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ANNEX 3

ANNEX

to the

Commission Implementing Decision

on the financing of the European Defence Fund established by Regulation (EU) No 2021/697 of the European Parliament and of the Council and the adoption of the work programme for 2023 - Part II

2023 call topic descriptions

ANNEX 3

2023 call topics description

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1. Content of the document

This document contains the description of all topics to be addressed by the seven EDF 2023 calls for proposals and by the EDF 2023 direct award.

2. Actions to be funded following calls for proposals

2.1. Call EDF-2023-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 130 000 000[1] to support the following 7 call topics:

2.1.1. EDF-2023-RA-SENS-EMSP: Electromagnetic signal propagation

- **Indicative budget:** EUR 22 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Situational awareness is one of the key elements affecting military field actions and planning. Most of the military detection and control methods are based on the use of electromagnetic (EM) radiation, either for detection and ranging, or data transfer. In the recent years, military activity has significantly increased, especially in the northern and eastern Europe and Arctic areas, where specific environment parameters prevail.

The performance of radar and communication systems depends on the characteristics of the electromagnetic signal propagation in the atmosphere. Properties of the atmosphere and the Earth's surface may lead to situations where propagation deviates drastically from normal, leading to situations where the radars and radio communications do not function as expected, including degradation of signal quality or even loss of signal. Under anomalous propagation conditions, radars and radio communications may have unusually long range or may be unable to reach and monitor certain locations. The latter may result in targets being invisible to radars and a loss of radio communications with any object traveling into, or operated from, an area.

The reflection and ducting in the troposphere can affect a large range of frequencies from VHF (50-100MHz) to EHF (40GHz) that are relevant for radar and communication applications. Due to its relatively frequent occurrence and intermittent nature, this phenomenon can have a heavy impact on the operations of defence systems.

Therefore, there is a need for forecasts of future environmental conditions that can be used to assess and predict the propagation conditions of electromagnetic signal in different relevant wavelengths with limit estimates for expected variability. The resulting anticipation and forecasting capability of system performance would increase the situational awareness of

[1] The budget earmarked on 2023 appropriations for this call may be complemented by an amount of up to EUR 27 000 000 from 2024 appropriations. This 2024 complementary budget is subject to the adoption of a separate financing decision.

military planners on both operational and tactical levels. It would also allow advance identification of locations and occurrences when alternative means of monitoring might be necessary.

The current openly or commercially available propagation models have limited functionality and/or accuracy, leading some nations to develop their own national propagation models tailored to national needs. The challenges are however common for all EU Member States and EDF associated countries (Norway) and require joint cross-border research as the current knowledge is fragmented, and many nations lack partly or fully the capability to address the problem. The relevant area of interest in e.g. radar surveillance for all nations stretches hundreds - or thousands of kilometres - behind the actual borders of a country, above the neighbouring countries and sea areas, thus requiring knowledge not only over a particular state, but over the whole region.

Simultaneously, new stealth capabilities, electronic counter measures or specific characteristics of new threats such as hypersonic threats, have compromised the detection capabilities of existing radars and radar networks used by all military branches. The performance of such systems must be known accurately and improved to ensure the capability to plan and conduct tactical military operations including monitoring, detecting, concealing, counter-measuring, and electronic counter-counter measuring of such threats.

Endo-atmospheric hypersonic weapons pose an entirely different challenge. Hypersonic weapons such as Hypersonic Glide Vehicles and Hypersonic Cruise Missiles are surrounded by a plasma sheath causing signal reflections to behave differently, including a distortion of radar signatures. The electromagnetic interaction with the plasma sheath, accurate models and experimental validation are not fully available up to now.

Specific objective

The main objective is to develop and test an efficient model of electromagnetic wave propagation capable of assessing and predicting EM signal propagation conditions to contribute to the creation of a tactical decision-making aid (TDA).

It is challenging to forecast and assess the prevailing environmental conditions affecting electromagnetic signal propagation, due to limited vertical resolution in the current meso-scale numerical weather prediction (NWP) models and accuracy of surface boundary condition fields. Another challenge is validating the model results. Above the ocean, where anomalous propagation conditions like ducting frequently occur, and in the Arctic areas, this is particularly challenging due to a limited number of meteorological and sea surface in-situ observations. Even more challenging is the Baltic Sea and its heterogeneous coastal environment, with low salinity creating unique reflection conditions for electromagnetic signal propagation. Current forecasting tools available to the military planners and operators are insufficient and often outdated with respect to the forecast of tropospheric ducting. In particular naval assets could benefit from a performant tool.

The rise of new, remotely controlled autonomous platforms is another rapidly developing field with strict requirements for electromagnetic data transfer. Awareness of data transfer performance will contribute to the optimisation of the usage of drone and other unmanned assets.

Additionally, another challenge arises for the detection and tracking of threats in endo-atmospheric hypersonic flight conditions. The study of plasma effects requires the definition

of an aerothermodynamic model, an EM plasma model, and a radiation and scattering model. To date, this overall set of models does not possess an established validation with experiments reproducing the actual flight conditions. Such investigations can only constitute a first step to the longer-term objective to develop specific tools that ensure the best detection and tracking performance during each phase of the hypersonic flight path (i.e. long range detection for Over-the-Horizon radar, short range detection and tracking ground radar, on-board radio-frequency missile seeker) and to identify innovative sensor architectures and techniques appropriate for hypersonic threat defence.

Scope and types of activities

Scope

The proposals must provide the first steps towards a joint European capability to estimate and address the impacts of anomalous atmospheric electromagnetic signal propagation on radar performance and RF communication over the ocean and ice-covered areas in and around Europe. The proposals should also address anomalous atmospheric electromagnetic signal propagation over land, over and around Europe. The proposals must consider atmospheric conditions up to 30km in height and may consider atmospheric conditions at other heights.

The proposals must aim at quantifying the frequency of occurrence and geographical extent of anomalous propagation conditions. They must address the key processes causing anomalous propagation and their occurrence.

They must also include research into a joint modular propagation model. They should improve understanding of the needs and quality requirements for in-situ instrumentation and observations of key environmental variables to support anomalous propagation forecasting.

The proposals should address the functional requirements and suggest a design for nowcasting and forecasting tools for signal propagation conditions and radar and communication performance.

The proposals must also address and aim to partially validate physical assumptions and electromagnetic signal interaction properties related to hypersonic threats, in particular related to the plasma sheath induced by hypersonic flight regime.

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	Yes (mandatory)

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	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 cover at least the following tasks as part of the mandatory activities:

- Generating knowledge:
    - provide the state of the art on and determine the frequency and occurrence of sea (including the Baltic Sea and its heterogeneous coastal environment) and land surface ducting and anomalous signal propagation conditions in Europe;
    - provide in-situ observations and accurate information on Earth's surface characteristics (e.g. topography, land cover and vegetation, temperature, waves, currents, evaporation, ice and snow cover), whether above the sea or land and identify and define the most efficient modelling approach(es) suited for nowcasting and forecasting electromagnetic signal propagation;
    - define a Hypersonic Glide Vehicle and Hypersonic Cruise Missile radiation and scattering model of electromagnetic signals based on an aero-thermodynamic and an electromagnetic plasma model for those threats;

- aim at partial validation of the computational models and the underlying physical assumption (e.g. by reproducing hypersonic flight conditions in a test environment);

- Studies:
  - assess the impact on radar performance (e.g. detection performance, classification of threats, tracking…) linked to anomalous atmospheric propagation conditions, including for new threats;

- Design:
  - design the models required for nowcasting and forecasting radar and electromagnetic signal propagation;
  - conduct tests of the designed electromagnetic propagation model.

In addition, the proposals should cover the following tasks:

- Generating knowledge:
  - assess necessary requirements to establish an accurate signal propagation model over different areas, including marine environements, such as vertical and horizontal resolution requirements of NWP models, refractivity conditions and surface heterogeneity (e.g. for archipelagos, mountains, sea ice) and sea surface properties (e.g. sea surface temperature, waves, sea-ice cover);
  - investigate plasma sheath specifications for the models by estimating hypersonic threat trajectories, e.g. using Artificial Intelligence techniques or others;
  - examine the signal frequency dispertion induced by the plasma sheath;

- Integrating knowledge:
  - investigate a joint observation approach and protocols for supporting and validating the forecasting;
  - assess different options for the transfer of information on anomalous propagation condition forecast to users to adapt it to the available bandwidth;
  - examine and suggest methodologies for using multiple assets to map anomalous signal propagation, e.g. by integrated multi-type radar mapping;
  - investigate signal modulation, such as scale effect and intra-pulse Doppler signal modulation, in presence of objects with hypersonic flight trajectories;

- Design:
  - design requirements for a future joint European electromagnetic signal propagation now- and forecasting tool;

- design requirements for an interoperable European reference observation network providing in-situ data to support electromagnetic signal propagation forecasting.

The proposals may also cover the following tasks:

- Generating knowledge:
  - identify necessary modifications and/or improvements of existing operational weather and ocean models to provide possible variable and boundary fields for assessment of electromagnetic signal propagation;
- Studies:
  - elaborate guidelines to enhance cost-efficiently the performance of existing radar networks used by all military branches in the context of anomalous atmospheric propagation conditions, including for hypersonic scenarios;
  - address the benefits of cooperative and multi-static radar architectures to enhance target detection and tracking in the context of anomalous atmospheric propagation conditions, including for hypersonic scenarios;
- Design:
  - identify the requirements for a European ducting and anomalous propagation forecast message format;
  - based on the defined models, provide recommendations on signal waveforms;
  - provide recommendations on detection, classification and tracking approaches for hypersonic threats and propose innovative solutions.

Functional requirements

The proposed technologies should meet the following functional requirements:

- be based on a solid open-source strategy, for EU Member States and EDF associated countries (Norway), that ensures the possibility to share source code, documentation and executables in accordance with the provisions and the objectives of the EDF regulation and with a licence scheme compatible with further development and commercial exploitation of the results;
- the determination of the frequency and occurrence of sea and land surface ducting and anomalous signal propagation should be based on existing military, marine and weather radars, and suitable sources of signal, e.g. AIS and radio transmitters;
- the meteorological and signal propagation observations should cover all seasons and include the following types of areas: sea surface, land surfaces with different vegetation cover types, and ice- and snow-covered areas;
- the modelling system should be applicable in varying specific circumstances, especially terrain, e.g. environment conditions like topography, surface roughness,

vegetation (height and nature), urban structures, open sea or coastal conditions with varying electric conductivities, waves (height and direction), snow, ice surface conditions;

- the model should be compatible with inputs and outputs of radar performance modules and tactical decision aid (TDA) modules;
- the signal propagation modelling and in-situ observation approach(es) should be wavelength dependent and suitable for the frequency range used by the military radars and for radio communication, covering VHF to EHF (up to at least 20GHz);
- the electromagnetic signal propagation model should take into account realistic conditions, such as land, sea and hydrometeors clutter as well as thermal noise and compute signal-to-thermal noise ratio and signal-to-clutter ratios;
- the signal propagation modelling approach should make optimal use of existing operational weather and ocean models and should be compatible with operational weather and ocean models used by the national (civil / military) operational weather and ocean model service providers, if useful for efficiency gains;
- the electromagnetic signal propagation model should cover a height of at least up to 30km;
- the electromagnetic propagation model should take into account refractive conditions (i.e. modified refractivity profiles including evaporation layer), diffraction (above land and sea), multipath (above land and sea) and hydrometeor attenuation (rain, snow...);
- the electromagnetic signal propagation model should be able to support estimates of the confidence interval of detection and communication ranges, based on uncertainty of atmospheric propagation characteristics;
- should be able to ensure some level of anomalous signal propagation forecasts and nowcasts under conditions where in-situ observations are not available or are unreliable, e.g. by extrapolation of suitable data;
- accuracy, resolutions of the nowcasting and forecasting should meet or outperform the state of the art;
- execution time of the electromagnetic propagation model should be compatible with modern multi-mode radars (e.g. less than few seconds for 400x400 altitude distance spatial grid for one radar mode), even without implementation on a GPU;
- the forecasting of ducting should cover time ranges at least up to 36h;
- the nowcasting and forecasting should include estimates of the generic communication distances, surveillance radar detection ranges and confidence interval of detection and communication ranges;
- the forecasting should give predictions of changes of propagating conditions.

Expected impact

The outcome should contribute to:

- providing a vital tactical advantage to the military performance of EU Member States and EDF associated countries (Norway) by improving the joint enhanced monitoring and situation awareness capability including with respect to stealth and hypersonic targets, the capability for stealth operations, the usage of Unmanned Aerial Vehicles and the performance of self-defence systems;
- the reduction of resources duplication and creation of collaborative long-term tactical advantages for the armed forces of EU Member States and EDF associated countries (Norway) by a reduction of the fragmentation of current methodologies;
- the overall improvement of resilience of communication methods for military and civil applications;
- supporting mission planning and strengthening hypersonic defence capabilities, amongst other through hypersonic system performance forecasting;
- the strengthening of the competitiveness of European radar and military communication industrial and technological base.

2.1.2. EDF-2023-RA-SENS-OPTD: Optronics detector technologies

- **Indicative budget:** EUR 20 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

The domain of infrared (IR) detectors encompasses a variety of technologies that operate in different spectral bands for a variety of applications. IR detectors are key elements to increase detection/recognition/identification (DRI) ranges of sensors and thus improve the global efficiency of the system with respect to situational awareness and targeting. Passive systems based on high-performance electrooptical (EO) thermal imaging are mandatory for realising these advantages under stealth conditions. IR thermal detectors usually operate either in the mid-wavelength (3-5µm[2], MWIR) or in the long-wavelength (8-12 µm[1], LWIR) atmospheric window.

For armed forces, sensor systems with maximised detection, recognition and identification ranges are key to prevail on the battlefield. In the naval domain, typical applications like surveillance against non-conventional threats require several sensors (active and passive) and visual confirmation is required in many cases. In the land domain, situational awareness in armored vehicles requires sophisticated IR sensors. Soldiers greatly benefit from IR sensors that are robust and comply with size, weight, power consumption and cost requirements (SWAP-C), especially in low visibility conditions. SWAP is also an important requirement for payloads of observation satellites. In the air domain, Missile Warning System (MWS) will

[2] Usually quoted frequency range.

also benefit from progress in IR technology. Similarly, for airborne surveillance, new generation of IR sensors will improve the trade-off between range and field of view.

The specific requirements of demanding military applications often require adapting existing products or developing specific products within the defence community. Several IR detector materials are particularly interesting for defence applications, amongst which II-VI compounds, where European manufacturers are currently able to offer state-of-the-art IR detectors and III-V compounds, which are regarded as possible cost-efficient and performant alternatives. One particular type of detectors are the Type-II superlattice materials, which are made of periodic structures of two III-V compounds (e.g. InAs and GaSb or other combinations). Additionally to the semiconductor material, most infrared sensors necessitate a Read-Out Integrated Circuit (ROIC) to convert the collected infrared light into a corresponding electrical signal. Finally, many IR sensors need cooling technology as, depending on the materials used and the wavelength of the radiation to be detected, high performance IR detectors must commonly operate at low temperatures to cope with the relatively small charateristic infrared energy and in order to achieve an adequate signal-to-noise ratio.

