response strategies.
  - Create immersive and detailed CBRNE training simulations, incorporating lifelike scenarios and interactive modules that simulate various aspects radiological incidents, emphasising comprehensive training in recognition, decontamination, and effective treatment protocols.
- Prototyping:
  - Develop a functional prototype of the MEDEVAC simulation model (with a focus on tactical MEDEVAC maneuver elements), testing its capabilities in simulating realistic logistical and casualty flow scenarios, and validating its effectiveness in providing an immersive training experience for military medical personnel. (expected to reach TRL 7)
  - Create a prototype of the Prolonged Field Care (PFC) and prolonged casualty care module within the virtual reality training platform, testing and validating advanced medical procedures and treatments beyond conventional planning timeframes, and assessing its effectiveness in improving critical decision-making and response strategies. (expected to reach TRL 7)
  - Build interactive prototypes of the CBRNE training simulation, testing lifelike scenario and interactive module that simulate various aspects of radiological incident, and assessing the effectiveness of the training in recognition, decontamination, and effective treatment protocols. (expected to reach TRL 7)
- Testing:
  - Perform rigorous testing of the military medical curriculum framework, assessing its effectiveness in addressing the diverse training needs and

[148] Focusing on personnel medical equipment (« backpack », TACEVAC, etc.) and additional on medical devices (e.g., patient monitors).

requirements of European Member States, and soliciting feedback from key stakeholders for further improvements.

- Test the MEDEVAC simulation model in simulated scenarios (with a focus on tactical MEDEVAC maneuver elements), assessing its ability to accurately simulate logistical and casualty flow dynamics, and soliciting feedback from military medical personnel for further enhancements and adjustments.

- Perform comprehensive testing of the Prolonged Field Care (PFC) module within the virtual reality training platform, evaluating its effectiveness in simulating advanced medical procedures, treatments and therefore also the usage of personal and/or vehicle specific medical equipment beyond conventional planning timeframes, and gathering feedback from trainees for further refinements.

- Conduct rigorous testing of the CBRNE training simulation, assessing their effectiveness in simulating realistic radiological incident, and soliciting feedback from trainees to ensure comprehensive training in recognition, decontamination, and effective treatment protocols.

b) Supporting elements enabling Military Medical Training Multi-Modular Simulation Federated network:

- Studies:

  - Conduct a comprehensive literature review and analysis of the current state of Military Medical Training Multi-Modular Simulation Federated networks and associated technologies.

  - Study the integration possibilities and challenges related to the exchange of data between computer-generated, physical manikin systems and medical equipment, emphasising the development of open standards for seamless data transfer and analysis.

  - Research cloud-based solutions for managing large quantities of casualties simultaneously and the combination of digital computer simulated casualties, physical simulated patients and physical manikin systems, with a focus on scalability, efficiency, and resource optimisation within a simulated training environment.

- Design:

  - Develop a detailed blueprint and architectural plan for the implementation of the Military Medical Training Multi-Modular Simulation Federated network, outlining the specific technical components and their interconnections.

  - Design an integrated data exchange system between computer-generated and physical manikin systems, and physical simulated casualties (with a digital device to simulate a casualty and thereby visible in the trainer) focusing on the development of standardised protocols and interfaces to facilitate seamless data transfer and interoperability between different simulation platforms and in addition to medical equipment.

  - Design the architecture of a cloud-based infrastructure for handling large quantities of casualties simultaneously, ensuring efficient resource allocation, data management, and communication protocols for seamless coordination and collaboration among various training centres and facilities.

- Prototyping:

  - Develop an initial prototype of the Military Medical Training Multi-Modular Simulation Federated network, integrating essential components and functionalities based on the design specifications and architectural plan (expected to reach TRL 6).

  - Construct a prototype of the data exchange system between computer-generated and physical manikin systems, testing its compatibility and effectiveness in facilitating seamless data transfer and interoperability between different simulation platforms (expected to reach TRL 7).

  - Develop a functional prototype of the cloud-based infrastructure for managing large quantities of casualties simultaneously, testing its efficiency in resource allocation, data management, and communication protocols for seamless coordination and collaboration among various training centres and facilities (expected to reach TRL 5).

- Testing:

  - Conduct extensive testing of the streaming software solution, evaluating its compatibility with 5G technology, and assessing its efficiency in delivering seamless and high-quality data transmission across various training locations and facilities within the European Union.

  - Test the cloud-based infrastructure for managing large quantities of casualties simultaneously, evaluating its efficiency in resource allocation, data management, and communication protocols, and soliciting feedback from training centre administrators for further improvements.

  - Conduct comprehensive system testing of the Military Medical Training Multi-Modular Simulation Federated network, evaluating its performance, scalability, and interoperability across various simulated training environments and scenarios.

c) Integration with Real World:

- Studies:

- Investigate and evaluate various learning analytics tools and systems, considering their applicability and effectiveness in tracking individual training progress and competency within the simulated environment.
- Study the capabilities and limitations of 5G technology, particularly in relation to its potential integration for scalable and distributed training solutions across the European Union.
- Investigate the current landscape of Augmented Reality surgical simulators and their applicability in providing training to different surgical capability levels (focusing on (r)DCS at Role 2 level, additional up to Role 4), focusing on the enhancement of surgical decision-making skills and techniques based on the specific guidelines.

- Design:
  - Design the architecture of a secure and efficient streaming software solution, leveraging 5G technology to enable seamless and high-quality data transmission across various training locations and facilities within the European Union.
  - Create a robust and user-friendly Learning Analytics Tool interface, integrating advanced tracking and monitoring features to provide real-time feedback and comprehensive data analysis capabilities for training administrators and instructors, but also the learning loop to use these data to enhance and/or simplify protocols.
  - Develop an augmented reality surgical simulation environment tailored to different surgical capability levels (focusing on (r)DCS at Role 2 level, additional up to Role 4) training, incorporating realistic surgical scenarios and procedures based on specific guidelines, emphasising hands-on training and decision-making skills for complex medical interventions.
- Protototyping:
  - Develop a prototype version of the streaming software solution, ensuring compatibility with 5G technology and validating its ability to deliver seamless and high-quality data transmission across various training locations and facilities within the European Union (expected to reach TRL 5).
  - Build a functional prototype of the Learning Analytics Tool interface, incorporating key tracking and monitoring features to allow for real-time data analysis and visualisation, enabling comprehensive insights for training administrators and instructors (expected to reach TRL 7).
  - Build a prototype of the augmented reality surgical simulation environment for training at different surgical capability levels (focusing on (r)DCS at Role 2 level, additional up to Role 4) , testing and validating its effectiveness in

providing hands-on training and decision-making skills for complex medical interventions based on specific guidelines (expected to reach TRL 6).

- Testing:
  - Execute thorough testing of the Learning Analytics Tool interface, validating its tracking and monitoring capabilities, and ensuring its seamless integration with the training platform to provide real-time data analysis and comprehensive insights for training administrators and instructors.
  - Perform thorough testing of the data exchange system between computer-generated and physical manikin systems, assessing its compatibility and effectiveness in facilitating seamless data transfer and interoperability between different simulation platforms, and gathering feedback from system administrators and users for further enhancements.
  - Conduct comprehensive testing of the augmented reality surgical simulation environment for training at different surgical capability levels (focusing on (r)DCS at Role 2 level, additional up to Role 4), evaluating its effectiveness in providing hands-on training and decision-making skills for complex medical interventions based on the specific guidelines, and gathering feedback from medical professionals for further refinements and adjustments.

In addition, proposals must address the following cross-cutting design activity:

- Design a concept for interconnectivity of Military Medical VR Training Simulation Modules to a Battle Management System's simulation, including interface to a MS or EDF Associated Countries Battle Management System's simulation.

Proposals may also address the following cross-cutting design activities:

- Study and Design a software decision support system elements, geared towards strategic planning of resource distribution, to training of operators using such resources to address multiple trauma victims in remote or poorly accessible theaters, and to the real-time support of decision making in the wake of an actually occurring accident. The technical specifications ought to include the class (types) of events addressed, the resources to be managed, the timeframe available for cognitive support delivery to the decision-maker. Test-beds, typically simulated (table-top or physical exercises) will have to be described and their relevance to the validation of the product detailed.
- Study and Design and create a stochastic (at its best AI-optimised) training simulation scenario, with multiple victims and realistic distribution of available resources, statistically adherent to disasters effectively recorded or to anticipated battlefield situations. It must include a learning loop on how to update these secanarios by real-life data of such incidents

- o Study and Design methods to augment situational awareness and decision support systems for decision-makers in real-time crisis development.

The proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of Simulation and Training, notably those described in the call topic EDIDP-SME-2020[149] related to *Simulation and Training*.

Functional requirements

The proposed product and technologies should enable medical (support) personnel and paramedics with regular joint and frequent access to lifelike, secure, immersive training environment from Care Under Fire throughout multiple levels of surgical capability (focusing on (r)DCS at Role 2 level, additional up to Role 4) and being designed to respond to the evolving training requirements for medics and paramedics both at individual and team levels, contributing for their readiness for national and multi-national missions.

The proposed product and technologies should therfore meet the following functional requirements in the following areas:

a) **Medical Training Modules:**

- o MEDEVAC: Connection between Field Care by MEDEVAC scenario to Role 1 and beyond to provide connection to a constructive simulation tool able to simulate logistics and the casualty flow and the (Med) C2 capabilty, including at least an interface to a MS battle management system .
- o Prolonged Field Care (PFC)/ Prolonged Casualty Care: Creation of a layer of PFC to the existing virtual reality medical training scenarios to increase training complexity, stress factor for the trainees and improve readiness for the armed forces medics and paramedics. The content of this training should address sustainment skills for Field Care applied beyond doctrinal planning time-lines (10-60-120 min) in order to decrease patient mortality and morbidity until the patient arrives at the next appropriate level of care.
- o CBRNE: Developed training scenarios to include CBRNE injury sample with a focus on burn injuries related to radiation exposure to teach how to recognise it, decontamination, trauma treatment and disposition.
- o Large Quantities of Casualties for Simultaneous Care: Developed cloud-based capability to increase the amount of patients up to 30 or more causalities.

b) **Supporting elements enabling Military Medical Training Multi-Modular Simulation Federated network**

- o Military Medical Curriculum:
  - ▪ Developed Prolonged Field Care military medical curriculum based on the available guidelines and research studies to enable unified set of instruction and ability to update those for the European Member States.

[149] Funding & tenders (europa.eu)

- Tactical Combat Casualty Care (TCCC) is a critical teaching curriculum that emphasises care under fire, tactical field care, and medical evacuation. Learnings from Ukraine, where prolonged field care has become necessary, underscore the need to adapt the curriculum. This requires incorporating provisions for sustained treatment beyond the initial phase, ensuring that combatants are equipped to handle extended care scenarios effectively.

- Additionally, the inclusion of Chemical, Biological, Radiological, and Nuclear (CBRN) elements in the curriculum is imperative. This means introducing comprehensive training in Personal Protective Equipment (PPE) usage, decontamination procedures, and the treatment of radiological exposure, to ensure troops are adequately prepared to manage diverse battlefield threats.

- Furthermore, the evolving protocols for medical evacuation, based on the insights garnered from Ukraine, should reflect a heightened emphasis on accommodating prolonged care scenarios and mitigating the risks associated with dynamic combat environments. This adjustment aims to optimise the efficiency and effectiveness of the evacuation process, prioritising the timely transfer of casualties.

- Learning Analytics Tool: Developed component to track individual training progress, competency, and proficiency across and between the toolboxes/systems of the federated network able to:

  - Generate adaptive learning experiences that enable individually tailored training programs to increase learning retention and effects;

  - Provide both distributed debriefing and AAR for training centers through the European Union, and an automated learning analytics system at scale for instructors and commanders.

- Scalability / Distribution via 5G: Developed streaming software from cloud services across European Union with 5G and beyond to integrate products and services into IT systems of end-users.

- Federated medical training network applying existing open and applicable standards and including the following features:

  - Interoperability: Ensures seamless communication and data exchange between various medical training entities, promoting comprehensive and unified learning experiences.

  - Versatile Learning Modalities: Facilitates diverse learning approaches, including virtual, augmented, mixed, and extended reality, as well as constructive simulations, enabling trainees to acquire practical skills in a simulated environment.

- Robust Competency Tracking: Enables comprehensive monitoring and assessment of individual progress, competence assertion statements, and on-the-job experiences, ensuring a holistic approach to skill development and evaluation.

- Integrated Federated Network: Provides a unified ecosystem for medical training across multiple institutions and organisations, fostering collaboration and knowledge sharing among diverse stakeholders.

- Granular Data Tracking: Offers detailed tracking capabilities, allowing the monitoring of specific skills development, course completion, and individual performance, facilitating targeted interventions and personalised learning paths.

- Extensive Customisation Options: Empowers users to tailor the platform to specific training needs and organizational requirements, ensuring a tailored and effective learning experience for all participants.

- Learning Management System (LMS) should include comprehensive integration and tracking capabilities, ensuring seamless coordination and monitoring of learning activities within the network. The LMS should be fully integrated within the federated medical training network, allowing for streamlined data management and tracking of various learning events, including live events and simulations. Competence assertion statements should be collected through comprehensive after-action reviews, capturing detailed insights into trainee performance and skill development.

- Individual on-the-job experiences contributing to training and education should be meticulously tracked through the LRS, ensuring a comprehensive understanding of each learner's professional development. The APIs within the system should be fully open and enable seamless integration with external applications, promoting flexibility and interoperability. Data export functions should be provided to allow for data analysis and reporting outside the system.