Infrared technology is an important element of Europe's technological sovereignty in key value chains. In this regard, the European defence industrial and technological base faces a threefold challenge in the field of optronic detectors: achieving high performance, maintaining international competitiveness and securing non-dependency of supply chains.

Specific objective

Currently, three domains in European cooled infrared sensors supply chain need further investment in cooperative R&D to answer to those challenges: detector materials, ROIC bumping technology and cryocoolers.

Concerning detector material, Type-II superlattice (T2SL) materials have been identified as a potential alternative to current technologies (like InSb and CMT) in the mid wave infrared (MWIR) range and may also be a viable alternative in the long wave infrared (LWIR) range. They may be usable for bi-spectral / multispectral applications and High Operating Temperature focal plane arrays, be more cost-effective, and also provide for very compact solutions. T2SL based technology may offer very fine pitch and process flexibility needed for future defence applications. T2SL have been under intensive development and promotion in the U.S., Israel and in some European contries. South Korea and China are also becoming very active in this field. T2SL offer in terms of supply chain and eco system remains for the time being poor in the EU and EDF associated countries, despite some already existing competitive fielded products in relevant military programmes. For example, European providers are facing today dependency on non-European suppliers of Gallium Antimonide material substrates (GaSb) and lack an industrial III-V epitaxy source, only available in the U.S.

Concerning the ROIC, critical steps to manufacture such circuits were addressed by the EDF-2021-SENS-R-IRD topic. Complementary activities are necessary on ROIC bumping technology in order to prepare for hybridisation of detection circuits on the ROICs. As defence applications require lower volumes of infrared detectors compared with civil applications, these activities need to be shared by IR manufacturers in Europe.

Cryocooling components needed for cooled infrared sensors must face both high requirements and strong competition from other continents, on a wide spectrum of products (handheld, embedded, airborne high-end). Fundamental technological improvements are necessary for the European cryocooling supply chain in order to remain competitive, both economically and performance-wise. Cryogenics technologies adapted for temperatures higher than 150K, are expected to bring significant gains in power consumption and volume, and will most likely require more efficient cryogenic solutions contributing to SWAP-C improvement.

Scope and types of activities

Scope

This topic aims at consolidating a fully sovereign common supply chain of some critical technology building blocks for the next generation of high performance infrared detectors for defence applications in all battlespace dimensions.

The proposals must address IR detector technologies based on Type-II Superlattice (T2SL) materials, including the necessary competences and know-how to supply large-diameter high-quality substrates to the infrared sensor providers, as well as a corresponding epitaxy process.

The proposals should also address advanced silicon ROIC technology with the objective to develop a common post-processing of future ROICs to prepare them for bumping and bumping technology.

Finally, the proposals must aim to improve the fundamental knowledge of cryocoolers and find innovative solutions in order to improve the performances of European cryocoolers solutions for IR sensors.

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,	Yes (optional)

Types of activities (art 10(3) EDF Regulation)		Eligible?
	including partial tests for risk reduction in an 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

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

- Integrating knowledge:
    - acquire necessary knowledge on substrate production processes, suitable for T2SL detectors;
    - acquire necessary knowledge on epitaxy for T2SL detectors, including epitaxial structure modelling activities, epitaxial structure growth, validation through test chip processing and electrical characterisations.

In addition, the proposals should cover the following tasks:

- Generating knowledge:
    - concerning the aspect of cryocoolers, create a complete thermodynamical model of cryocoolers based on an innovative principle;
- Integrating knowledge:
    - concerning the aspect of ROIC technology, improve the technology of common ROIC bumping process steps (e.g. Under Bump Metallisation and indium bumps) and process flow;
    - concerning the aspect of cryocooler technologies, investigate characteristics of cryocoolers with improved performances with respect to cost, size, weight and efficiency, low vibrations and acoustic noise of cryocoolers;

- concerning the aspect of cryocooler technologies, investigate new materials, concepts, manufacturing technics to improve the thermal transfer internal to the cooler and its interfaces;

- Studies:

  - identify physical parameters and sensors allowing to predict the time-to-failure of coolers and of solutions to provide efficient Health monitoring of cryocoolers;

- Design:

  - design of innovative and improved cryocoolers adequate for T2SL applications and demonstration by partial testing of the designed solutions in a relevant environment.

The proposals may also cover the following tasks:

- Design:

  - validation of substrate and epitaxy processes using sample focal plane arrays;

  - implementation of an IR T2SL detector with high-resolution / small pitch based on the substrate and epitaxy processes investigated;

  - complete testing of the designed solutions in a relevant environment.

In addition, the proposals should substantiate synergies and complementarity with foreseen, ongoing or completed activities in the field of infrared technologies, notably those performed or foreseen in the context of the call topic EDF-2021-SENS-R-IRD[3].

Functional requirements

The proposed technologies should meet the following functional requirements:

- reduction of size, weight, power, and cost;

- the solutions of substrates for T2SL detectors should:

  - be suited for all IR detector providers in the EU and EDF associated countries;

  - be suited for at least MWIR and LWIR wavelengths;

  - address large diameter (≥3''), cost-effective bulk crystal growth;

  - ensure an epi-ready surface preparation that is compatible with imagery requirements (e.g. low dislocation density, high homogeneity, low bow, low warp, adequate doping…);

- the epitaxy solutions for T2SL should:

[3] Infrared detectors (https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/edf-2021-sens-r-ird).

- be suited for all IR detector providers in the EU and EDF associated countries;
- ensure a material quality in accordance with IR detectors requirements (operating temperature for defence applications, suited for at least MWIR and LWIR wavelength bands, high homogeneity and low defectivity on large wafers (≥3'') …);
- ensure an epitaxial stack in accordance with the detector design;

- the ROIC post processing should:
  - be compatible with 300mm Silicon wafers;
  - be compatible with the common bumping process with low defectivity (< 0.05% defects) and high homogeneity;
- the proposed crycoolers solutions should:
  - be compliant with SWAP-C requirements;
  - exhibit vibration and noise reduction for stealthiness;
  - be based on innovative cryocooler models valid for temperatures ranging from 120K to 200K.

Expected impact

The outcome should contribute to:

- improved situational awareness and decision-making thanks to sensors with better detection, recognition and identification performance;
- improved characteristics of infrared detectors, including SWAP-C, available to the armed forces of EU Member States and EDF associated countries (Norway);
- preparation of technologies necessary for a sovereign European supply chain for substrates, epitaxial wafer and ROIC processing for infrared imaging based on T2SL;
- preparation of technologies necessary for a sovereign European supply chain for cryo-coolers adapted to new high performance infrared image sensors based on T2SL technology with improved characteristics;
- improving the competitiveness and innovation capacity of the EDTIB in the field of infrared detectors by providing complementary technological know-how to ongoing efforts and established solutions.

2.1.3. EDF-2023-RA-SPACE-PSA: Threat surveillance and protection of space-based assets

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

Space has become a domain of strategic and military competition. While space capacities have become strategically important to Europe's civil and commercial objectives, and are critical to ensure vital functions in military operations, the easier access to space, the growing number of space debris in orbit and the existence of counterspace capabilities and actions introduce increasing risks and threats to space assets. This implies the necessity to protect European space assets in their outer space environment.

Protection can be achieved by active and passive measures. This includes steps such as anti-jamming protection and other on-board countermeasures. It also includes means to characterise and attribute actions and effects of adversaries to enable satellite operators to restore functions, capabilities, or capacities after a human-made space incident.

Passive protection allows the detection and the characterisation of any attempt and action considered as hostile in order to limit the effects or to propose a counter action.

Considering the increasing threats and hazards towards space-based capabilities, technologies for passive protection of space assets should be developed for a better efficiency, safety and resilience of core missions. Such technologies should in particular address local detection, identification and characterisation of threats and protection mechanisms (including manoeuvres) with a focus on the capability to complement ground-based observations by leveraging on the use of space-based sensors.

General objective

The general objective of this topic is to conduct research activities on space-based technologies contributing to the protection of space-based assets against a wide range of threats and to demonstrate the feasibility of selected technological solutions.

Specific objective

The specific objectives of this topic are to identify and consolidate the potential threats to space assets and an overall preliminary system layout with associated functional chains of the different components (open architecture with interfaces and the possibility to integrate other and legacy systems), to study and select the best promising technologies to counter such threats based on this overall preliminary system layout, and to elaborate the associated technological roadmap as well as to start its implementation on some technological blocks.

In addition, this topic aims at studying the repartition of functionalities between ground- and space-based components to achieve an effective protection of the space assets, taking into account the interfaces with a wider space surveillance network for military space situational awareness: e.g. repartition of the sensors (on-board – as a primary or secondary sensor – or on the ground) and an overall preliminary system layout linked to a command and control (C2) approach to gather data and then elaborate a common operational picture of threats.

Scope and types of activities

Scope

The proposals must address the identification and consolidation of the main threats against generic space assets and associated vulnerabilities, the identification of technical solutions or adaptation of procedures to counter these threats, as well as the definition of the overal

preliminary architecture for the elaboration of a comprehensive approach (satellite, C2 and system layout) to deal with these threats.

The proposals must consider at least the following threats:

- interference, uplink and downlink jamming and spoofing;
- electromagnetic pulse attacks, high-energy lasers and high-powered microwave weapons;
- physical attacks (e.g. threatening objects coming from intended space debris generation, as well as co-orbital and ground based anti-satellite weapons (ASAT)).

The proposals must consider technologies contributing:

- to the detection and identification of the threats, including, but not limited to, anti-satellite weapons and space objects with unexpected behaviour, using data processing for space applications and spectral signature;
- and to the protection of the space assets;

such as:

- passive or active optical sensors, radar sensors, on-board processing for proximity surveillance and tracking, including AI[4]-based on-board elaboration for high-level actionable information extraction from measurements to support autonomous decision-making and manoeuver;
- manoeuvrability to protect platform and payload, including technologies for instantaneous, rapid and agile evasive manoeuvres to escape objects that carry out suspicious/attacking proximity maneuvers;
- technologies to protect satellite communication resources and C2 activities access from unwanted usage;
- electronic support measures (ESM) sensors for space assets;
- protection against high-energy laser, electromagnetic pulse attack and high-power microwave (HPM) weapons;
- technologies allowing various level of autonomy and generation of preprocessed information for data volume reduction during transmission to ground.

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,	Yes

[4] Artificial intelligence.

Types of activities (art 10(3) EDF Regulation)		Eligible?
	which can achieve significant effects in the area of defence (**generating knowledge**)	(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 (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

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

- Generating knowledge:
    - the identification and analysis of current and expected threats against space assets and evaluation of associated vulnerabilities;
- Studies:
    - the consolidation of technological solutions to address these threats, their technology readiness level (TRL), the performance required and the evaluation of their interest/operational added value;
    - the elaboration of a technological roadmap at equipment level to further develop the best promising technological solutions;

- the analysis/study of the space system protection architecture (including ground control) to propose solutions trade-off in order to answer to each identified threat (e.g. dedicated satellites, on-board payload integrated in satellites as a secondary mission, inter-satellite links, impact on the ground segments);
- the analysis of the integration constraints of each technological block (e.g. SWaP[5] requirements, class of satellite platform on which it is integrable).
- the development of an overall and preliminary system layout, based on the threat analysis. The system layout must address the operational use of identified self-protection solutions and include:
  - the operational scenarios to be taken into account;
  - the level of automation of the technical solutions;
  - the data needed at C2 level to contribute to the monitoring of the space situation limited to the threatened space asset and counteraction;

- Design:
  - the definition and design of selected technological blocks (sensors, on-board processing and passive counter actions). A layout as hosted payloads for big satellites and small satellites as well as a single payload for dedicated "protection" small satellites must be considered for each proposed technological solution;
  - the risk reduction tests/demonstration of these technological blocks.

In addition, the proposals must substantiate synergies and complementarity with foreseen, ongoing or completed activities in the field of Space situational awareness (SSA), notably those performed in the context of the call topics EDIDP-SSAEW-SC2-2020[6] and EDIDP-SSAEW-SSAS-2020[7], or foreseen in the context of the call topic EDF-2023-DA-SPACE-SSA[8].

Functional requirements

The technologies for space asset protection should meet the following requirements:

State of the art of the threats: ability to detect, to identify and to mitigate a wide range of threats (see Scope section above) in terms of power, origin and destination (e.g. LEO[9] to LEO, ground to LEO, GEO[10] to GEO, ground to GEO).

On-board autonomy:

[5] Size, weight and power.
[6] Advanced Space Command and Control (SC2) capability to process and exploit SSA data generated from sensors and catalogues to provide a complete space picture (edidp_call-texts-2020_en.pdf (europa.eu)).
[7] Enhanced SSA sensors for accurate identification and characterisation of existing Geostationary Earth Orbit (GEO) and Low Earth Orbit (LEO) public and private assets (edidp_call-texts-2020_en.pdf (europa.eu)).
[8] Initial operational capacity for Space situational awareness C2 and sensors (cf. section 2.5.8.).
[9] Low Earth Orbit.
[10] Geostationary Earth Orbit.

- enable autonomous extraction of actionable information from the captured imagery/data including through AI-based techniques (see Scope section for examples of sensors and technologies);
- enable autonomous decision-making to implement safety procedures on the satellite and/or payload, including manoeuver execution and mission operation rescheduling (see Scope section for additional examples of targeted mitigation measures).

Space-to-ground efficiency: the transfer of data should minimise the impact on the primary missions.

Feasibility of integration in space assets: adaptability to various space platforms (EU, Member States and EDF associated countries (Norway) assets) taking into account the technological constraints linked to the integration of secondary missions on space assets (cost, volume, energy…).

Expected impact

The outcomes should contribute to:

- the development of technological components that will have a major impact on the detection and identification of threats and protection of space assets;
- the development of technological solutions against space threats;
- the future integration of the developed components in Member States and EDF associated countries (Norway) solutions and in European programmes space assets;
- the resilience of space systems and a better space domain awareness associated to the protection of space-based assets;
- EU approaches regarding "Defence in Space".

2.1.4. EDF-2023-RA-DIGIT-HAAI: Dedicated hardware architectures for energy-efficient AI

- **Indicative budget:** EUR 20 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

Artificial Intelligence (AI) is becoming increasingly important for most defence capabilities. However, the energy consumption of AI implemented on classical processors limits its practical usage, especially for embedded systems and edge computing. Indeed, existing processors are far from optimal for most AI applications in terms of efficiency and energy consumption, due to their architecture (digital representation of information, separation of memory and computing). While this issue has been overridden for decades by the steady technological progress of these processors in terms of miniaturisation and performance following Moore's law, this trend is reaching its limit, and the need to move to dedicated architectures is coming to the fore.

In particular, moving from digital to analog computing has the potential to improve computing in terms of speed and/or energy-efficiency by several orders of magnitude (expectedly by a factor of at least thousands). Furthermore, it can benefit from the increasing versatility of artificial neural networks to address a variety of AI applications. In addition, it offers enhanced security by coding the information in a way that strongly limits information leaks, as this information is deeply intertwined with the processing hardware. Besides, sensing functionalities can be integrated into analog processors to produce very low power consumption smart sensors or to increase the frequency range of radiofrequency signals that can be processed.

In addition, this is an emerging technological domain within the field of processors where competition is relatively open and where there is an opportunity to build on European competencies.

The goal of the topic is thus to create new types of processors for AI that offer very significant performance gains for defence applications, and to develop European supply chains offering a technological autonomy for these technologies.

Scope and types of activities

Scope

The proposals must address research on new hardware architectures for AI that offer very significant gains in term of power consumption, processing speed and latency, as well as in terms of size, weight and cost. Any type of architecture deemed suitable to address the objectives may be investigated (e.g. magnetic tunnel junctions (MTJ), memristors, in-memory computing, etc., possibly combined with other relevant hardware and software technologies in hybrid architectures).

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)
(d)	**Design** of a defence product, tangible or intangible component or technology as well as the definition of the technical	Yes

Types of activities (art 10(3) EDF Regulation)		Eligible?
	specifications on which such design has been developed, including partial tests for risk reduction in an industrial or representative environment	(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

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

- Studies:
    - study of new processing architectures and their physical implementation;
- Design:
    - design and small-scale fabrication of such innovative processors;
    - integration in technology demonstrators, and measurement of performances on AI data and tasks relevant for defence applications.

The proposals should describe how synergies and complementarities with activities funded by other sources of funding, including civil ones such as Horizon Europe, are sought and maximised.

Functional requirements

The proposed solutions should meet the following functional requirements:

- They should offer very significant gains over classical hardware architectures in terms of computing power (speed and/or energy efficiency) and compactness (size, weight and cost), including for complete systems (e.g. including thermal dissipation management). The gains are expected to be of several orders of magnitude. The proposals should clearly describe and justify the expected gains;
- These gains should be measured on well-identified defence AI use cases, with clear metrics and on data sets that are representative of military mission profiles. The proposals should describe clearly these use cases, metrics and data. They should also

describe how the absence of bias in the measurements and comparability with state-of-the-art approaches can be ensured;

- Solutions addressing the detection and recognition of radiofrequency signals should address frequencies up to several tens of GHz.

Expected impact

The outcome should contribute to:

- the ability to integrate high-end AI features into various embedded defence equipment while offering reasonable battery life and at a reasonable cost;
- enhanced security of AI-based systems;
- strengthened European supply chains and technological autonomy in the domain of high-efficiency computing and processors for AI.

2.1.5. EDF-2023-RA-PROTMOB-DEXPLO: Demonstrators and technologies to defeat threats posed by Unexploded Explosives Ordnances (UXO) and Improvised Explosive Devices (IED)

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

In the context of a changing geopolitical landscape, Member States and EDF associated countries (Norway) armed forces are facing new and evolving threats encountered in asymmetrical and potentially in symmetrical operational situations. This is the case of IED[11] (subsurface, surface, directional/side attack; suicide person- and vehicle-borne) and UXO[12] (bombs, shells, grenades, land mines and cluster munitions), which entail a significant hazard for military personnel, critical infrastructures and equipment in both urban and out-of-area operations. Obtaining effective countermeasures (detection and mitigation) against these threats is therefore essential to improve force mobility and freedom to act, by increasing the security in operation areas.

[11] Improvised Explosive device (IED): a device placed or fabricated in an improvised manner incorporating explosive material, destructive, lethal, noxious, incendiary, pyrotechnic materials or chemicals designed to destroy, disfigure, distract or harass. They may incorporate military stores, but are normally devised from non-military components (Source: IMAS 04.10 Second Edition, Amendment 10, February 2019). Note: an IED may meet the definition of a mine, booby trap, and/or other type of explosive ordnance depending on its construction. These devices may also be referred to as improvised, artisanal, or locally manufactured mines, booby traps, or other types of explosive ordnance.

[12] Unexploded Ordnance (UXO): explosive ordnance that has been primed, fused, armed or otherwise prepared for use or used. It may have been fired, dropped, launched or projected yet remains unexploded either through malfunction or design or for any other reason. (Source: IMAS 04.10 Second Edition, Amendment 10, February 2019). This term includes explosive weapons such as bombs, shells, grenades, mines and cluster munitions.

An important challenge of counter-IED, and UXO capabilities lies in the fact that the threat evolves constantly (e.g. IED systems carried by UAVs[13], or IEDs using frequencies that are not yet addressed by our electronic counter measure (ECM) equipment/systems, etc.). As a consequence, our systems need to be adapted accordingly to remain up-to-date with these evolutions, while keeping up compatibility with the operational use (not requiring a high level of expertise) and the rhythm of the manoeuvre.

This research topic aims at developing technologies to defeat the threats posed by explosive ordnance (UXO and/or IED), in complex and diverse environments within the military domain.

Specific objective

The main objective of this topic is to prepare a next generation of explosive hazards countermeasures (equipment, materials, etc.) using innovative technologies in order to perform the following functional tasks:

- threat detection (including identification, classification and data fusion) - Rapid and improved (e.g. remote or stand-off) detection of buried or hidden UXO/IED, including threat identification and classification, including area monitoring for the presence of explosive threats. Sensor fusion to achieve a more reliable output is considered under this topic, as well as the use of UAV/UGV[14] for remote detection;

- threat investigation - Following the UXO/IED first alert, obtained either by means of device/explosive detection or from a suspicious behaviour/event, the confirmation of it being a real or false alarm may be necessary. Technologies for threat investigation operations are considered in this topic (e.g. land digging by specialised UGV);

- neutralisation and disposal;

- decoying;

- electronic counter measures;

- breaching.

This topic will contribute to studies aiming at maturing innovative technologies in order to overcome current and new threats (UXOs and/or IEDs).

Scope and types of activities

Scope

The proposals must focus on the research of new technologies and adaptations of existing technologies addressing the above-mentioned counter-IED/UXO functional tasks, including (but not limited to) the following technologies:

- threat detection: visible/infrared (IR) imagery, laser, integration of electro-optical (EO)/IR passive (including hyper/multispectral) and active (LIDAR[15]) sensors, integration of non-linear junction detection, wire detection, change detection, radar

[13] Unmanned aerial vehicles.
[14] Unmanned ground vehicle.
[15] Light detection and ranging.

(GPR[16], SAR[17]), terahertz imager, artificial intelligence (AI) techniques, IMS[18], DMS[19], LIF[20], gamma detection, fluorescent nanoparticles, etc.;

- threats investigation: camera, laser, tools;
- neutralisation and disposal: high-energy weapons (laser beams), high-power electromagnetic (HPEM) beams, chemical desensitisation of explosive materials, among others;
- decoying: mass, mechanical, magnetic, heat (IR);
- ECM: evolutions for ECM systems (innovative antennas, e.g. planar, ability to characterise signal in order to avoid interference to friendly Electronic systems including friendly ECM systems...);
- breaching: evolutions for tools, energetic materials and machinery (hand, mechanical or explosive or combination of those) to create safe passage through obstacle (landmines, minefields).

The compromises cost/performances and lifetime/recyclability must be highlighted. The technologies used should be without end-user restrictions by non-associated third countries.

The proposals must substantiate synergies and complementarity with foreseen, ongoing or completed activities in the field of the technological challenge on hidden threats detection *Unmanned ground and aerial systems for hidden threats detection* (EDF-2022-DIGIT-R-HTP-P and O), as well as to the development topic *Mine counter-measures capabilities* (EDF-2023-DA-UWW-MCMC), or in the context of the EDA activities conducted.

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 aimto 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)

[16] Ground penetrating radar.
[17] Synthetic aperture radar.
[18] Ion mobility spectrometer.
[19] Differential mobility spectrometry.
[20] Laser-induced fluorescence.

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

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

- Generating knowledge:
    - RCIED[21]: research innovative jamming techniques for remote-controlled IED;
    - (S)PBIED[22] and (S)VBIED[23]: research sensor technology for standoff detection and neutralisation of person- and vehicle-borne IED including suicide PBIED and suicide VBIED;
    - countermine: research sensor technology for standoff detection, methods and techniques for decoying and effectors for neutralisation of surface, subsurface and directional landmines;
- Integrating knowledge:
    - research and compare several multisensor data fusion (algorithms) concepts for RCIED, (S)PBIED and (S)VBIED with synthetic and real sensor data;
    - provide the requirement needed to integrate the equipment on a military platform (size, weight, power...);
    - evaluate the impact of the C-IED equipement on the other system that could already be integrated (radio, sensors...) on a military platform;
- Studies:

[21] Radio Controlled Improvised Explosive Device.
[22] (Suicide) Person Borne Improvised Explosive Device.
[23] (Suicide) Vehicle Borne Improvised Explosive Device.

- define a realistic military scenario with the generated and integrated knowledge, taking into account both IED and UXO threats; RCIED, (S)PIED and (S)VBIED have to be included;
- feasibility studies on choosing specific sensors and effector sets for the three threat scenarios IED, landmines and UXO;
- feasibility studies on operational time criticality of IED and landmine scenarios and expected capability gain;

In addition, the proposals should cover the following tasks:

- Design:
  - design of a threat (IEDs, landmines, UXOs) detection, classification and signaling system, preferably using unmanned systems;
  - design of a system to neutralise, deactivate or disrupt threats (IEDs, landmines, UXOs), preferably using unmanned systems;
  - design of low cost, small size and easily replaceable UGV systems for threat manipulation (IEDs, landmines, UXOs).

In accordance with the maturity of the technology under study, the proposals should also include:

- state-of-the-art technologies offering opportunities to respond to the different counter explosive threats functions listed above in the scope section;
- research of innovative technologies offering opportunities to respond to the different counter explosive threats listed above in the scope section;
- demonstrations of the feasibility to use the technologies developed for counter explosives threat purposes, in different scenarios;
- evaluation of the performances of demonstrators in relevant environments.

Functional requirements

The proposed technologies should meet the following functional requirements:

- ability to detect and map threats (IEDs, UXOs and landmines) in a given area, with maximum accuracy;
- ability to classify threats, with maximum accuracy;
- ability to investigate and identify threats, including with the support of AI;
- ability to neutralise and dispose of threats;
- ability to decoy threats;
- ability to jam threats;
- ability to breach an obstacle with the help of hand, mechanical or explosive means or a combination of such means;

- ability to be used in an operational environment with IEDs, UXOs or landmines.

The performances associated with these technologies should be measurable through evaluation campaigns conducted in the framework of the present project, using shared protocols and metrics.

Demonstrators should be able to record the data acquired through their sensors, in order to enable reproduction of experiments and comparison of technologies in a simulated environment.

Expected impact

Thanks to the studies validated through demonstrators and field experiments, the following impacts should be delivered:

- significantly improve counter-mine IED and UXO technologies to deal with new and evolving threats;
- facilitate the development of new technologies that each Member State, EDF associated country or industry partners cannot achieve easily on its own;
- reduce the development time of counter explosive threat solutions;
- contribute to increasing the industrial cooperation and integration between European defence companies and SMEs;
- contribute to the strategic autonomy of the EU.

2.1.6. EDF-2023-RA-PROTMOB-SATOC: Strategic air transportation of outsized cargo

- **Indicative budget:** the EU is considering a contribution of up to EUR 20 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

Strategic Air transport for Outsized Cargo (SATOC) is a core capability for the rapid projection of military capabilities over long distances and mission support worldwide. All operations carried out so far have always had to fall back on this important capability for deployment and subsequent sustainment. Beyond their military role, SATOC aircraft are also key assets for providing better civilian support for EU-internal needs, including critical and essential contributions to immediate logistic support over large distances, disaster relief and fast general crisis response. However, there is currently no adequate service provider who has the appropriate capability to meet the needs of the Member States and EDF associated countries (Norway). Therefore, this topic proposes to study the possibility of a future aircraft development or the acquisition of an appropriate contractor support.

Specific objective

“Strategic airlift requirements and strategic airlift, notably of oversized cargo, have been provided almost entirely by third countries, creating a critical dependency for the EU. The Russia-Ukraine war has significantly reduced the ANTONOV logistics fleet. This has created

a looming strategic capability gap in the upcoming years with no clear solutions for a replacement. In addition, a certain degree of uncertainty about the supportability of the remaining fleet constitutes a significant factor. This is true in particular with respect to the availability of replacement parts and replaceable units as well as the availability and integrity of design information, should, for example, new structural issues arise.

In order to preserve European sovereignty and enable global force projection, it is critical to establish a strategic airlift capability by either re-designing / adapting an existing or developing a new solution.

Furthermore, from a European perspective it is of vital importance to underline the fact that strategic airlift capability is not exclusively restricted to military purposes, but is also an asset in various crisis scenarios as well as on humanitarian aid missions.

Scope and types of activities

Scope

Based on the Member States and EDF associated countries (Norway) requirements, the objective of this topic is to explore the range of options towards creating a new European SATOC capability. The proposals are to identify, define, and evaluate short-term and lasting strategic airlift solutions. More precisely, the study must map the individual solutions against their respective parameters such as economic or military performance and availability. The study is expected to not only assess re-design options of various existing aircraft and civilian outsized cargo solutions, but also to identify development options, resulting in possibly two different life-cycle timeframes. Furthermore, the platform solutions must also be evaluated in various possible operating schemes, including either the full acquisition of aircraft and/or the provision of services, while taking into consideration the respective certification (military vs. civilian) aspects. It is understood that SATOC will play a support role and not a combat/in-theatre role. The study may involve the identification of potential economies of scale through parallel civilian and military applications (dual-use) of the chosen solution in an effort to reduce the overall development and operating costs associated with a small fleet. The study is to address a possible future operation and service provision from a common military (e.g. NATO's AWACS[24] base, MMF[25] base) or civilian hub.

The proposals should draft conceptual assessment of options able to achieve initial and possibly partial capability in the short term, and a full capability in-service solution in the next decade. However, the timeline can be accelerated if deemed necessary to meet the requirements of EU Member States and EDF associated countries (Norway). The scope might well consist of a staggered two- (or multi-) fold approach, for example:

- Solution A: desired solution with desired capability and clearly defined IOC/FOC[26]; required to have maximum life cycle;

- Solution B: (interim) solution with less than desired capability and no clearly defined IOC/FOC; required to be supportable and to have a life cycle enabling operations until FOC is reached.

[24] Airborne Warning And Control Systems.
[25] Multinational Multi-Role Tanker Transport Fleet.
[26] Initial Operational Capability / Final Operational Capability.

Nevertheless, the key element of this topic will be to establish the feasibility of the common European requirements for this capability, aiming for unity of effort among Member States and EDF associated countries (Norway) in order to create a single platform. This will maximise the cost efficiency of SATOC and also create a basis for interoperability, at least among the Member States and EDF associated countries (Norway).

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)
(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

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

Technical studies:

- analysis of the requirements of the Member States and EDF associated countries (Norway) and its translation into potential solutions;
- identification of possible solutions – both short- and long-term – (technical modifications on existing solutions or developments of new solutions) or combination of solutions to best meet the desired capability;
- studies, such as feasibility studies to explore the feasibility of new or improved technologies, products, processes, services and solutions;
- pre-design, including pre-definition of technical specifications and partial tests for risk reduction;
- feasibility analysis of each solution or combination of solutions;
- evaluation of achievable performances and response to operational needs (partially or totally) of each solution or combination of solutions;
- preliminary life cycle analysis.

Operations studies:

- support the drafting of CONOPS for each proposed solution;
- Identification of logistic solutions (in-service support).