- The results should excel in tracking very granular details, such as specific skills acquisition versus overall course completion, providing a nuanced understanding of trainee progress and proficiency. The results should also generate detailed reports and analytics, including performance metrics, skill mastery levels, and learning outcomes, which can be easily configured to meet the specific needs of different stakeholders.

- The result should offer extensive customisation options, enabling users to adapt the platform to diverse training requirements and institutional preferences. The result should be able to scale efficiently to accommodate approximately 30 000 concurrent users, ensuring seamless access and smooth user experiences across the network.

c) Integration with Real World:

- Data Exchange Between Computer-Generated and Physical Manikin Systems, physical simulated casualties and medical equipement provided with a digital simulation device. Integration with physical manikins in combination with centralised data analysis and distribution. Open standards and/or other simulation systems or their providers available to transfer scenario data between the systems.

- Integration with Augmented Reality simulators for training at different surgical capability levels (focusing on (r)DCS at Role 2 level, additional up to Role 4) in context. Surgical decision training and skills based on the specific guidelines.

Expected impact

The outcome should contribute to:

- Reduce dependencies on non-European suppliers by boosting the EDTIB and promoting the development of a European solution.
- Increase variations of military medical simulation training scenarios, providing better-prepared personnel both at individual and team's level, including distributed, multi-national team training.
- Enable one-stop toolbox of interconnected simulation systems that are currently dispersed across Europe to create unified environment for Prolonged Field Care military medical training, including mixed, augmented, hybrid, part-task trainers, logistics and manikins.
- Expanded immersive virtual reality simulation training environment for continuous education and maintenance of readiness for military medics critical for their missions, particularly in Prolonged Field Care circumstances with situations having high casualty numbers requiring treatment of polytrauma including CBRNE injury types.
- Significantly enhance availability, intensity, and speed of military medical personnel training.
- Reduce costs for military medical personnel cooperation training, particularly on cross-border training practices.
- Increase interoperability between paramedics, military medical (support) personnel and civilians both in military and natural disaster context.
- Provide more accessible training environments to strengthen cross-border civil–military medical forces collaboration for emergency preparedness, resulting in increased patient safety- enabled reuse of simulation data on user performance for strategic and tactical decision-making of national armed forces.
- Provide Military Medical Modelling & Simulation as a Service to the IT systems of the European Union Member States armies.
- Enhance European technological know-how in medical simulation systems strengthening European Defence Technological and Industrial Base (EDTIB).

2.6. Call EDF-2024-DA-EUCI

- **Targeted type of actions:** Development actions (EU classified information)
- **Form of funding:** Actual costs grants following the call for proposals
- **Targeted type of applicants:** Any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation, but, given the highly sensitive nature of information which will be EUCI in the context of this call, each member of the consortium must provide a Facility Security Clearance at SECRET UE/EU SECRET level or equivalent issued by the national security authorities of the EU Member State or EDF Associated Country of establishment, at the time of submission of the proposal which must be classified at the level of EU Secret.
- **Specific provisions for the call:**

  The foreground information generated during the implementation of the proposals selected for EU funding will be entirely or partly classified at the same level, under Commission's responsibility (Commission Decision 2015/444 and implementing rules).

  In accordance with abovementioned Commission Decision and national security rules, Personnel Security Clearance at the same level of SECRET UE/EU SECRET or equivalent issued by the national security authorities of the EU Member State or EDF Associated Country of establishment, is required for personnel involved in the preparation of the proposals and, if selected for EU funding, subsequent implementation of the action.
- **Indicative budget for the call:** EUR 8 400 000[150] for one topic addressing one category of actions

2.6.1. EDF-2024-DA-EUCI-AIRDEF-CHGV: Countering hypersonic glide vehicles

- **Indicative budget:** EUR 78 000 000 for this topic under the call EDF-2024-DA-EUCI.
- **Number of actions to be funded:** One proposal is to be funded for this topic. However, depending on the quality of the submitted proposals and the available budget, more than one proposal may ultimately be funded for this topic.

Objectives

General objective

In the context of future armed conflicts, hypersonic weapons could increasingly be used against the EU Member States and EDF Associated Countries and circumvent current air and missile defence systems. Numerous models have been developed to describe a hypersonic glide vehicle (HGV), but there is a need to further improve knowledge on the HGV threats, notably on the most demanding ones and on the combination of their signatures and kinematic behaviours to successfully detect, track and counter these threats.

[150] The budget earmarked on 2024 appropriations for this call may be complemented by an amount of up to EUR 69 600 000 from 2025 appropriations. This 2025 complementary budget is subject to the adoption of a separate financing decision.

Specific objective

Against this background, this topic aims to improve the defence capability against HGV threats by collecting all information necessary to successfully counter HGV systems.

<u>Scope and types of activities</u>

Scope

To build a common understanding and classification, proposals must address studies and performance assessment of the most demanding HGV systems, detailing their signature and behaviour depending on their characteristics.

Based on the results of these studies, proposals must also design a representative HGV model. This model must be validated in a relevant testing environment, using all the resources made available by supporting EU Member States and EDF Associated Countries. Proposals must address the extraction and processing of relevant signatures and kinematic data, including through at least in-flight demonstration(s) of a simplified basic HGV demonstrator.

Types of activities

The following types of activities are eligible for this topic:

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 (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(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 (mandatory)
(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)

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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)

Accordingly, the proposals must cover at least the following tasks as part of mandatory activities:

- Integrating knowledge and studies:
    - Perform a technological assessment for HGVs, taking into account the existing and identified emerging technologies on hypervelocity, using different geometric and physical parameters (range, materials, trajectories, speed, manoeuvres capability, signatures, etc.) and combining physical and functional accurate modelling.
    - Explore the materials and technologies required for HGVs.
    - Study aerodynamic loads, heating and kinematics, EM and IR signatures, plasma effects on signatures and kinematics.
    - Explore on-board sensor technologies to overcome failure e.g., due to heat, as well as properly hardened up- and down-link communication technologies.
    - Assess sensor platforms (space-and/or air- and/or surface-based) needed for multiple wavelengths recording and data integration.
    - Model and simulate possible trajectories, behaviours and manoeuvring capabilities of HGVs.
    - Propose solutions for further development regarding action towards further activity within the scope of this project.
- Design:
    - Design and build up a simplified basic HGV demonstrator.
    - Design a testing environment for the designed simplified basic HGV demonstrator, which should:
        - Use components, facilities and resources provided by the supporting Member States and EDF Associated Countries.
        - Be a combination of simulation, ground-based demonstrations and in-flight demonstration(s), where applicable and relevant.

        - Be able to collect, extract and process all relevant signatures and kinematic data with a view to validate the model resulting from the studies.
    - Select and adapt the launcher and booster system, as required for the simplified basic HGV demonstrator, as available to supporting EU Member States and EDF Associated Countries.