Programme studies:

- market analysis to quantify demand across European nations, and export-potential analysis, including civil dual-use applications, and, accordingly, description of the capability. Identification of the potential specific military features of the proposed solutions and analysis of their impact on a potential dual-use civil commercial activity and on profitability;
- definition and analysis of procurement and sustainment models (for example the renting of a flight-hours contingent or the acquisition of the capability), deployment possibilities and associated proposal by an industrial organisation;
- impact of the proposed solutions on infrastructure;
- establishment of the programme schedule, IOC and FOC target dates and pre-development plans;
- conduct of an economic analysis (global cost analysis);
- identification and analysis of risks, including SWOT analysis, related to technical issues, market, implementation, costs, schedule, organisation, operations, maintenance, safety, sovereignty, production and disposal;
- preliminary requirement reviews for each assessed option or combination of options to confirm technical feasibility and programmatic industrial and market impact of the proposed solution to allow the Member States and EDF associated countries (Norway) to assess all elements and identify a preferred option which must be carried forward through a development, manufacturing, and certification phase;

- proposition of the best solution (which could be for example a combination of short-term partial-capability and long-term full-capability solutions), including platform acquisition vs. service provision.

In addition, the proposals should cover the following tasks:

Generating knowledge:

- use of new materials in view of weight reduction and performance increase (composite, hybrid, multifunctional materials, with advanced production technologies);
- use of technologies towards lower or zero emission production and operation;
- application of integrated design and production methods based on the platform's dynamic digital twin concept, to be used in all phases of the platform's life cycle (not only design and construction, but also use, maintenance and dismiss);
- definition of an Integrated System Health Management (ISHM) system to be applied to the platform for an efficient and high availability management of the life cycle and an increase in the overall safety of the aircraft;
- assessment of the integrated survivability characteristics of the platform (also considering the use of physical and electronic deterrence technologies) with respect to the threats identified within the different scenarios defined in the CONOPS.

Functional requirements

The proposed deliverables should fulfil the following common requirements:

- competitive overall flight hours in line with current market solutions (recurring and non-recurring costs);
- ability to transport oversize/overweight loads that do not fit in existing solutions (without significant maintenance act);
- flexibility to operate on different logistics missions (compatible with pelletised cargo);
- ensure fast (with limited turnaround time and limited footprint) and self-contained (autonomous, e.g. roll-on/roll-off or on-board-installed) handling of transported goods (also consider existing/future EU multimodal logistics hubs). This should include:

  A) equipment like armoured vehicles, heavy transport helicopters (considered as routine cargo), RPAS[27];

  B) main battle tanks (considered as exceptional cargo, potentially loaded with support of dedicated external equipment, excluding cranes);

- include the transport of goods of all kinds, including dangerous goods as specified by (but not limited to) ICAO TI[28] / IATA[29] Dangerous Goods Regulation (DGR) and optionally forbidden;

[27] Remotely Piloted Aircraft Systems.
[28] International Civil Aviation Organization Technical Instructions.
[29] International Air Transport Association.

- ensure worldwide operations in accordance with all international and national air traffic regulations for all airspaces.

Expected impact

This outcome should contribute to:

- establishing EU autonomy for SATOC;
- EU technological sovereignty and strategic autonomy;
- improving European deployment and sustainment capabilities on a global scale.

2.1.7. EDF-2023-RA-DIS-LDEW: Laser-based directed energy weapons

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2023-RA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

Threats of various kinds are growing (traditional as well as low-cost, swarming or proliferating targets), in asymmetrical conflicts as well as in more conventional high-intensity warfare. Moreover, a sovereign, highly precise, agile and graduated response against conventional and unconventional threats is a must-have for the European end-users.

Recent developments show that Laser-based Directed Energy Weapons (LDEW) systems have the potential to be a game changer on the battlefield, particularly when facing evolving conventional and unconventional threats where there is an emerging need for highly-precise, targeted and agile weapon systems. LDEW systems could provide a cost-effective answer to all these capability needs.

Investing in LDEW technologies is paramount in order to bring High Energy Laser (HEL) weapons closer to an end-user uptake in the medium term, and to provide sovereign capabilities with a European supply chain.

Specific objective

Ongoing EU-funded research (with a dedicated call in PADR 2018[30]) paved the way to the design and build of an EU high-power laser effector to be integrated in military systems once mature.

However, the limited budget available under PADR constrained the TRL increase. Hence, some further research activities should be performed in order to increase the level of maturity of some of the most critical LDEW technologies and subsystems to ensure strategic autonomy and security of supply in this critical domain.

In particular, the development of a future LDEW capability requires to address specifically:

a) operational challenges. Laser weapons must be able to operate safely and efficiently in two different categories of use cases:

[30] Call – Effects - PADR-EF-2018.

(1) Use case type 1: easy targets such as NATO class 1 UAV, ground robots, antennas, radars must be neutralised within a populated environment, which requires a low probability of collateral damage.

(2) Use case type 2: more difficult targets such as fast boats, NATO class 2 UAVs, unmanned surface vehicles (USVs), rocket, and missiles must be neutralised within an open field environment.

Those two-type scenarios induce the challenge for a broad approach that covers:

- a first situation with moderate power [5-20kW] and intrinsic limited collateral damage probability, especially associated with an eye-safer wavelength;

- a second situation with high power [50-100kW] capacity associated with moderate SWaP[31].

b) technological challenges.

(3) Coherent beam combining is one of the challenging parts of high-power generation for laser weapons. This technological part is a major contributor to the complexity and volume of the laser weapon architecture as well as to the long times observed in all the development roadmaps on both shores of the Atlantic Ocean. The European HEL strategies and technological basis rely on solid-state lasers, mainly fibre lasers, and amplifiers. This leads to the main challenge of mastering a European combination technology that allows compact and rugged addition of laser power. The capabilities sought for combination should be compatible with established 1µm wavelength and other safety re-enforced wavelengths.

(4) Propagating of a high-power beam within the laser system while minimising thermal distortions.

(5) Increasing power density on target through higher quality fine tracking and pointing.

(6) Maximising operators and third parties safety.

(7) Compensating atmospheric detrimental effect.

(8) Making 1µm narrow bandwidth amplifier and relevant component industrial sector accessible to EU and EDF associated countries (Norway) stakeholders and implemented in the EU and EDF associated countries.

(9) Making 2µm narrow bandwidth amplifier and relevant component industrial sector accessible to EU and EDF associated countries (Norway) stakeholders and implemented in the EU and EDF associated countries.

(10) Designing a compact laser system optimising SWaP.

(11) LDEW integration and compatibility with the hosting platform in full harmonisation with other on-board armaments and without compromising the platform's mobility.

Scope and types of activities

[31] Size, Weight and Power.

Scope

HEL weapons need to highly concentrate light energy on designated targets to defeat incoming threats. The laser beam must dwell and remain focused on target during several seconds, after having propagated through a turbulent atmosphere. Moreover, it should be possible to repeat this action as many times as needed to achieve the desired effect and address all incoming threats.

Hence, the proposals must address in priority:

- beam combining techniques;
- development of laser sources, allowing significant output power increase;
- shaping and propagation of the beam;
- fine tracking and pointing;
- electrical and thermal management.

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 (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

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 cover at least the following tasks as part of the mandatory activities:

- Generating knowledge:
    - the effects of high-energy lasers on the considered targets need to be assessed, including the effect of simple countermeasures such as protective coatings. This will allow the LDEW system sizing to be tailored to the need and the end-users to determine how LDEW will be used on the battlefield;
    - the proposals must include an assessment of the capability of a HEL effector to defeat the considered targets, with particular reference to the two above-mentioned use cases (see "Specific objective"): range of effect and neutralisation time, with respect to laser power and atmospheric conditions;
    - an analysis of the failure modes of these targets and a characterisation of the possible types of effects must be provided. This analysis will require the development of performance models.
- Integrating knowledge: LDEW require both quite high power and high beam quality in order to reach high brightness laser beam. These two characteristics are essential to obtain high optical power density on target and produce the desired effects. Whatever the considered emitted wavelength, fibre lasers are limited in power to a few kW. In order to obtain a laser beam of tens or hundreds of kW, it is necessary to combine elementary laser beams into one output beam.
    - different kinds of combining techniques must be considered: coherent and incoherent. The proposals must consider the various possible combination solutions and identify those which will be investigated in the study;
    - the following criteria must be used:
        - power increase potential;
        - availability of European components;
        - global efficiency of the combining method;

- compacity (SWaP optimisation);
- industrialisation capacity of the technology.

- Studies:
  - one or several of the above-mentioned combining technologies must be matured during the study. A demonstrator combining several high energy laser beams must be included in the proposals. The objective is to reach TRL 5;
  - by a proper choice of wavelength, intrinsic low collateral laser damage low bandwidth amplifier must be scaled in power. The proposals must assess the possibility of developing European high power components at the considered wavelengths;
  - a roadmap for the two use cases must be given in the study, taking into account possible operational updates given lessons learned from recent conflicts. This roadmap will propose to reach TRL 8 in a few years with a power up to 100kW class. An outline of the roadmap should be included in the proposals.

In addition, the proposals should address the following tasks:

- generating knowledge on other types of lasers, especially on solid-state lasers, such as advantages and viability of novel and scalable laser sources and short or ultrashort pulse lasers;
- an assessment of the capability of a HEL effector to defeat targets that have employed reasonable contermeasures that do not influence the perfomance of the system significantly or lead to largely increased cost;
- propose technical solutions for the optics able to transport and to shape the laser beam in a HEL system. Large optics for laser beams having high energy should be considered. Laser damage threshold and minimisation of thermal distortion of the optics should be addressed;
- design and demonstrate a fine tracking system able to accurately track [<5µrad] a large variety of targets;
- address the measurement and correction of atmospheric perturbations;
- design solutions or rules providing safe use of the laser effectors in their operational environments. Different operational scenarios could be considered, inducing different technical solutions and different operating rules to address the safety of the high energy laser effector;
- design and demonstrate European high power 1µm and 2µm laser sources meeting the specific needs of the laser effectors and enabling a large access to EU and EDF associated countries (Norway) stakeholders. Development of critical laser components not currently available in the EU or EDF associated countries (Norway) should be considered.

Functional requirements

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

- optimise the power density of the laser beam on target in order to reduce the neutralisation time and to be able to address harder targets, such as targets with protective surface treatments and RAM;
- optimise the operational range of the high energy laser;
- optimise the SWaP of the high energy laser and integration of the HEL effector on different platforms (ground vehicles, ships);
- address the safety of the HEL by technical solutions and by rules for the operational use;
- provide a demonstration of laser combining at 1µm for HEL effector. Integrability of the combining system and the HEL effector on various platforms and resistance to associated environments should be taken into account and analysed;
- mature and test a high power laser source (oscillator and power amplifier) adapted to combination and atmospheric propagation, which limits potential collateral damages.

Expected impact

The outcomes should contribute to:

- increasing maturity of the critical technological blocks of an LDEW and prepare the development of an operational demonstrator. As above mentioned, the objective is to reach TRL 5;
- providing European solutions for these blocks, and especially a secured supply chain;
- providing EU Member States and EDF associated countries (Norway) armed forces with an operational capability in the medium term to fill capability gaps. This capability will allow to address the two types of scenarios identified by EU Member States and EDF associated countries (Norway) end-users, and ensure operational safety;
- a strong and more competitive and technologically independent EDTIB and enhance cross-border cooperation (from large industrial groups to SMEs) in a high-tech sector;
- European technological sovereignty and strategic autonomy.

2.2. Call EDF-2023-RA-SI

The objective of this call is to spin-in results generated in other civil EU-funded programmes to the defence sector. The aim is to encourage cross-fertilisation of the civil-defence innovation landscape. Furthermore, it encourages proposals to drive forward and integrate results from other sectors, combining them with defence-specific solutions.

This will enhance the overall EU R&D efficiency, avoid unnecessary duplication of R&D efforts, improve defence industrial innovation capacity and make sure the armed forces will have access to the most performant solutions.

- **Targeted type of actions:** Research actions.
- **Form of funding:** actual costs grants following the call for proposals.
- **Targeted type of applicants and activities:** any eligible consortium as defined in Articles 9 and 10(4) of the EDF Regulation. The proposals need to build upon or integrate results that have been achieved within one or several projects funded under an EU programme call with a focus on civil applications. This(these) previous project(s) may be completed or may still be active. The submitting consortium does not necessarily need to include the participants or result owners 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:** the European Union is considering a contribution of up to EUR 59 000 000 to support the following 3 call topics:

2.2.1. EDF-2023-RA-SI-CYBER-ASPT: Automation of security penetration tests

- **Indicative budget:** EUR 14 000 000 for this topic under the call EDF-2023-RA-SI.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

Cyber defence applications are in most cases relying on cybersecurity technologies. There are many actions in the civil domain on the automation of penetration test. However, due to the particular conditions of defence-related use-cases, civil technologies need to be adapted, further improved or combined with defence-specific technologies through additional R&D efforts to make them suitable for defence applications. This research topic aims to overcome defence-specific obstacles associated to the automation of penetration tests, and at least partially automate the process by developing a user-friendly software solution that performs network security penetration tests for cyber defence actors.

General objective

Vulnerability scanners and various policy audit tools are available to system administrators today. However, the use of such tools are not sufficient to protect computer networks against advanced threat actors and internal threats. To complement them, many organisations employ penetration testers who actively try to think as a threat agent and compromise computer networks. Penetration testers can be used for many different purposes. For example, they can be assigned the task of verifying a system administrators hypotheses concerning a vulnerability in the computer network, to identify vulnerabilities missed by scanners and administrators, or to act as a red team that test the security operations centre of an organisation.

Specific objective

To emulate the thinking and actions of a real threat agent is difficult, and is even more complex as the capabilities of likely threat agents increase. Consequently, competent penetration testers are scarce and to regularly run penetration tests is associated with considerable costs. A number of conceptual attempts have been made to automate this process, e.g. by modelling the process as hidden Markov model and train models on

theoretical/artificial data. However, security audits and penetration tests involve many activities that are non-trivial to automate.

Scope and types of activities

Scope

The proposals should adress research that is based on use cases where the system owner administrates the penetration tests. Thus, non-cooperative computer networks are outside the scope of this topic. For instance, the use cases can include a) whitelisting of payloads in antivirus software, or b) release of initial information about the targeted network to the penetration testing systemis. The expected scope is to create a user-friendly software solution that performs network security penetration tests. Interference on deployed systems should be on a minimal/acceptable level, while simultaneously leaving a realistic imprint in the systems, as security logs, etc. Furthermore, the final outcome of the proposals should be suitable for the context of military security operation centres (SOC) and evidence of this should be provided 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 (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

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 cover at least the following tasks as part of the mandatory activities:

- Generating and integrating knowledge and studies:
    - automation of tasks performed by penetration testers. For example, network/vulnerability tests, security misconfiguration tests, identifications and authentication failure tests, broken access control tests, injection tests, web/contact scraping and credential harvesting, email validation, integration with online reconnaissance tools like Shodan, creation of password guessing lists based on per domain/organisation information for feeding password cracking tools;
    - bring about an artificial intelligence capable of making relevant decisions. For example, effective ways to perform a network scan without being blocked, choosing the most effective exploitation method on a vulnerability(ies), evaluate the outcome of the exploitation and in cases of exploitation failure decide whether the exploitation method was wrong or a secondary security control prevented the execution of the payload, etc, given the costs and benefits involved;
    - defining user interfaces for operators of the automated penetration testing solution, e.g. a GUI[32] showing the progress of the test, showing future plans of the artificial intelligence, and making it possible to control these plans through constraints;
    - evaluation of the solutions capability and suitability for operational use, e.g. by comparing its behaviour and capability to penetration testers of different competence.
- Design:
    - producing the blueprints for a product capable of automating penetration tests based on the technical model, along with suitable use cases.

[32] Graphic User Interface.

In addition, the proposals must include methods for the evaluation of the outcome of the automated penetration testing based on well-established standards such as the Common Vulnerability Scoring System (CVSS).

The proposals must also give due consideration to design principles and implement a specific ethics-focused approach during the development, deployment and/or use of AI-based solutions, e.g. by using the Assessment List for Trustworthy Artificial Intelligence (ALTAI) to develop procedures to detect and assess the level and address potential risks.

In order to avoid unnecessary duplications and to best complement R&D efforts already targeting civil applications, the research conducted must build on R&D results of projects funded by EU programmes targeting civil applications for efficient spinning-in of knowledge and innovative solutions to the defence sector.

Functional requirements

The proposals must benefit a future solution for the armed forces of the Member States and EDF associated countries (Norway).

The outcome should enable or be capable of:

- executing a number of tools and techniques typically used during penetration tests, e.g. tools available in platforms such as Kali Linux;
- assessing alternatives, predict the effect of actions, and/or plan for future actions, e.g. by evaluating which actions are the most valuable in the long run;
- performing actions so that they leave a footprint (e.g. host logs) that is representative of the actions taken;
- having a user interface which allows a human operator to specify its behaviour, e.g. by selecting profiles representing tests with different focus and aggressiveness;
- allowing a human operator to specify acceptable and non-acceptable actions, e.g. in terms of white-listed hosts and black-listed hosts;
- having a user interface which communicates plans, assessments, and previous actions to a human operator.

Expected impact

The outcome should contribute to:

- a stronger, more competitive and technologically independent European Defence Technological and Industrial Base (EDTIB) when it comes to solutions for security penetration test automatisation and capability to test the security posture of operational computer networks and emulate threat agents during training, exercises, and system tests;
- enhanced security for the EU, its Member States and EDF associated countries (Norway) and more capable and interoperable forces performing cyber defence operations;
- the spin-in of civil European R&D into the defence sector.

2.2.2. EDF-2023-RA-SI-ENERENV-IPS: Innovative propulsion systems for defence applications

- **Indicative budget:** EUR 25 000 000 for this topic under the call EDF-2023-RA-SI.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

The EU has set the goal of becoming a climate-resilient society by 2050, fully adapted to the unavoidable impacts of climate change. With this target, the EU tracks its progress on cutting emissions through regular monitoring and reporting, and sets targets to progressively reduce its greenhouse gas emissions targeting net-zero greenhouse gas emissions by 2050.

These targets could affect also military platforms, which progressively must reduce their GHG (Green House Gases) emissions similarly as other economic sectors. In the field of mobility and transportation, the Green Deal objectives aim especially at boosting energy efficiency and ecodesign of products, reducing dependence on fossil fuels, promoting renewable and low-carbon gases and also supporting sustainable and sovereign key component development.

Innovations on propulsion systems are of higher interest in the heart of the contribution of the defence sector to address the European "Fit for 55" target. It is also an opportunity for defence to foster sovereignty and strategic autonomy while enhancing defence core capabilities (range, autonomy, silent operation and watch, lower signature…).

Developing innovative propulsion systems adapted for military operations without compromising current defence capabilities is challenging, and the specific military environment can limit the transfer of civil technologies regarding safety, maintenance, cost and supply issues.

In this sense, one of the main issues that Member States and EDF associated countries (Norway) armed forces, especially in the land and naval domain, are facing is to meet EU Green Deal (EUGD) targets with the existing fleets. Long military platforms lifespan forces to analyse existing and emerging sustainable fuels regarding their projected availability and useability as sustainable fuel solutions for a transitional period without significantly modifying current platform's configuration.

Therefore, a first step on the green transitional pathway must be a focus on the land and naval domain, to offer solutions to their existing platforms, for example by analysing Sustainable Fuels (SF) keeping EUGD and suitable to be used in retrofitted conventional combustion engines or looking at adaptations of conventional propulsion systems to enhance efficiency. The use of SF must not change the vessel's and vehicle's current structure neither compromise their present operational range.

Supporting the scale-up of innovative propulsion technologies for defence applications (marine, land) is essential to make military equipment more efficient and less reliant on fossil fuels. This research topic may cover several areas such as low carbon advanced fuels, improved engine energy efficiency, hybridisation or alternative propulsion concepts.

Future capability and operational challenges require to conduct research on the next generation of integrated architectures for military platforms, able to manage energy distribution for propulsion, in order to enhance their mobility, their survivability, their capability and their resilience to cope with multiple threats within a large range of missions, while reducing fossil energy, ensuring maintainability and support, and optimising life cycle costs.

Technological challenge:

The solutions must ensure high level of safety, low logistics footprint and life cycle cost reduction. The solutions must also take into account the possibility of retrofitting existing units at low cost.

Based on civil industry research achievements and civil-driven innovations, no technology risk is expected regarding, for example, the adaptation of available bio-fuel and e-fuel to be used as a reference to develop a military standard for the use of SF.

Market barriers:

The solutions may derive from COTS components when possible in order to be affordable and to ensure maintainability and support in operations.

Specific objective

The specific objective of this topic is to spin-in results generated in other civil EU-funded research programmes to the defence sector. To do so, different types of innovative propulsion systems that are integrated into innovative energy architectures are to be identified and analysed. This spin-in of knowledge into the defence sector should aim to the highest possible reduction of greenhouse gases integrating new technologies. The solutions should consider alternative sources of sustainable fuels (pure biofuels, hydrogen, hydrogen-based fuels as ammonia, methanol, LOHC[33] and e-fuels), used standalone or mixed with conventional fuels, and propulsion solutions. As a first step, the proposals must define the gradual adaptation for the land and naval domain.

As the current platforms appear to be vulnerable to fossil energy supply, the operational benefit provided by the innovative propulsions and energy solutions (higher autonomy, efficiency, redundancy, new operating modes, as e.g. silent mode and extended silent watch, low thermal signature, maintaining access to emission control area[34]) represents an opportunity to foster users' capability needs. The development of joint European capabilities on core alternative propulsion and energy architectures must nevertheless address the ability to operate in specific military scenarios and ensure the highest level of safety, low logistics footprint and life cycle cost reduction.

[33] Liquid organic hydrogen carriers.

[34] Reference to:
- The emission control area (SECA, NECA and ECA) under the MARPOL (Marine pollution) convention as adopted by the IMO (for maritime domain);
- The LEZ (Low emission zone) or ZEZ (zero emission zone) for metropolis access –ground domain).

Increasing the ability for military platforms to operate with SF can participate to maintain the capacity to operate in those area in peacetime (incl. training in Europe).

The proposals should analyse a range of solutions that can contribute to the reduction of greenhouse gases to meet the EUGD without compromising operational capabilities, including solutions suitable for retrofitting existing units/vessels but also solutions for future units/vessels.

It is also of interest to provide an overview of innovative management of energy for propulsion systems in combination with all the aforementioned additional measures and assess which combination can reduce greenhouse gases most efficiently while maintaining at the same time the requirements requested.

As main challenge, alternative propulsion and energy systems for military platforms will imply to study their integration into a wider scope, in order to maintain their combat effectiveness, thus covering energy supply in operations including powering infrastructure and logistical issues.

The proposals should provide solutions to issues of safety and long-term storage concerns, which make them otherwise inapplicable for military uses. The solutions should be specifically adapted to platforms that operate in critical combat scenarios. Attention should be given to promote solutions for the next generation systems and for retrofitting the current military propulsion systems.

Scope and types of activities

Scope

The proposals must address solutions of innovative architectures based on efficient energy management and advanced propulsion technologies for application in defence. Solutions will be analysed/compared through presentation of KPIs[35] or other parametric method. Relevant indexes valid for multiple domains will are preferable.

The proposals must focus on key subsystems covering a complete value chain including sustainable fuels storage and supply, analysing the impact of the military requirements on the internal combustion engines design (covering current and future engines) and auxiliary energy systems in order to optimise the cost-effectiveness of the solution implemented.

The proposals must include the exploration of technologies, from off-the-shelf (civilian, pending relevance and military solutions) to alternative power/energy generation capacities or innovations, and characterise the potential gains, risks, development and production roadmaps regarding platform propulsion performance needs and different operational scenarios (training, missions, low / high intensity conflicts). Moreover, the proposals should analyse the best option in every case in terms of cost, efficiency and safety.

Types of activities

The following types of activities are eligible for this topic:

[35] Key performance indicators.

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 (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

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

- Integrating knowledge:
    - state-of-the-art of current military and civilian SF and propulsion solutions;
    - identification of several improved technological solutions for optimised propulsion architecture allowing to increase power density, energy generation, energy storage and energy distribution and management efficiency;
    - define together with defence end-users best efficient and sustainable solutions for the military applications and in different operational scenarios, the storage

and operational requirements in terms of risk of explosion, corrosion, toxicity, safety and logistic facilities;

- identify and analyse possible SF regarding their properties and availability regarding military constraints;
- provide monitoring and analysis of critical technologies, their potential applications, identify barriers, existing gaps and dependencies related to sustainable fuels.

- Study:
  - evaluate advanced propulsion and energy architectures for next generation of platforms und upgrade/retrofitting of current platforms, including from a cost perspective;
  - characterise the effect of the solutions on the physical components, engine behaviour, efficiency, consumption, maintained plans, life cycle cost, and materials behaviour;
  - define the optimum operational scenarios (area, modes, type of mission, etc.) offered by each solution including the characterisation of the improvement of military functions (stealth mobility, low emissions, etc.) but also the performance limitations (range, autonomy, speed, etc.);
  - assess the impact of the solutions on safety, risk of incidents, vulnerability towards threats through a FMECA[36] approach;
  - define the business case, cost analysis and the supply chain of the solutions that contribute to EU strategic autonomy;
  - define SF application standard for military including onboard storage and distibution system analysis, including long-term storage and stability;
  - run a training and manufacturing requirement analysis in order to sustain their manufacturing and application processes;
  - evaluate the environmental benefits of the solutions with life cycle assessment including at least greenhouse, NOx, SOx gases and particles impact, as well as impact on abiotic depletion and use of critical raw materials.
- Design:
  - simulation and modelling in order to provide a technical evaluation of the solutions and to define the adaptations needed whether they are physical components or functionality ones;
  - provide long-term test bench information regarding the behaviour of the plateform propulsion architecture and its different components, including fuel

[36] Failure mode effects and criticality analysis.

storage solutions. Depending on the technologies to be evaluated, one or several tests should be used to identify the relevant ones for maturity;

- develop a production roadmap along with the design of the most relevant energy management architecture;
- demonstration of technologies and partial testing of a proposed solution. Design a maintenance plan for the technologies involved.

In addition, the proposals should cover the following tasks:

- Study:
  - identify technology shortfalls that need to be addressed in subsequent activities at EU or national level.
- Design:
  - demonstrate the product/technologies in a representative military environment.

In order to avoid unnecessary duplications and to best complement R&D efforts already targeting civil applications, the research conducted must build on R&D results of projects funded by EU programmes targeting civil applications for efficient spinning-in of knowledge and innovative solutions to the defence sector.

In addition, research activities should be in line with activities conducted by EDA (e.g. the incubation forum for circular economy in European defence (IF-CEED)[37] activities) in this area.

Functional requirements

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

- be compatible in a dual-use approach with at least one of the following sustainable fuels: biofuels[38], hydrogen, hydrogen derived fuels and e-fuels;
- be capable to use greener sources of energy and operate with a dual fuel engine which combines current fuel solutions and advanced sustainable fuels;
- improve efficiency of propulsion component technologies (weight, volume and other performances such as acceleration, stealth mobility, etc.);
- improve the energy and power generation to serve increasing energy demand of auxiliary energy production for onboard systems and unmanned aerial and naval vehicles;
- improve energy storage density without compromising safety;

[37] https://eda.europa.eu/what-we-do/eu-policies/if-ceed

[38] Excluding E5, E10, B7 fuels, synthetic navy fuels derived from biomass already compliant with the STANAG 1385

- be adapted for the retrofit of typical defence solutions currently present in the Member States and EDF associated countries (Norway) armed forces or for the development of future solutions, while meeting the Green Deal requirements;
- be compatible with NATO/EU logistics, meaning it should lead to a common solution that allows, amongst others, for refuelling;
- ensure the possibility of global operations;
- be compliant with relevant national, European and global regulations and standards.

Expected impact

The outcome should contribute to:

- the spin-in of civil European R&D into the defence sector;
- enabling Member States and EDF associated countries (Norway) armed forces to meet EU Green Deal targets, and to be climate neutral by 2050, with only minimal loss of military and joint operational capabilities;
- facilitating the introduction of new propulsion and energy integrated systems technologies by reducing their evaluation time and cost, thus providing a cutting-edge tactical advantage in operations, while contributing to energy transformation in Europe;
- developing the autonomy of the industrial sector in the EU and enhance cross-border cooperation (from large industrial groups to SMEs) in a high-tech niche sector;
- the EU technological sovereignty and strategic autonomy ahead of future non-associated third-country competitors;
- enhancing complementarity and stimulate cross-fertilisation between civil and defence technologies and solutions in this area.

2.2.3. EDF-2023-RA-SI-MATCOMP-HPM: High performance materials for Defence applications

- **Indicative budget:** the EU is considering a contribution of up to EUR 20 000 000 for this topic under the call EDF-2023-RA-SI.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

The complex tasks in operational scenarios require specific technical characteristics for the defence equipment and materials. The performance and life-cycle cost of defence platforms and equipment directly depend on the materials properties of the solutions available for their manufacturing. In particular, the resistance to high temperatures is an important feature for use in specific environments or for components that need to withstand high thermal loads due to their functionality. At the same time, future materials and structural solutions should

exhibit low weight and keep the same material performances necessary for specific defence applications.
Furthermore, in addition to the physical and chemical required properties of the materials themselves, there are challenges related to availability, production, processing, export control and environmental concerns which also need to be taken into account.

Specific objective

Defence applications require the investigation and improvement of materials that are able to withstand hypersonic flight, extreme thermal loads, ballistic loads, electromagnetic pulse, etc.

The development of material solutions for civil applications is a broad and dynamic technological field. Temperature resistance and weight reduction are aspects of interest for civil applications also and R&D efforts in this regard regularly result in new materials, design, structures, processes or standards that improve material performance. However, due to the harsh and particular conditions of defence-related use-cases, civil technologies need to be adapted, further improved or combined with defence-specific technologies through additional R&D efforts to make them suitable for defence applications.

The capacity to withstand high temperatures is a particularly important characteristic for materials used in many defence applications. Parts of aircraft, both airplanes and helicopters, especially close to the engine, need to yield the necessary temperature resistance, weight and structural characteristics. Concerning ground systems, components withstanding high temperatures do not only need to have acceptable weight but should also demonstrate good ballistic performance, for example to gain protection against kinetic energy penetrators. For missile, air and space applications, materials need to reach the state of the art in terms of lightness, structural strength as well as withstanding extreme thermal loads (e.g. typical of hypersonic flight). High temperature materials used for naval applications need to additionally be protected against salty water corrosion or other types of corrosion but also to save weight by reducing insulation or to enhance heat resistance. Sensor systems need materials that exhibit transparency in spectral band suitable for their function, such as visual frequencies, near infrared, radiofrequencies or others, while maintaining mechanical properties in terms of hardness and temperature resistance.