In order to ensure no duplication of efforts, the proposals must substantiate synergies and complementarities with foreseen, ongoing or completed activities in the field of air and missile defence, notably those described in the call topics EDIDP-SSAEW-EW-2020[151] and EDF-2022-DA-SPACE-SBMEW[152] respectively related to *Early waring* and *Space-based missile early warning*, as well as EDF-2021-AIRDEF-D-EATMI[153] and in EDF-2023-DA-DS-AIRDEF-EATMI[154], both related to *Endo-atmospheric interceptor – concept phase*.

Functional requirements

The proposed product and technologies should meet the following functional requirements:

- The simplified basic HGV demonstrator to be built and used for the validation of the designed HGV model should:
    - Have main typical characteristics of known HGVs as weapon systems from possible adversaries, in terms of size, symmetry, GNC and payload, but suitable for the validation of the designed representative HGV model.
    - Be equipped with a set of various onboard sensors, data-recording systems and other instrumentations to allow the collection of relevant data.
    - Include a capability of real-time transmitting of measurement data (e.g., telemetry or datalink system).
    - For in-flight demonstration(s), be launched at the required altitude (between 30 and 80 km during gliding phase) with the velocity between 8 and 12 Mach, using relevant adapted launcher and booster systems.
- The testing environment, including at least in-flight demonstration(s) of the simplified basic HGV demonstrator should:
    - Evaluate stable flight and structural endurance for a realistic trajectory with speed in the hypersonic regime.
    - Allow to observe, collect and record signatures and kinematic behaviours during the gliding phase with at least two different existing sensors (e.g., Visual, IR with multiple wavelengths from NIR to LWIR, UV, RF with multiple frequencies , etc.).

[151] Funding & tenders (europa.eu)
[152] Funding & tenders (europa.eu)
[153] Funding & tenders (europa.eu)
[154] C_2023_2296_EDF Financing Decision and Work Programme 2023 Part 2 (2).pdf (europa.eu)

- Allow to validate the designed representative HGV model.

Expected impact

The outcome should contribute to:

- The reduction of dependencies on non-EU solutions regarding counter hypersonic technologies.
- Increase knowledge on hypersonic threats and technologies with a view to develop an effective European air and missile defence.

2.7. EDF-2024-LS-RA-SMERO

- **Targeted type of actions:** Research actions (dedicated to SMEs and research organisations).
- **Form of funding:** lump sum grants following the call for proposals.
- **Targeted type of applicants:** any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation. Members of the consortium need to be SMEs (as self-declared according to Commission Recommendation 2003/361/EC) or research organisations (as self-declared according to European Commission Rules for Legal Entity Validation[155]). However, the coordinator of the consortium must be an SME. The budget allocated to research organisations cannot exceed 40% of the total requested grant amount.
- **Indicative budget for the call:** the European Union is considering a contribution of up to EUR 34 000 000 to support one call topic:

2.7.1. EDF-2024-LS-RA-SMERO-NT: Non-thematic research actions by SMEs and research organisations

- **Number of proposals to be funded:** several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** The requested funding cannot exceed EUR 4 000 000.

Objectives

This call topic encourages the driving role of innovative SMEs and Research Organisations (RO) in bringing forward innovation defence research, possibly by adapting technologies from civil applications or addressing hybrid warfare.

Scope and types of activities

Scope

The proposals must address innovative technologies and solutions for defence, including those that can improve readiness, deployability, reliability, safety and sustainability of forces in defence tasks and missions, for example in terms of operations, equipment, infrastructure, energy solutions, surveillance systems or digital solutions.

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[155] European Commission, *Rules for Legal Entity Validation, LEAR Appointment and Financial Capacity Assessment*, rules-lev-lear-fca_en.pdf (europa.eu)

The proposals may address any area of interest for defence, such as, but not limited to, the following ones:

- Measurement and monitoring of physiological and cognitive state.
- Optimisation of cognitive performance in human-machine interaction, including for human-robot teaming.
- Blockchain applications (e.g., for Identification of Friend or Foe).
- Tools and applications improving cybersecurity talents screening.
- Artificial intelligence and robotic autonomous systems.
- System health monitoring and through life-cycle interoperability.
- Solutions for mechanical and "green" chemical recycling of waste of soldier individual equipment (uniforms, helmets, boots, rucksacks, plastic elements, harness, etc.)
- Concepts and corresponding technologies to ensure a safe water reuse throughout the entire water cycle of a deployable camp or a deployed combat group, including with microbial safety and hygiene considerations.
- Synthetic fuel production from waste and biomass for military use.
- High Power Microwave (HPM) Electronic Waveform Technology countering electronic systems.
- Technologies for advanced Printed Circuit Boards (PCB) for defence electronics.

In addition, in order to best complement R&D efforts already targeting civil applications and to encourage the efficient spinning-in of knowledge, innovation and technological development to the defence sector, this topic also welcomes proposals for add-on research actions to adapt solutions originally developed for civil applications and previously not applied in defence sector. The proposals should drive forward or integrate results of projects funded under EU funded programme calls with a focus on civil applications and under the provision that the applicants have the necessary rights to access and commercialise the results of the precursor project.

Types of activities

The following types of activities are eligible for this topic:

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**)	Yes
(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
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services	Yes

	and solutions	
(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
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

The proposals must not cover studies only.

The proposals must describe a clear work breakdown structure and link the proposed tasks to eligible activities.

The proposals should include clear descriptions of the proposed criteria to assess work package completion.

Functional requirements

This call topic is open to any technological research for defence. The proposals should describe the targeted functionalities and the foreseen means to measure progress toward the achievements of these functionalities.

Expected impact

- Innovative and cost-effective solutions for defence applications.
- Ground-breaking or novel concepts and approaches, new promising future technological improvements or the application of technologies or concepts previously not applied in the defence sector.
- Enhanced innovation capacity across Europe by involvement of SMEs that can make a difference in the future.
- Potential for future market creation for SMEs, especially by facilitating access of SMEs to defence markets and supply chains.

- Contribution to the development of European research and technology ecosystems and to the strengthening of European defence supply chains.

2.8. EDF-2024-LS-DA-SME

- **Targeted type of actions**: Development actions (dedicated to SMEs).
- **Form of funding:** lump sum grants following the call for proposals.
- **Targeted type of applicants:** any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation. Members of the consortium need to be SMEs (as defined in Commission Recommendation 2003/361/EC).
- **Indicative budget for the call:** the European Union is considering a contribution of up to EUR 33 000 000 to support one call topic:

2.8.1. EDF-2024-LS-DA-SME-NT: Non-thematic development actions by SMEs

- **Number of proposals to be funded:** several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** The requested funding cannot exceed EUR 6 000 000.

Objectives

This call topic encourages the driving role of innovative SMEs to turn technology and research results into defence products in a fast and cost-efficient way, possibly by adapting technologies from civil applications or addressing hybrid warfare.