All of these application examples will additionally benefit from materials that feature a certain level of protection against effects of electromagnetic pulse and contribute to ensuring electromagnetic compatibility.

Scope and types of activities

Scope

Several key components and structural parts of defence systems are subject to extreme conditions (like high temperatures, ballistic impact or explosions), often in combination with harsh conditions in terms of stress, chemical environment, etc. In these conditions, material properties at high temperatures and/or when subject to high velocity impact represent a limiting factor for the performance of the system as a whole. In addition, for some applications, the critical components consist of or are protected by insulation materials. This leads to a considerable increase in total weight and a significant rise in material costs.

The proposals must focus on design and/or adaptation of high performance materials for future use in defence applications while achieving weight saving. The proposals must also

address demonstration of material performance in a laboratory environment that recreates realistic conditions for the materials used.

Types of activities

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

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

- Generating knowledge:
    - determination of the property ranges (density, mechanical properties, temperature resistance, etc.) for new materials;

- determination of components exposed to operating conditions;
- description of the chemical, physical and mechanical requirement profile.

- Integrating knowledge:
  - identification and selection of candidate materials from suppliers within the EU and EDF associated countries (Norway) and that are not subject to export restrictions by non-associated third countries;
  - setting-up cross-disciplinary collaboration between material suppliers, Original Equipment Manufacturers (OEMs), research institutes and defence end-users on the considered use-cases.

- Studies:
  - evaluation of components exposed to operating conditions on the basis of their performance characteristics.

- Design:
  - test of partial demonstrators in a representative defence environment (e.g. plasma wind tunnel, mechanical and chemical testing, ballistic testing, electromagnetical testing, fire testing, etc.);
  - demonstration of the feasibility of the manufacturing in industrial conditions typical of the considered application.

In addition, the proposals should cover the following tasks:

- Generating knowledge:
  - Investigation and evaluation of processing parameters through process simulation, thermal analysis and manufacturing tests;
  - Investigation and evaluation of different material and/or coating configurations according to the defined requirements;
  - If the proposal targets materials for hypersonic environment or protection against kinetic energy penetrator impacts, it should address adequate advanced ablation kinetic/fragmentation models under high-temperature hypersonic conditions or kinetic energy penetrator impacts respectively.

- Integrating knowledge:
  - use of high performance computing, application of digital twin methods, multiphysics and multiscale 3D simulation;
  - characterisation of materials, and/or coatings, including, if relevant for the envisaged application, aspects of:
    - fire/heat resistance;

        - erosion;
        - adhesive strength;
        - advanced ablation;
        - electromagnetic (EM) transparency;
        - structural strength.
    - investigation of manufacturing processes, including, when relevant, aspects related to:
        - joining of (smaller) tiles;
        - electromagnetic compatibility protection;
        - high thermal flux in oxidising environment, e.g. with usage of Ceramic Matrix Composites (CMC), Ultra-high-temperature ceramics (UHTC), Ultra high temperature ceramic matrix composite (UCTCMC), Organic Matrix Composites (OMC)…
        - high temperature application of ceramic-like materials (CMC) for ballistic protection.
    - investigation of processes with a high reproducibility and repeatability for the manufacturing of the new material.

- Studies:
    - evaluation of fire test procedures according to IMO (International Maritime Organisation) related to military relevant operational conditions and requirements in particular for materials considered for navy applications;
    - determination of operating temperature critical areas;
    - feasibility of recycling processes by evaluating the overall material performance impact while paying attention not to downgrade its quality and properties.

- Design:
    - implementation of material design to optimise the tailored properties of the components and to predict their limits in expected conditions;

The proposals may also cover the following tasks:

- Design:
    - design of tests facilities on material coupons, including for mechanical, thermal and chemical stresses, thermomechanical, oxidation, and other functional properties.

In order to avoid unnecessary duplications and to best complement R&D efforts already targeting civil applications, the research conducted must build on R&D results of projects funded by EU programmes targeting civil applications for efficient spinning-in of knowledge and innovative solutions to the defence sector.

Functional requirements

The proposed technologies should meet one or several of the following functional requirements that are specific to defence applications:

- hypersonic flight, characterised by high thermal flux in oxidising environment;
- high specific strength in severe environments for both engine and platform parts for military aircraft and missiles;
- passive ballistic protection against opponents with similar characteristics, e.g. threats such as armour-piercing fin-stabilised discarding sabot;
- protection against explosive and blast effects used against physical systems like infrastructure, vehicles and/or personnel;[39]
- protection of electromagnetic sensors by ensuring specific mechanical properties such as mechanical hardness and extreme thermal loads, while maintaining transparency in specific sensors' spectral bands;
- materials to enhance electromagnetic compatibility and protection;
- fire/heat resistance for defence purposes such as in case of fire of unexploded fuel of missiles, missile and ammunition carriage, requirements for structural engine parts, etc.;
- compliance with military standards and regulations for the intended use-case and mission efficiency requirements;
- adjustment of dimensions according to the actual process and test environment;
- operation for time periods that uphold the structural integrity of the material itself, and the system properties it is intended to uphold for the defence application considered;
- efficiency of solutions to equip heat-sensitive components with materials with adapted properties.

[39] Experience of the European Commission's Joint Research Centre in the field of material testing and simulation might be considered, see for example Peroni, Jung, Larcher and Solomos, High strain-rate properties of hybrid aluminium and polyurethane foams, In: International conference on impact loading of structures and materials 2016 and Solomos, Larcher, Valsamos, Karlos and Casadei, A survey of computational models for blast induced human injuries for security and defence applications, Publications Office of the European Union, Luxembourg, 2020.

Expected impact

The outcome should:

- contribute to the EU technological sovereignty and strategic autonomy by developing an autonomous industrial sector and enhance cross-border collaboration involving both large industrial groups and smaller players such as SMEs;
- strengthen European supply chains on materials, by including actors from different sectors and across the EU and EDF associated countries;
- reduce the operating and lifecycle costs of the component and/or the system by use of new material concepts;
- reduce the time and cost of new material development by making best use of technologies available in the civil sector;
- provide ecological benefits such as CO_2 balance, lifetime energy consumption analysis, REACH compliance and reduced usage of ozone layer depleting substances on military vehicles;
- provide new business and cooperation opportunities to innovators that have not been active in the defence sector before.

2.3. Call EDF-2023-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 (Norway) 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 16 000 000 to support the following call topic:

2.3.1. EDF-2023-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-2023-LS-RA-DIS.
- **Indicative 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 should not 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 should include clear descriptions of the proposed criteria to assess work package completion.

The proposals must address disruptive technologies.

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

- blockchain applications (e.g. for identification of friend or foe);
- tools and applications improving cybersecurity talents screening;
- artificial intelligence and robotic autonomous systems;
- future naval platform control and management;
- smart damage control related to future naval platforms;
- ship signature management;
- secure and reliable underwater communication solutions and interfaces (radiofrequency, acoustic, optic or others);

- measurement and monitoring of physiological and cognitive state of soldiers;
- 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;
- synthetic fuel production from waste and biomass for military 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**)	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

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 big companies, universities or research and technology organisations.

2.4. Call EDF-2023-LS-RA-CHALLENGE

- **Targeted type of actions:** Research actions (technological challenge).
- **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:** the European Union is considering a contribution of up to EUR 25 000 000 to support the following two call topics:

2.4.1. EDF-2023-LS-RA-CHALLENGE-DIGIT-HLTP: Agile and robust human language technologies for defence – Participation to a technological challenge

- **Indicative budget:** EUR 18 000 000 for this topic under the call EDF-2023-LS-RA-CHALLENGE.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** the requested funding for individual proposals should not exceed EUR 6 000 000.
- **Funding information:** a lump sum approach will be used. For selected projects, the maximum EU contribution will be based on the eligible costs in the requested funding, but actual payments will be conditioned to the completion of work packages. The proposals should include clear descriptions of criteria to assess work package completion. Criteria should include the participation to the test campaigns organised in the framework of the technological challenge, and the delivery of descriptions of the systems submitted to the tests.

This call aims at progressing Human Language Technologies (HLT) for defence applications. The HLT scientific and technological community has a long experience in participating in technological challenges, whereby different research teams submit their systems to blind testing using common evaluation protocols and datasets, with the support of an organising third party. This scheme is needed to evaluate systems involving machine learning in an objective and reproducible way. This leads to two topics, one to support the research teams participating in the challenge (HLTP), and one to support the challenge organisers (HLTO). A preliminary evaluation plan common to the two topics is provided as part of the call document (cf. Annex TBD). It is an integral part of the topic description for each of the two topics.

The technological challenge organised through this call addresses several technologies where significant progress is needed. In addition, the call covers the production of complete HLT demonstrators that can be tested by representative defence users on their own data.

Objectives

With the digitalisation of the battlefield, which leads to more and more complex user interfaces and to ever-increasing volumes of language data to process, language technologies such as multilingual written or spoken interaction, translation, and information retrieval are needed in an increasing number of defence systems, especially for C4ISR[40] and joint multinational and/or peacekeeping operations.

These technologies have been the subject of much research for several decades, which has led to impressive improvements for some applications such as voice assistants, semi-automated call centres, online translation services, etc. However, even if most of the techniques used in current systems have emerged from defence research, these improvements also rely on the availability of huge amounts of data, typically by internet actors with a large user base, and have therefore taken place mostly in the civil sector. In the defence sector, where the amounts of data that can be made available to developers are much more limited for confidentiality reasons, improvements have been more limited too, and progress is still needed to meet the requirements of most applications.

In order to address this issue of the lack of availability of operational data for system developers, a workaround is to resort to similar but sharable data. However, this generally implies the ad hoc creation of data, which can be relatively costly, and does not fully solve the issue. A better-suited solution would be that systems could learn directly from user data without disclosing any confidential information to developers. This would not only enable to make use of in-domain data hitherto unused and answer major security and sovereignty concerns, but also lead to significant performance progress thanks to a much more efficient use of the existing data. In addition, while there is already an increasing body of research on innovative approaches to machine learning related to this issue, such as semi- and self-supervised learning, active learning, transfer learning, and frugal learning, channelling these efforts through a technological challenge organisation has the potential to lead to a breakthrough. In this context, the call aims at creating not only generic systems that offer better performance for a wide range of conditions, but also systems that can be adapted by users to offer enhanced performances for specific applications.

The overarching goal of the call is to create a European library of generic and adaptive human language technology components that offer high performances for several defence

[40] Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance.

applications. In particular, the technologies should be robust to noise and communication quality, cover a wide range of language and dialects including under-resourced ones, manage specific vocabulary, and offer more robust processing of high-level semantic information.

Scope and types of activities

Scope

The proposals should address technological solutions to process linguistic information in its different forms, i.e. spoken and written (handwriting, printed documents or typed text), in order to recognise, understand and translate it. These solutions should be evaluated in the framework of the technological challenge organised under this call topic. The proposals should in particular address the issue of user-driven system adaptation, i.e. the ability of systems to learn from user supervision without intervention from developers and without regression in terms of performances. Technologies should be integrated into demonstrators with user-friendly interfaces and be easy to integrate into other defence systems.

Targeted 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 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

Types of activities (art 10(3) EDF Regulation)		Eligible?
(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 cover at least the following tasks as part of the mandatory activities:

- Generating knowledge:
    - research on human language technologies, including innovative approaches for user-driven system adaptation;
    - participation to the evaluation campaigns organised in the framework of the technological challenge, including:
        - exchanging with other stakeholders on the evaluation plans;
        - submission of systems to experimental performance measurements during the test campaigns managed by the challenge organisers;
        - participation to debriefing workshops.
- Integrating knowledge:
    - Integration of technological modules into demonstrators that can be tested by representative defence users.

Functional requirements

The proposed solutions should fulfil the following requirements:

- Systems should be based on software components performing a variety of human language processing functions. These components should be integrated into demonstrators with a user-friendly interface. They should enable users to adapt the components using their own data, without intervention from the system developers.
- Systems should be able to run locally, without a connection to a wide area network, except for specific functions for which this can be duly justified and is compatible with operational missions (e.g. to achieve higher performances when adapting under user supervision).
- Systems should be optimised in term of memory and CPU footprint and more generally need reasonable resources in terms of hardware size, weight, price, and energy consumption, in view of their potential integration into existing or future larger defence systems.
- Systems should accept as input files linguistic information in its different forms:
    - speech (in audio files or in the audio stream of video files);
    - handwritten or printed documents;
    - text.

- For each of these forms, systems should accept a wide variety of possible inputs without necessarily having information about the specific type of input. Variability can be in terms of speakers or writers, speaking or writing style, vocabulary, accents, noise, recording or scanning conditions, transmission channels, etc. Systems should thus be speaker/writer-independent, channel-independent, robust to various accents, types of noise, etc. They should in particular be robust to conditions more frequently encountered in military environments (e.g. highly noisy, low communication quality, non-native speech, etc.).
- The scope of the human language processing functions should cover:
    - language identification from speech, documents and text;
    - speech recognition;
    - handwritten and printed document recognition;
    - keyword spotting from speech and handwritten or printed documents;
    - translation from speech, handwritten or printed documents, and texts;
    - high-level semantic (including military-specific) information extraction, such as named entity and event recognition, and relation extraction;
    - cross-language information retrieval;
    - automatic (multi-)document summarisation and visualisation.
- Software components corresponding to the above functions should cover multiple languages and dialects including EU and non-EU ones. Translation should cover all official EU languages as target languages. The proposals should mention the list of languages and dialects that are foreseen to be covered for each function.
- Software components should offer state-of-the-art performances. For each human language processing function mentioned above and for each language or dialect covered, the proposals should mention objectively measured performances (including information on the data and metrics used for the measurements, and if applicable on the evaluation campaign in the framework of which the measurements where made), and associated references.
- Software components corresponding to functions covered by the technological challenge organised in the framework of the call should be submitted for evaluation therein. Any difference between the version evaluated through the challenge and a version integrated in the demonstrator should be documented. How the proposed approaches and systems will address the tasks outlined in the preliminary evaluation plan should be described in the proposals. Components corresponding to functions that are not covered by the challenge may also be adapted and enhanced during project execution if deemed appropriate, possibly using data from the challenge.
- The software components 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.

- Systems and user interfaces should help users as much as possible to understand how the outputs are derived from the inputs (explainable AI), and in particular provide links to the inputs. For example, translations should be accompanied by links to the source language at the level of the term or phrase, and visualisations should include links to the inputs that support the displayed information. Knowledge that is instrumental in determining the output or that can help users making more sense of the inputs, such as bilingual dictionary entries for translation, should also be provided.
- Systems should enable users to adapt them using their own data, e.g. by providing batches of raw or annotated data, or by interactively providing supervision.

Expected impact

The outcome should contribute to:

- a strengthened EDTIB (European Defence Technological and Industrial Base) and enhanced technological autonomy for defence-oriented HLT systems;
- a broader, cheaper and easier usage of HLT systems for defence;
- enhanced defence systems in various domains, in particular C4ISR;
- enhanced EU freedom of action.