Scope and types of activities

Scope

The proposals must address innovative defence products, solutions and technologies, including those that can improve readiness, deployability, reliability, safety and sustainability of forces in defence tasks and missions, for example in terms of operations, equipment, infrastructure, energy solutions, surveillance systems or digital solutions.

The proposals may address any area of interest for defence, such as, but not limited to, the following ones:

- Measurement and monitoring of physiological and cognitive state
- Optimisation of cognitive performance in human-machine interaction, including for human-robot teaming
- Blockchain applications (e.g. for Identification of Friend or Foe)
- Tools and applications improving cybersecurity talents screening
- Artificial intelligence and robotic autonomous systems
- System health monitoring and through life-cycle interoperability
- Solutions for mechanical and “green” chemical recycling of waste of soldier individual equipment (uniforms, helmets, boots, rucksacks, plastic elements, harness, etc.)
- Concepts and corresponding technologies to ensure a safe water reuse throughout the entire water cycle of a deployable camp or a deployed combat group, including with microbial safety and hygiene considerations

- Synthetic fuel production from waste and biomass for military use
- High Power Microwave (HPM) Electronic Waveform Technology countering electronic systems
- Technologies for advanced Printed Circuit Boards (PCB) for defence electronics
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In addition, in order to best complement R&D efforts already targeting civil applications and to encourage the efficient spinning-in of knowledge, innovation and technological development to the defence sector, this topic also welcomes proposals for add-on development actions to adapt solutions originally developed for civil applications and previously not applied in defence sector. The proposals should drive forward or integrate results of projects funded under EU funded programme calls with a focus on civil applications and under the provision that the applicants have the necessary rights to access and commercialise the results of the precursor project.

Types of activities

The following types of activities are eligible for this topic:

	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
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes
(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
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes
(h)	**Certification** of a defence product, tangible or intangible	Yes

	component or technology	
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes

The proposals must address at least one activity among design, system prototyping, testing, qualification, certification and increasing efficiency.

The proposals must describe a clear work breakdown structure and link the proposed tasks to eligible activities.

The proposals should include clear descriptions of the proposed criteria to assess work package completion.

Functional requirements

This call topic is open to any technology development for defence. The proposals should describe the targeted functionalities and the foreseen means to measure progress toward the achievements of these functionalities.

Expected impact

- Innovative, rapid and cost-effective solutions for defence applications;
- Ground-breaking or novel concepts and approaches, new promising future technological improvements or the application of technologies or concepts previously not applied in the defence sector;
- Enhanced innovation capacity across Europe by involvement of SMEs that can make a difference in the future;
- Potential for future market creation for SMEs, especially by facilitating access of SMEs to defence markets and supply chains;
- Contribution to the development of European technological and industrial ecosystems and to the strengthening of European defence supply chains.

Appendix 1 - Preliminary Evaluation Plans for the EDF 2024 Technological Challenges

This appendix includes the preliminary evaluation plans for the two EDF 2024 technological challenges:

- 1.A – EDF technological challenge on Robust Autonomous Drone Navigation (cf. topics EDF-2024-LS-RA-CHALLENGE-SENS-RADNP and EDF-2024-LS-RA-CHALLENGE-SENS-RADNO)
- 1.B – EDF technological challenge on Multi-source Satellite Image Analysis (cf. topics EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAP and EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAO).

1.A – Preliminary evaluation plan for the EDF technological challenge on Robust Autonomous Drone Navigation (topics EDF-2024-LS-RA-CHALLENGE-SENS-RADNP and EDF-2024-LS-RA-CHALLENGE-SENS-RADNO)

This appendix 1.A is the preliminary evaluation plan for the EDF technological challenge on Robust Autonomous Drone Navigation (RADIAN). It provides a general description of the testing environment, metrics and protocols under which the research teams participating to the challenge will evaluate their systems. It is provided as part of the call documents for the topics of the EDF call EDF-2024-LS-RA-CHALLENGE in order to enable applicants to prepare projects that can cooperate smoothly with one another. For each actual test campaign, a more detailed evaluation plan will be produced by the challenge organisers in coordination with the participating teams.

1) <u>Overall concept and timeline</u>

The challenge aims at measuring, in an objective and comparable way, the performances of different approaches to **autonomous aerial drone navigation** in non-permissive environments.

In the framework of the challenge, **field tests** are organised during which autonomous drones should go from start areas to target areas, possibly through designated waypoints. Depending on the scenarios, the target area may be the same as the start area. For the sake of clarity of the assessments, the target areas are clearly designated, e.g., by their geographical coordinates, and clearly recognisable visually, e.g., with easily distinguishable markings and well-defined boundaries.

The field tests are organised **in various environments** (indoor and outdoor, with various weather and illumination conditions) **with different levels of difficulties** in terms of obstacles (e.g., buildings, hills, trees, power lines, nets, etc.), visual cues (uniform vs. varied landscapes), distance between waypoints, GNSS jamming or spoofing, communications jamming, radar jamming and deception, direct threats to the drone platforms, etc. These environments and threats are representative of real operational conditions. However, direct threats to the platforms are simulated and do not lead the concerned platforms to be actually damaged, even if they may lead to abort their participation to the mission. Furthermore, to enable experimenting solutions that are not yet optimised in terms of power consumption, the flight scenarios are designed to require relatively short flight durations.

Four types of field tests are conducted:

- Single drone flights, with the goal of *reaching the target area in minimum time*. Two variants of these tests are conducted:
    - **Autonomous drone** flight
    - **Semi-autonomous drone** flight controlled by a pilot assisted by autonomous navigation functions such as obstacle avoidance.
- Drone swarm flights, with the goal of *maximising the proportion of drones reaching the target area within a given time*. Two variants of these tests are conducted:
    - **Autonomous swarm** flight

- **Semi-autonomous swarm** controlled by a pilot. Only one pilot is involved.

An underlying goal is that the drones **estimate their positions with maximum accuracy**. In order to determine the actual position of the drones (reference position) despite potential GNSS jamming or spoofing, an independent system is set up by the organisers. It may be based on surveillance cameras, a motion-capture system, or other systems involving a payload provided by the organisers, e.g., based on radio beacons. If the reference positions cannot be collected in all parts of the test zones, at least the most important parts for the experiments are covered. Test flights with no jamming are also conducted whereby the on-board GNSS receivers are used for establishing the reference positions but not for autonomous navigation.

Sensor data acquired and used by the systems during the field tests should be recorded in order to further develop autonomous navigation modules in a well-controlled way and with short development cycles. Such data is shared across teams in order to experiment different approaches on various data. A framework for trusted and secure information exchange is set up for that purpose. In order to measure performances of AI-based software modules in an objective and comparable way, **data-based tests** are organised whereby test data is released simultaneously to all participating teams who send back the system outputs by a given deadline (typically a few days later) to the organisers for scoring.

A core function for robust navigation that is evaluated with these data-based tests is **obstacle detection**. This may include obstacles that are difficult to detect such as narrow, small, or moving obstacles. The objective is to estimate the range of objects surrounding the drone, especially in the flight direction but also over a wider field of vision to enable the timely detection of fast-moving objects. The software modules should output range images, which can be compared to manually verified range images on areas of interest in the images.

Data-based tests take place in between two field test campaigns, in order to use data collected during a given field test campaign to enhance software modules and use them for the next one. Both data-based and field tests are followed by **debriefing workshops**, where the organisers present the consolidated performance measurements, and all teams present an analysis of their approach and results.

The challenge lasts four years and covers **four evaluation campaigns**, each lasting about a year. The first one involves only field tests. It is a dry-run phase, where some adaptation of the evaluation protocols might be needed before delivering meaningful measurements. The next three evaluation campaigns are fully-fledged ones involving both field and data-based tests.

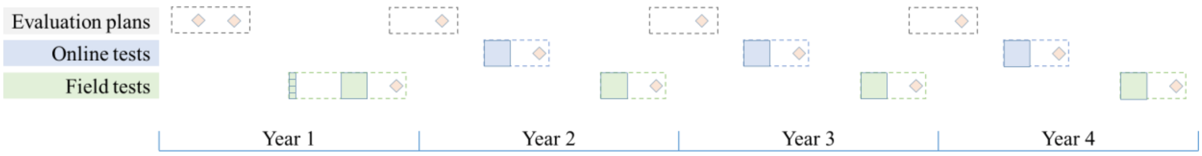
For each of the three fully-fledged campaigns, a proposed general timeline is as follows:

- January: Evaluation plan discussion workshop;
- April: Data-based tests;
- June: Debriefing workshop;
- September: Field tests;
- November: Debriefing workshop.

For the first campaign, a proposed general timeline is as follows:

- Spring: Evaluation plan discussion workshops;
- June: Individual on-site trials;
- September: Field tests;
- November: Debriefing workshop.

This proposed general timeline is illustrated below.



Each field test campaign lasts about a week and a half. The first days are devoted to the installation of the teams and trials using a small-scale testing area available to the participating teams with minimal constraints. At least three days are devoted to actual tests. At least one evening session is organised to experiment night flight conditions. Several testing zones with various levels of difficulties are available. Runs can be performed by different teams in parallel in the different testing zones. The last day is devoted to a debriefing meeting before departure of the teams.

The precise timeline of the field and data-based test campaigns is determined in the specific evaluation plan of each evaluation campaign.

A few weeks before the first field test campaign, on-site trials are organised individually for each team, for a duration of up to two days per team.

Discussion and debriefing workshops gather all stakeholders and are expected to last about two days, travel included. Additional meetings are likely to be needed but can be organised online.

Over the challenge duration, field test campaigns are hosted in at least two different sites.

2) **Systems**

The drones used in the challenge should be relatively small drones offering a compromise between the ease of experimentations (including the ease of transportation to the field test locations) and the ability to carry the relevant sensing and computing payloads. Swarms of different sizes and various platforms and/or payloads in heterogeneous swarms may be tested to explore the impact in terms of robustness to difficulties present in the test scenarios.

The drones in the swarm may be wirelessly connected with one another and share data and computational power. They may also be connected to a ground station and rely on cloud-based computing. However, navigation should be robust to communications loss. Most of the processing for navigation is therefore expected to take place on-board.

Interoperability standards should be followed as much as possible. Participating teams are welcome to team up and participate jointly for some tasks in addition to their individual team participations.

The drones should be able to record the data acquired through their sensors. If some sensor data used for navigation during field tests cannot be recorded for practical reasons, this should be justified.

3) Tasks and metrics

Overview

The table below provides an overview of the minimal set of tasks that are evaluated in the framework of the challenge. Further tasks, for example speed estimation, may also be evaluated.

General objective	Task	Metric	Measurable during	
			Field tests	Data-based tests
Navigation	Autonomous drone navigation	Time to reach the target area	X	
	Semi-autonomous drone navigation	Time to reach the target area	X	
	Autonomous swarm navigation	Proportion of drones reaching the target area in time	X	
	Semi-autonomous swarm navigation	Proportion of drones reaching the target area in time	X	
Positioning	Positioning	Average positioning accuracy	X	X
Obstacle detection	Obstacle range estimation	Median of the relative range error		X

These tasks are detailed in the following subsections.

For each test zone, a first run is conducted without direct prior knowledge of the zone by the autonomous drones. However, use of information available from other sources such as maps, and satellite or aerial images is allowed. Further runs are conducted in the same zone to give systems the possibility to learn its characteristics. However, some obstacles may be added or removed for specific runs without prior notice.

Autonomous drone navigation (field tests only)

The objective of the task is to go from a starting area to a designated target area in a minimum time, possibly through waypoints. The metric is the time from take-off from the starting area to landing on the target area. If the drone crashes, misses a waypoint, or if a predefined maximum duration is reached, the test is aborted and recorded as such.

Semi-autonomous drone navigation (field tests only)

The metric is the same as for the autonomous drone navigation.

Autonomous swarm navigation (field tests only)

The objective of the task is to go from a starting area to a designated target area, possibly through waypoints, while maximising the proportion of drones reaching the target area within a given time. The metric is the proportion of drones reaching the target area after going through all waypoints.

Semi-autonomous swarm navigation (field tests only)

The metric is the same as for the autonomous swarm navigation.

Any relevant information for clearly identifying the target area is provided to the pilot including geographical coordinates and relevant maps. Runs of reconnaissance with only the piloted drone, and without recording any sensor data, may be performed. The boundaries of the zone within which the run should be conducted should also be clearly indicated to the pilot.

Positioning

The objective of the task is to estimate the drone positions with maximum accuracy. For a single drone, the metric is the average positioning accuracy over the parts of the flight where the reference position is available. For a swarm of drones, the average is computed over all drones.

Obstacle range estimation (data-based tests only)

The objective of the task is to estimate the range of the objects surrounding the drone and which could be obstacles. The input is all available sensor data up to the current time. The output is the range information for a set of directions from the sensor. Such a set can typically be all pixels in an optical image. The reference range information is established by manually correcting errors in such outputs and/or exploiting a 3D model of the test zone. A subset of the directions which are most interesting for obstacle range estimation is considered. In particular, directions where the range cannot be unambiguously determined are discarded. Directions where the range is beyond a certain ceiling may also be discarded. The relative range error (in percentage) is computed for each considered direction. The overall metric is the median of the relative range error over all considered directions. The use of the median is intended to limit the influence of potential outliers. However, other metrics such as the average may be considered.

4) <u>Data collection, annotation and sharing</u>

By default, all sensor data collected during field tests and used for any challenge task should be provided to the challenge organisers and made available to the other teams in the framework of the challenge. In order to ensure trust and secure exchange of data, teams must sign a data management agreement (template to be developed).