2.4.2. EDF-2023-LS-RA-CHALLENGE-DIGIT-HLTO: Agile and robust human language technologies for defence – Organisation of a technological challenge

- **Indicative budget for the call:** the EU is considering a contribution of up to EUR 7 000 000 for this topic under the call EDF-2023-LS-RA-CHALLENGE.
- **Indicative number of proposals to be funded:** one proposal is to be funded for this topic.
- **Funding information:** a lump sum approach will be used. For selected projects, the maximum EU contribution will be based on the eligible costs in the requested funding, but actual payments will be conditioned to the completion of work packages. 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.

Objectives

The objective evaluation of artificial intelligence (AI) technologies such as human language technologies (HLT) requires a specific organisation whereby systems are tested in a blind manner on data that is representative of the tasks under study, using common protocols. This scheme, which has been pioneered by the HLT community under the term “evaluation campaign”, is also often called a “technological challenge”. One objective of the call is to

organise a technological challenge driving research toward enhanced HTL systems for defence applications.

Scope and types of activities

Scope

The proposals should address the organisation of a technological challenge on HLT based on the preliminary evaluation plan provided as part of the call document (cf. Annex TBD). This includes the collection, annotation and distribution of data, and the writing of the evaluation plans.

Targeted 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

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

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

- setting-up of the infrastructures for testing HLT systems in the framework of the technological challenge;
- 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 the participating teams and any other relevant stakeholders on the evaluation plans and elaboration of these plans;
    - management of the experimental 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.

Functional requirements

The proposed solutions should enable the measurement of the performances of HLT systems according to detailed evaluation plans based on the preliminary evaluation plan provided as part of the call document (cf. Annex TBD). Key aspects of the foreseen detailed evaluation plans and associated data management should be described in the proposals. The proposals should in particular describe:

- the scenarios considered, and the nature and size of data to collect;
- the languages and dialects that can be covered;
- the nature and volume of data annotation to be produced;
- 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, such as peacekeeping operations, ISR[41] and C2[42]. The proposals should describe the foreseen efforts from users to test demonstrators and provide feedback.

[41] Intelligence, Surveillance and Reconnaissance.
[42] Command and Control.

During the challenge, detailed evaluation plans 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 the feedback for the actual evaluation 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.

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

Expected impact

The outcome should contribute to:

- enhanced metrics and protocols to measure progress of R&D on HLT;
- standardisation of testing for HLT;
- enhanced clarity on the performances of HLT systems for all stakeholders, including system developers, funders and users;
- enhanced framework for EU and EDF associated countries (Norway) cross-border collaboration and sharing of linguistic resources, software components, systems and services;
- HLT community building at the European defence level;
- availability of databases to further develop and test HLT systems.

2.5. Call EDF-2023-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:** the European Union is considering a contribution of EUR 375 500 000[43] to support the following 17 topics:

2.5.1. EDF-2023-DA-MCBRN-FCS: Federating CBRN systems

- **Indicative budget:** EUR 15 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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.

[43] The budget earmarked on 2023 appropriations for this call may be complemented by an amount of up to EUR 339 000 000 from 2024 appropriations. This 2024 complementary budget is subject to the adoption of a separate financing decision.

Objectives

General objective

Recent CBRN[44] events necessitate an increased and comprehensive CBRN-defence effort. The CBRN threat is also continuously evolving and imposes adaptation of existing technologies and development of new solutions in order to improve the armed forces' CBRN defence capabilities.

The general objective of this topic is to create an overarching information system that enables interoperability between the different existing national CBRN defence information management systems, or subsystems, with the aim to improve and to better use and coordinate available CBRN defence resources within the EU Member States and EDF associated countries (Norway) to obtain greater endurance for their armed forces.

Specific objective

Member States and EDF associated countries (Norway) armed forces need to act in a combined and joint environment and maintain the operational capabilities under CBRN conditions.

However, European CBRN capabilities are currently mainly based on widely different equipment and systems, hence making it challenging to obtain a coherent and efficient EU and EDF associated countries (Norway) CBRN defence. Therefore, this topic aims to create a comprehensive software system that enables interoperability between the Member States and EDF associated countries (Norway) through a system-of-systems approach including modular equipment.

Scope and types of activities

Scope

The proposals must address the design and the prototyping of a European CBRN system of systems cross-border solution.

The proposals should focus on integration of CBRN defence technologies into a comprehensive software system. However, the proposals may also provide analysis of the relevance and feasibility of novel CBRN technologies, mapping of CBRN defence capacities across the EU and EDF associated countries, as well as options for ensuring access and availability of CBRN technologies.

The proposals may also consider others aspects such as education, training and logistics and may specify a solution that can task and manage CBRN operations both in the military and civilian realm.

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,	No

[44] Chemical Biological Radiological Nuclear.

Types of activities (art 10(3) EDF Regulation)		Eligible?
	products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence (**generating knowledge**)	
(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 (optional)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes (optional)
(h)	**Certification** of a defence product, tangible or intangible component or technology	Yes (optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (optional)

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

- Studies:
    - provide an inventory of the systems available (or in development) in the Member States and EDF associated countries (Norway) armed forces;
    - provide a comprehensive approach analysis with solutions and functionalities that covers Detection, Identification and Monitoring (DIM), CBRN Knowledge Management (KM), Physical Protection (PP), and Hazard Management (HM) for all adressed CBRN-threats;

- provide a proof of concept based on one, several or all of these functions (DIM, KM, PP, HM);

- address the requirements for a standardised IoT[45] framework, enabling more equipment integration. The proposed framework should be presented and described in OV-1 format[46].

- Design:

  - identify an overall architecture, based on open, publicly available and international standards widely used, such as ISO 10303[47] and related specifications from ISO TC 184/SC 4[48];

  - provide for a modular approach that facilitates the possible subsequent evolutions of the different systems composing the CBRN defence.

- System prototyping:

  - the prototype must be validated through a technical demonstration on at least TRL 6[49].

In addition, the proposals must subtstantiate[50] coherence and interoperability with exisiting CBRN-related initiatives (such as, but not limited to, PESCO CBRN-SaaS, EDA CatB CBRN-SaaS, Horizon Europe framework programme, NATO initiatives) regarding sensor networking, data exchange and data fusion, as well as substantiate synergies and complementarity with the activities described in the call topics EDIDP-CBRN-DEWS-2020 on *capabilities for CBRN risk assessment, detection, early warning and surveillance* and EDF-2021-MCBRN-R-CBRNDIM on *Detection, identification and monitoring (DIM) of CBRN threats*.

Functional requirements

The demonstrated federated CBRN system of systems should meet the following functional requirements:

- General:

  - include functional chains from detection, identification and monitoring (DIM), data communication and management, including sensing data, hazard prediction, decision support, visualisation and other CBRN functions;

  - federate multiple actors and systems and exploit legacy capabilities;

[45] Internet of things.
[46] High Level Operational Concept Graphic.
[47] ISO standard for the computer-interpretable representation and exchange of product manufacturing information.
[48] International standards organisation responsible for industrial data. ISO/TC 184/SC 4 develops and maintains ISO standards that describe and manage industrial product data throughout the life of the product.
[49] Technology Readiness Level 6 (System/subsystem model or prototype demonstration in a relevant environment.
[50] To the extent of information available on open sources.

- include modular kits that are easy to deploy in different operational situations, strategic, operational and tactical levels, in and out the territory of the Member States and EDF associated countries (Norway) in a multi-domain environment;
- able to integrate innovative technologies such as new sensors, robotics, AI[51], virtual reality;
- able to fuse all generated data into an intuitive common operational picture and present it in a single front end;
- able to ensure overall data exchange in situations with constrained communications.
- be built upon existing harmonised civilian and military standards widely used in this domain (e.g. NATO ATP-45/AEP-45[52], JC3IEDM[53]) where applicable;
- be modular and scalable in order to be able to integrate future solutions.

- Usability:
  - ensure exchange of data and information between CBRN information systems, covering joint military branches, multi-domain (Land, Air, Sea) and civil-military cooperation (CIMIC) to support collaboration and cooperation between Member States and EDF associated countries (Norway). In addition, possible solutions for data exchange regarding classified and protected data may be included;
  - ensure fusion of all available data and information sources to achieve an easy-to-understand common operational picture that enables deliberate and ad-hoc decision making, and should be connectable to existing crisis management software applications;
  - include the availability of sensor data, as well as the complete configuration management aspects and logistics status including maintenance status of these systems;
  - include solutions to predict and simulate hazard development in time and space in case of a CBRN defence event, and that should be applicable also in urban and indoors settings. The simulation solutions should be applicable for planning-, excersise- and real instances;
  - implement mathematical modelling methods like reverse dispersion modelling to enable localisation of CBRN-sources;

[51] Artificial Intelligence.
[52] NATO ATP- AEP-45 Warning and reporting and hazard prediction of chemical, biological, radiological and nuclear incidents (reference manual).
[53] Joint Consultation, Command and Control Information Exchange Data Model.

- allow communication between the different constituent parts, including a common standardised API for application integrations.

- Interoperability/Data sources:
  - include integration of weather data (live and forecast);
  - include interface and data transfer solutions to integrate information from civilian data sources (e.g. radiation early warning sensor networks);
  - include alternative data sources (e.g. social media reports of smell/symptoms, uncommon symptom results from hospitals, emergency call centre reports, etc.) also using novel approaches (e.g. AI) for data analysis and evaluation.

Expected impact

The outcome should contribute to:

- improved CBRN defence capabilities of Member States and EDF associated countries (Norway) armed forces, with an enhanced level of situational awareness, as well as a reduced risk of false alarms and misinterpretation in order to enable a quicker and more efficient response;
- a standardisation of CBRN defence systems information and data exchange at European level;
- the integration of contemporary and emerging CBRN defense technologies;
- an enhanced operational readiness and effectiveness.

2.5.2. EDF-2023-DA-C4ISR-LCOM: Laser communications

- **Indicative budget:** EUR 17 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Information superiority is a critical capability to be developed and improved with the aim to address future challenges to be faced by European defence forces, and more specifically to support reactive and efficient decision-making processes. To this purpose, an effective and robust EU military Intelligence, Surveillance, Target, Acquisition and Reconnaissance (ISTAR) capability for missions and operations is an essential element of the overall EU effort to facilitate international conflict prevention and crisis management. Moreover, an ISTAR capability could support border and maritime surveillance tasks as well. Acquiring this capability necessitates the drastic improvement of Intelligence, surveillance, and reconnaissance (ISR) and CIS[54] operational capabilities, notably with regard to persistence,

[54] Communications and information system.

acquisition of high-quality and high volume of data, automatic airborne processing and dissemination of information to relevant stakeholders.

Against this background, the unmanned aerial systems (UAS), and in particular the Medium Altitude Long Endurance Remotely Piloted Aircraft System (MALE RPAS), are key for ISTAR missions. An unmanned platform is also able to establish a central/relay node, collecting tactical communications of friend forces in the nearby and relaying to C5ISR[55] centre.

The ISTAR mission of the UAS include EO[56]/IR[57], radar and signal intelligence sensors, as well as generation of geo-intelligence data. To accomplish these tasks, one of the most critical elements of the UAS aircraft architectural configuration lays in its telecommunications subsystem. In addition, communications play a more important role in the operation of unmanned aircraft than they do in manned ones, since all the decision-making occurs on the ground. The subsystem functionalities must thus provide both command and control instructions (C2 datalink) and relay collected ISR data (ISR data link) by the use of Radio line-of-sight (RLOS) and /or beyond radio line-of-sight (BRLOS).

However, all communications with the ground control station are usually performed via satellite links, which have bandwidth limitations. Therefore, enhanced telecommunication links are required, providing higher wideband characteristics, as well as efficient means of electronic and cyber defence properties against detection, acquisition, jamming and cyber-attacks. Otherwise, loss of the aircraft own control, compromise of the information collected and in the worst-case total control of the aircraft by the adversary may occur. Moreover, the overwhelming demand for data communications with ever increasing data rate, has drastically reduced the availability of RF[58] transmission bandwidth, converting it to a valuable resource. Although hundreds of deployed satellites practically provide global Ku band coverage, the overall congestion of the Ku band causes problems in particular with regard to unmanned aircraft operations. In parallel, timely transmission of voluminous ISR sensor data is often not possible within the available RF channels capacity limitations.

Optical links have already proven their suitability for satellite to mobile platforms applications, by providing orders of magnitude faster transmission, while using much less power than traditional RF links to aircrafts, ships, and even other satellites. The future utilisation of optical data links for Beyond Line of Sight (BLOS) operations of UAS can simultaneously combine all capabilities of high data rate, unlimited bandwidth, low probability of detection (LPD) and low probability of intercept (LPI) communications and integration to network centric architectures. For high bandwidth transmission and to gain an additional communication link, a laser communication between UAS and satellite terminals could be installed. This idea of airborne optical wideband communication via satellite, immune to eavesdropping and jamming, constitutes the general objective of this topic.

Specific objective

[55] Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance, and Reconnaissance.
[56] Electro-optical.
[57] Infrared.
[58] Radiofrequency.

The specific objective of this topic is the development of an Airborne Laser Communication System (ALCoS), able to establish a very high data rate bi-directional communication link to satellite, providing BLOS communication capability with LPD and LPI characteristics.

Scope and types of activities

Scope

The proposals must address activities to design a prototype for airborne laser communication system (ALCoS) to be used on various types of aircraft, manned or unmanned (e.g. envisioned European MALE RPAS).

In detail, the proposals must address:

- an overview about a suitable configuration for airborne laser communication including all parts of the communication chain (RPAS terminal, satellite terminal, satellite orbit position, inter-satellite communication, downlink);
- identification, analysis and mitigation of critical technical risks especially those relating to integration and certification;
- definition of a set of requirements, considering the whole product cycle;
- life cycle cost analysis and management;
- developing of a prototype to demonstrate the possible airborne integration.

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)

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

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

- Studies:
    - identify which configurations to be used in the design. As outcome, a set of requirements must be assessed and jointly agreed by supporting Member States and EDF associated countries (Norway);
    - provide influences and limitation of weather and atmospheric conditions on laser communications and possible countermeasures;
    - execute risk management for the development of airborne laser communications, including all parts of the communication line, especially for integration, certification and qualification issues;
    - provide drawings, reports, analyses, certification plan and data in view of the future certification of the system by the authorities concerned.
- Design:
    - provide a set of requirements, to be assessed and jointly agreed by the supporting Member States and EDF associated countries (Norway);
    - design a flight test campaign to ensure airspace integration and the future certification;

- design a system prototype in view of a serial system complying with the qualification standards usually applied in this domain (e.g. RTCA/EUROCAE[59] DO-254[60], DO-178[61] and DO-160[62])

- System prototyping:

  - a system prototype must be produced to enable concrete testing in live environment.

- Testing:

  - the performances of the system prototype according to the functional requirements, as well as certification and qualification potential issues as identified in the certification plan, must be evaluated through a consistent test campaign, including through a flight test campaign if possible.

In addition, the proposals must substantiate synergies and complementarity with ongoing multilateral European programmes and activities in the field of laser communications (e.g. EDRS[63]).