If some of the data used by a system cannot be shared for any reasons, and if the comparison between performances obtained during field tests (using all data) and data-based test (using only the provided subset) show a significant difference, the concerned team should report on an analysis of this difference.

For the field test runs where GNSS receivers are used to establish the reference positions, these reference positions for at least one of the test zones are not kept by the participating teams so that they can be used for data-based tests, together with the corresponding sensor data. Such data is expectedly used in the immediately following campaign. However, some of it may be set aside for a next campaign, in order to benefit then from data recorded in more varied conditions, and to enable more meaningful performance comparisons across the years.

Additional training and development data coming from other sources beyond the challenge may be used if available and relevant.

Sensor data annotation for the obstacle range estimation task follows guidelines documented by the organisers. These guidelines are presented and discussed together with the evaluation plans.

After each test campaign, the teams noticing possible errors in the reference data used to score their systems may send them to the organisers, who should duly take them into account to improve the quality of the reference data if relevant.

5) Communication

Representatives of potential users of the technologies are invited to assist to field tests, and possibly to workshops.

Without prejudice to other provisions, participating teams may communicate on their own results and methods. Documents on challenge-level results are prepared by the organisers and are submitted for comments to the teams and for approval to the granting authority before actual publication.

6) Security aspects

All participating systems should be fully compliant with the safety and security regulations (to be appended to the detailed evaluation plans). In the event such compliance cannot be ensured, the concerned team must communicate this timely to the organisers in view of finding a suitable solution.

Further security aspects related to the field-testing sites can be defined in the detailed evaluation plans. Systems should comply with the flight restrictions provided by the organisers and remain in the test zone foreseen for each run. They should also respect any limitations in term of usable radio frequencies and power.

7) Participation rules

Participants must respect the rules ensuring that data-based tests are not biased. In particular, they should not look at the data content until completion of its processing during the test.

8) Logistics

During each field test campaign, the organisers make available a separate working area for each team. Accommodation and travel costs are covered by the teams.

1.B - Preliminary evaluation plan for the EDF technological challenge on Multi-source Satellite Image Analysis (topics EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAP and EDF-2024-LS-RA-CHALLENGE-SPACE-MSIAO)

This appendix 1.B is the preliminary evaluation plan for the EDF Challenge on Multi-source Satellite Image Analysis (MSIA). It provides a general description of the testing environment, metrics and protocols under which the research teams participating to the challenge will evaluate their systems. It is provided as part of the EDF-2024-LS-RA-CHALLENGE call document and topic descriptions to enable applicants to prepare projects that can cooperate smoothly with one another. For each actual test campaign, a more detailed evaluation plan will be produced by the challenge organisers in coordination with the participating teams.

1) **Overall concept and timeline**

The challenge aims at measuring, in an objective and comparable way, the performances of different MSIA systems developed by the participants to the challenge, and at supporting their progress.

The challenge covers three types of tasks: **semantic segmentation**, **object recognition**, and **characteristic estimation**. The tasks are described in the next section.

One specificity of this challenge compared to others in the same domain is that **extensive efforts are invested in annotating data to ensure highly accurate and meaningful performance measurements**. First, guidelines for the data annotation are documented in writing, discussed, and agreed by all stakeholders. Second, part of the data is annotated by two annotators independently of each other based on these guidelines, the level of consistency between the two resulting sets of annotations (the "inter-annotator agreement") is analysed, and the guidelines may be revised if needed to improve the inter-annotator agreement. Third, parts of the data that are intrinsically ambiguous for a given type of annotation are marked as such and discarded from the scoring. Fourth, any issue in the annotation identified by the challenge participants should be considered by the organisers and corrected if relevant. These provisions ensure that only real errors from the systems are measured as such.

Thanks to this way of measuring error rates without overestimation, these error rates can be summed over the different semantic classes to be recognised in the images in order to yield meaningful **multi-class error rates (MCER)**. Using such an integrated multi-class metric is another specificity of the challenge. It creates **an incentive for systems to model inter-class dependencies** compensating the risk of getting higher error rates when the number of classes increases.

The challenge lasts four years and covers **four evaluation campaigns**, each lasting about a year. The exact choice of semantic classes, object types and characteristics to be recognised in a given campaign is part of the definition of the evaluation plan, taking into account the possibilities of the organisers and of the participants as well as the guidance provided by the user board. A preliminary list is provided in appendix.

Test data for one evaluation campaign can be used as **training or development data** for the next ones. The first evaluation campaign is a dry run, whereby setting up the testing protocols is a goal in itself and the meaningfulness of measurements might not be guaranteed, but any measurement issues should be identified and remedied in order to ensure that subsequent campaigns yield meaningful measurements.

Tests are followed by **debriefing workshops**, where the organisers present the consolidated performance measurements, and the participating teams present an analysis of their approaches and results.

2) Tasks and metrics

O*verview*

The challenge covers three types of tasks:

- Semantic segmentation;
- Object recognition;
- Characteristic estimation.

Details per type of task are provided in the following subsections.

For each specific task:

- Background information of any type may be used as input provided that it is not more recent than a cut-off date specified in the evaluation plan of each campaign.
- In order to assess the added value of combining optical and radar images, contrast experiments, where only one type of images is used, are conducted.
- A given team can submit several variants of a system. However, one of these submissions must then be designated as the primary one and be used for the official performance measurement.

Semantic segmentation

This task consists in a pixel-wise classification of an image for a given set of semantic classes. A semantic class is defined by a textual description and training labelled image data.

Classes to be recognised may be semantically overlapping. Relationships between classes may be provided when relevant (e.g., 'truck' 'is a' 'vehicle', 'airport hangar' 'is part of' an 'airport'). Further relationships between classes are expected to be modelled by the systems in order to improve multi-class recognition.

For each class, a sub-task consists in determining which regions of a test image correspond to the class. This is a binary classification, the rest of the image being considered as not corresponding to the class. However, parts of the image for which the reference is considered as ambiguous are not scored. The pixels in error are thus those where the system hypothesis (system output) does not match the reference (ground truth) if this reference is considered as unambiguous for the considered class. The error rate for the sub-task is the number of such pixel-wise errors divided by the total number of pixels in the image.

For classes involving change detection, images covering the same areas at different dates and against which changes should be estimated are provided.

For the overall task, the error rate is this total number of errors over the set of classes to be recognised divided by the number of pixels in the image. This multi-class error rate (MCER) can be computed in the same way over a set of images.

Object recognition

This task consists in the recognition in images of objects from a given set of object types. An object is defined by a textual description and training image data annotated with the regions where the object can be seen.

The different object types to be recognised may be semantically overlapping. Relationships between object types may be provided when relevant.

An object is considered as correctly recognised (true positive) if the following conditions are met:

1) The hypothesised object type is the same as the reference object type;
2) The hypothesised region significantly overlaps with a reference region, and more precisely the intersection over union is above a given threshold (a priori 50%);
3) Neither the hypothesised object nor the reference object have already been matched with the correct type and a better overlap.

Similarly, an object is considered as mistaken for another (substitution) if the following conditions are met:

1) The hypothesised object type is different from the reference object type;
2) The hypothesised region significantly overlaps with a reference region, and more precisely the intersection over union is above a given threshold (a priori 50%);
3) Neither the hypothesised object not the reference object has already been matched with a better overlap.

A hypothesised object that cannot be matched with any reference object is considered as a false positive. A reference object that cannot be matched with any hypothesised object is considered as a false negative. Ambiguity in the image data and annotated as such is taken into account in the scoring. For example, a reference object for which the presence is considered as ambiguous does not lead to false negatives. The error rate is the total number of errors (substitutions, false positives, and false negatives) divided by the total number of objects present in the reference. This multi-object detection error rate (MODER) can be computed in the same way over a set of images.

Other metrics such as the mean average precision (mAP) may be computed for the sake of comparison with other research works using these metrics.

Characteristic estimation

The tasks falling under this category consist in the estimation of specific characteristics of certain types of semantic classes and objects.

By default, for characteristics that are continuous (volume, height, depth, slope, speed, humidity level, etc.), the metric is a percentage of error, and for characteristics that are discrete attributes, the metric is an error rate. For the estimation of the composition in terms of materials, the proportion of a given material in the composition is considered. For semantic classes, the error percentage or rate is averaged over the concerned area. The median is also computed.

3) Data

The challenge organisers annotate the image data with reference annotations according to guidelines documented in a separate document. These annotations are used to score the submitted systems. Where the image data do not allow an unambiguous recognition, this is annotated as such and used during scoring to not penalise systems recognising either way.

For object detection, the images regions where an object can be seen may be simply defined by a bounding box where appropriate. However, whenever needed to ensure an accurate evaluation, the regions may have to be defined by a polygon or even by a set of pixels.

Following test periods, the participants are invited to check the annotations used for scoring in order to spot any needed correction and submit candidate corrections to the organisers. The organisers take them into account to improve the annotations. Any unresolved discrepancies between participant and organiser views on the annotations is described in a document produced by the organisers and shared with the participants before the debriefing workshop.

File formats will be described in the detailed evaluation plans.

Table of semantic classes and objects to recognise and characterise

The table below provides a proposed list of semantic classes, objects, and characteristics to recognise in order to bootstrap the discussions toward the elaboration of the evaluation plan of the first evaluation campaign. The first three columns provide the information for semantic class recognition. The fourth column lists the classes that should also be recognised as individual objects. The last column provides the information for characteristic recognition. The actual list for each campaign is expected to be expended with further specific classes, especially for various types of aircrafts, ships and vehicles. Definitions may also need to be refined.

Name	Definition	Involves change detection	Object	Characteristics
Aircraft	Planes, helicopters, UAVs		x	Length, width
Airfield	Airfields and airports, including the runways, taxiways, aprons, control towers and terminals. Car parks around the airport are not included. Vegetation within the airport secured perimeter, if any, is not scored.			
Airfield runway	Airfield runways		x	Length
Airport control tower	Airport control towers		x	Height
Airport hangar	Airport hangars that can shelter planes			
Antenna	Radar or communication antennas			
Bridge	Bridges over bodies of water, roads, railways, valleys, for vehicles and/or pedestrians, without blocking the way underneath. Pontoon bridges are not included.			

Name	Definition	Involves change detection	Object	Characteristics
Building	Inhabitation or office buildings			Height, composition (concrete, metal, glass, wood)
Climate/environment disaster-affected areas	Areas where there is a change that can be attributed to natural hazards and affects human life	x		
Communication antenna	Communication antennas			
Construction works	Works towards the construction of infrastructures such as buildings and industrial facilities.	x		
Dam	Dams, including weirs			
Damaged (weapon-affected) areas	Areas where there are damages from weapon attacks	x		
Factory	Manufacturing or production plants			
Fighter aircraft	Military aircraft designed to establish air superiority of the battlespace		x	Length, width
Fixed artillery	Artillery equipment that is not self-propelled		x	
Ground	Area not covered by water			Slope

Name	Definition	Involves change detection	Object	Characteristics
Helicopter	Rotating-wing aircraft		x	Length, width
Industrial installation	Facilities for producing or processing equipment, materials, energy, or information at an industrial scale. Includes factories, power stations, water treatment plants, and telecommunication plants.			
Lock	Device used for raising and lowering watercraft between stretches of water of different levels on river and canal waterways. Lock gates are included.			
Military camp	Military barracks and camps			
Military transport aircraft	Military-owned transport aircraft used to support military operations by airlifting troops and military equipment		x	Length, width
Minefield	Areas with landmines			
Missile system	Equipment for launching missiles		x	
Mobile artillery	Self-propelled artillery equipment		x	
Oil tank	Oil tanks		x	Volume
Pipeline	Pipelines			Diameter

Name	Definition	Involves change detection	Object	Characteristics
Plane	Fixed-wing aircrafts, possibly with VTOL capabilities		x	Length, width
Pontoon bridge	Floating bridges			
Port	Maritime facilities comprising one or more wharves or loading areas, where ships load and discharge cargo and passengers			
Power station	Power stations of any types (fossil fuel, nuclear, solar, etc.)			
Radar antenna	Radar antennas		x	Diameter
Railway station	Railways stations including the station buildings and platforms, but not the tracks			
Railway	Railway tracks, including the area between the tracks in case of parallel tracks			
Road	Paved roads for transportation			
Ship	Surface watercrafts designed for carrying cargo or passengers, or for specialised missions, such as defence, research and fishing. Hovercrafts are not included.		x	Length, speed

Name	Definition	Involves change detection	Object	Characteristics
Ship repair facility	Ship repair facilities			
Smoke	Smokes produced by human activities, including water vapor that cannot be confused with clouds.			Composition (various gases)
Soil	Ground that is not built or covered by vegetation			Humidity level
Storage and repair facility	Storage depots and maintenance facilities for such as weapons, fuel, food and vehicles			
Submarine	Watercraft capable of independent operation underwater		x	Length, speed
Surface-to-air missile system	Equipment for launching surface-to-air missiles		x	
Surface-to-surface missile system	Equipment for launching surface-to-surface missiles		x	
Tank	Armoured fighting vehicle		x	
Tent	Shelters consisting of sheets of fabric or other material draped over, attached to a frame of poles or a supporting rope		x	
Vegetation	Assemblage of plants covering ground			

Name	Definition	Involves change detection	Object	Characteristics
Vehicle	Piece of equipment designed to transport people, cargo or both, on ground		x	
Vehicle trail	Unpaved lane in a natural area that can be used by motorised vehicles			
Water	Bodies of water, including wetlands and puddles			Depth (bathymetry)
Water Control Facilities	Dams, locks, and sluice gates			
Watercraft	Vehicle designed for travel across or through water bodies (boat, ship, hovercraft, submersible or submarine)		x	Length, speed