Functional requirements

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

- obtain higher reception power and signal-to-noise ratio at the receiver side, as compared to RF, enabling faster bi-directional communications with lower bit-error-rates and high data rate in the order of Gbps;
- achieve reliable airborne laser telecommunications within 2 seconds for establishing the link with the satellite;
- use same interfaces as for RF communications;
- include beam-steering for precision pointing and tracking of the satellite (LEO[64], MEO[65] and GEO[66]), compensate vibrations or resist to vibrations;
- provide power consumption and heat dissipation that can be supported by the aircraft;
- perform signal transmission which does not risk inflicting any danger, while being resistant to blinding and dazzling;
- establish a laser communication link under influence of challenging atmospheric (e.g. magnetic anomalies) and light weather conditions (e.g. partly cloudy conditions);

[59] Radio Technical Commission for Aeronautics/European Organisation for Civil Aviation Equipment.
[60] RTCA/EUROCAE DO-254 ED-80 Design Assurance Guidance for Airborne Electronic Hardware.
[61] RTCA/EUROCAE DO-178C Software Considerations in Airborne Systems and Equipment Certification.
[62] RTCA/EUROCAE DO-160 Environmental Conditions and Test Procedures for Airborne Equipment.
[63] European Data Relay System (European Space Agency project).
[64] Low Earth Orbit.
[65] Medium-Earth Orbit.
[66] Geostationary Orbit.

- be designed to be integrated into various aircraft (e.g. fixed-wing medium/high-altitude unmanned aerial vehicles, fixed-wing governmental multi-role aircraft), with enhanced SWaP-C[67].

Expected impact

The outcome is expected to contribute to:

- the enhancement of information superiority during EU missions and operations;
- the effectiveness and unity of command during ISTAR operations;
- the enhancement of the EU freedom of action in the field of ISTAR, but also joint electronic warfare, hence reinforcing the strategic autonomy of the EU;
- the increase of survivability of UAS, notably MALE RPAS, due to the drastic increase of the aircraft C2 link immunity;
- the acquisition of an increased innovative potential for the European defence industry in the technological field of airborne laser communications.

2.5.3. EDF-2023-DA-C4ISR-TRPAS: Tactical RPAS

- **Indicative budget:** EUR 42 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Due to rapidly and continuously evolving geopolitical conditions, EU Member States and EDF associated countries (Norway) are facing the challenge to carry out operational tasks and military missions, including with relation to Common Security and Defence Policy (CSDP). This requires a credible tactical picture built in an efficient and timely manner, hence contributing to situational awareness, while helping to manage the battlefield and the forces engaged. For that purpose, a set of Information, Surveillance and Reconnaissance (ISR) capabilities, notably including tactical Unmanned Aircraft Systems (UAS), is necessary.

As highlighted in commonly agreed capability development priorities, there is a permanent need to detect, identify and track ships, aircraft, vehicles, personnel and other equipment through a continuous air-space wide area, using interoperable unmanned surveillance systems. Such systems should operate with guaranteed data integrity in all weather conditions and all types of environment, including in contested and denied environments. To support this need, tactical remote piloted aircraft systems (T-RPAS) equipped with modern sensors for ISR missions can provide reliable, cost-effective, easily deployable and recoverable means for the effective collection and timely delivery of information for the production of intelligence, situational awareness and decision-making.

[67] Size, Weight, Power and Cost.

Specific objective

The specific objective of this topic is to develop a multi-purpose/multi-role T-RPAS, for the potential use by units of mainly up to divisional size. It will collect tactical level intelligence (real-time target cinematics, terrain, enemy location and movements) with high-performance multi-sensor equipment, through ISR (ground, maritime and air) and targeting missions, in addition to other related tasks (target acquisition, identification, tracking).

T-RPAS pose the problem of operational versatility. Indeed, fitting these platforms with best-in-class performance characteristics could lead to an increase in size and weight, with the risk of losing their tactical specificity. Therefore, the new generation of T-RPAS should meet the need for an efficient payload while being equipped with low SWaP (Size, Weight and Power) vehicle management systems. The aircraft should also have increased endurance and range, in order to maximise its operational availability in a given Area of Interest (AoI).

Most of EU Member States and EDF associated countries (Norway) need to grant a Type Certificate to their RPAS through their military aviation or civil airworthiness authority. Up to now, most systems have been certified according to in-house rules elaborated from existing standards and specificities related to RPAS. Consequently, one challenge is to unify the approach of the supporting Member States and EDF associated countries (Norway) for T-RPAS certification by applying standards widely used in this domain (e.g. NATO STANAG[68] 4671[69]) as well as processes for fixed-wings RPAS of more than 150kg. In that respect, compliance with such standards, also applicable to T-RPAS already under development, must be carefully taken into account from the early design of the proposed new capabilities.

The proposals should target at least TRL[70] 8 (actual system completed and "flight qualified" through test and demonstration) to be validated through extensive flight testing and verification of the level of compliance with applicable airworthiness requirements.

Scope and types of activities

Scope

The proposals must address:

- airworthiness type certification and relevant supporting actions for certifying T-RPAS under development that can carry, release and control small Unmanned Aircraft (UA)and/or weapons;

- development of technology blocks to improve the T-RPAS capabilities, notably a vehicle management system (VMS) and parts of mission management system (MMS), allowing T-RPAS effective operations, including in GNSS[71] denied or contested environments, mission autonomy, and weapons engagement.

The unmanned nature of RPAS impacts the VMS and MMS architectures, the level of mission autonomy, as well as the envisioned weapons engagement capability, and requires

[68] North Atlantic Treaty Organisation STANdardization Agreement.
[69] NATO STANAG 4671 Ed.3 Unmanned aircraft systems airworthiness requirements (USAR) - AEP-4671 Edition B.
[70] Technology Readiness Level.
[71] Global Navigation Satellite System.

demonstration and certification of a quantified level of safety, redundancy and accuracy, in line with the functional requirements.

The proposals must substantiate synergies and complementarity with activities described in the call topic EDIDP-ISR-TRPAS-2019 targeting the *development of a low-observable tactical RPAS with the capability to provide near real time information and with modern self-protection*.

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 (mandatory)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (optional)

Each capability of the T-RPAS should be tested and demonstrated separately.

A flight demonstration is required for the weapon release/engagement capability. The effort should focus on safety with respect to applicable standards in military aviation combined with RPAS specificities. This work will be followed closely by the supporting Member States and EDF associated countries (Norway) military airworthiness authorities in order to define a common weapon integration preliminary standard for T-RPAS.

Supporting Member States and EDF associated countries (Norway) military airworthiness authorities will closely follow airworthiness type certification and relevant supporting actions of T-RPAS under development that can carry, release and control small UA and/or weapons.

Functional requirements

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

1) The system to develop should possess the following main top-level capabilities:

- technologies and standards that allow an open architecture, autonomy, modularity, and interoperability according to standards widely used in such fields (e.g. NATO STANAG 4586[72]);
- re-configurable sensor payloads flexibly selectable according to the mission;
- operation in contested and denied airspace environment;
- short take-off and landing (STOL)[73] capabilities[74];
- long-range, robust, covert and ad-hoc radio communication systems;
- near real-time data processing for target detection, recognition, classification, identification and tracking;
- support of collaborative ISR missions while minimising operator workload;
- cyber-secure and versatile ground station supporting multiple user profiles;
- incorporated sensor suite able to detect and localise enemy threats;
- execution of tactical air reconnaissance missions, which obtain combat information about enemy and population activities and resources through sensing payloads;
- execution of surveillance missions, which focus on systematic observation of airspace, surface or subsurface areas, places, persons or things, by visual, aural, electronic, imagery or other means to collect information;

[72] NATO STANAG 4586 Ed.4 standard interfaces of UA control system (UCS) for NATO UA interoperability - AEP-84 Edition A.

[73] Ability of the aircraft to clear a 50-foot (15-metre) obstacle within a distance of 1500 feet (450 metres) when taking-off or landing.

[76] Proposals may also consider vertical take-off and landing (VTOL).[75] In line with the weapon integration preliminary standard for T-RPAS to be addressed within the current call for proposals.

- equipment with low SWaP (Size, Weight and Power) vehicle management systems;

- release of small UA or weapons[75], with the capability to control them through the available communication links and the ability to hand over control of small UA to other parties;

- supporting training and exercises for pilots and payload operators, using an embedded simulation system within the Ground Control Station (GCS).

2) Several key aspects of the functions and/or equipment to be installed on T-RPAS should be addressed, notably:

- versatility: functions/equipment/architectures to be implemented on several T-RPAS;

- compliance with standards widely used in this domain, such as NATO STANAG 4586 and NATO STANAG 4671. A European Military Advisory Circular (AC) should be proposed to provide details for acceptable means on showing compliance of a UA VMS to applicable standards and references (e.g. STANAG 4671 / USAR.U1330 (Flight control performance), taking also into account RTCA[76]/EUROCAE[77] DO-178C[78] and DO-254[79], as well as SAE[80] ARP94910[81]);

- special conditions covering aspects beyond the applicable standards (e.g. STANAG 4671), as well as the relevant Acceptable Means of Compliance (AMCs), which are expected to be related to small UAs or weapons delivery from the T-RPAS;

- interoperability in terms of ISR product exchange in near real-time;

- cost effectiveness.

3) In particular, the VMS should:

- be capable to effectively manage a T-RPAS in GNSS denied or contested environment;

- enable hand over of control to other remote operators, or other manned assets;

- provide systems and functions that are used to sense and effectively derive vehicle position, airspeed, wind frame angles, inertial velocity, attitudes, rates, and accelerations, heading and altitude;

- provide guidance, navigation and control systems and functions that generate flight path commands and follow these commands by controlling aircraft force and moment

[75] In line with the weapon integration preliminary standard for T-RPAS to be addressed within the current call for proposals.
[76] Radio Technical Commission for Aeronautics, United States non-profit organisation.
[77] European Organisation for Civil Aviation Equipment.
[78] RTCA/EUROCAE DO-178C Software Considerations in Airborne Systems and Equipment Certification.
[79] RTCA/EUROCAE DO-254 Design Assurance Guidance for Airborne Electronic Hardware.
[80] SAE International, previously Society of Automotive Engineers.
[81] SAE ARP94910 Aerospace - Vehicle Management Systems - Flight Control Design, Installation and Test of, Military Unmanned Aircraft, Specification Guide For ARP94910.

producers. The flight path commands should be derived using various sources i.e. way points, curve paths, 4D trajectories or time coordinated paths with other UAS;

- provide control functions for altitude, airspeed, heading, attitude, body and stability axis angular rates, lateral, normal and longitudinal accelerations, aerodynamic or geometric configuration and structural modes, and follow the commands transmitted by a remote operator;

- include flexible data communication interfacing properties.

In any case, the prototyped VMS must be installed and tested in at least one RPAS satisfying relevant standards, such as STANAG 4671.

4) The mission autonomy and safety technology blocks contributing to the MMS, should:

- provide solutions for optimum 2D or 3D almost real-time flight path generation considering a combination of constraints such as:

    - threat avoidance and survival of T-RPAS;
    - specific information collection, i.e. electronic or signal intelligence;
    - EO[82]/IR[83] sensors capabilities;
    - emergency landing;
    - remote operator defined:
        - area coverage for ISR within specific time boundaries;
        - spots of high interest;
        - avoidance areas, i.e. crowded areas or hot zones;
        - landing areas in case of power loss;

- enable remote operators, in their workspace, to define the combination of constraints and to intervene at any time through automatic mode by altering those constraints or switching to manual or semi-automatic mode[84];

- be capable to engage weapons with specific safety chain and relevant functionalities of the Ground Control Station;

- include scalable level of autonomy to alleviate the workload of the operators and allow more automatic and high-level control of the T-RPAS while preserving safety (i.e. loss of control) and minimising certification needs;

[82] Electro-optical.
[83] Infrared.
[84] Semi-automatic modes are manual modes augmented partially by automatic means that minimise the remote operator's workload in lateral or longitudinal guidance.

- allow for multiple and reconfigurable sensing payloads depending on the missions, such as airborne Synthetic Aperture Radar (SAR), maritime surveillance radar, EO/IR imaging sensors, COMINT[85] / ELINT[86] equipment;

- provide on-board processing, to improve mission efficiency and target correlation, avoiding significant loss of information due to datalinks limitations. Data considered could be EO and IR full definition motion video, radar, COMINT, ELINT, etc.;

- provide automatic orientation of the different payloads based on on-board information fusion (e.g. based on available information fusion, the EO/IR payload automatically takes pictures and even identifies targets);

- allow for automatic path alteration for the accomplishment of a high value task, i.e. target identification within a window of opportunity, threat avoidance or emergency landing.

5) The T-RPAS under development and those T-RPAS used for testing and demonstrating the technology blocks must:

   - have a maximum take-off weight between 450 and 1250kg;

   - have a minimum endurance of 8 hours;

   - be able to release at least four small UA with Maximum Take-Off Weight (MTOW) between 10 and 50kg, or weapons. The weapons and the releasable UA must be certified for safe separation and engagement. The releasable UA must also be qualified for safe teaming with the mothership tactical RPAS (including datalinks, latency for critical aspects, C2[87], guidance and position in GNSS-denied or contested environment, etc.);

   - be certified in accordance with applicable requirements and AMCs as per applicable standards, such as NATO STANAG 4671 taking also into account RTCA/EUROCAE DO-178C and DO-254, as well as SAE ARP94910, with additional special conditions related to releasable UA or weapons engagement and delivery from the T-RPAS.

   In case the T-RPAS uses a not yet certified engine, certification actions must be proposed accordingly.

   Where relevant, type certificate or equivalent from EASA[88] should be considered in order to cover the envisioned non-military functions and systems of the T-RPAS.

   A Military Type Certificate must be issued by a competent European Military Airworthiness Authority containing at least: (a) System Identification, (b) System configuration details, (c) Requested operating frequencies, (d) Statement of compliance with applicable standards, such as STANAG 4671 (including if applicable additional

[85] Communication intelligence.
[86] Electronic intelligence.
[87] Command and Control
[88] European Union Aviation Safety Agency

conditions, exemptions, and deviations), (e) List of approved publications – Operating and maintenance, (f) Issuing Agency, (g) Date of Issue.

Expected impact

The outcome is expected to contribute to:

- improving the usage of the civilian airspace for a European tactical RPAS without compromising flight safety;
- decreasing the risk of unmanned ISR missions through the drastic increase of the T-RPAS survivability thanks to the adoption of self-protection measures regarding robustness to GNSS jamming and datalinks contests at the borders of Europe;
- raising a unified airworthiness certification methodology and baseline for Tactical RPAS by all supporting Member States and EDF associated countries (Norway), based on applicable standards, such as NATO STANAG 4671. This will ease the mutual acceptance of Type Certificates for T-RPAS delivered by the supporting Member States and EDF associated countries (Norway);
- opening the way for certification according to applicable standards such as STANAG 4671 by EU Member States and EDF associated countries (Norway) Military Airworthiness Authorities for tactical RPASs with small releasable drones or weapon engagement capability;
- maximising the capability of the tactical RPAS system to operate efficiently in wider operational domains by developing a state-of-the-art Vehicle Management System;
- strengthening the European RPAS industrial base at the front edge of the international RPAS competition, enabling a real EU strategic autonomy in this domain, especially on critical functions.

2.5.4. EDF-2023-DA-C4ISR-DAA: Detect and avoid

- **Indicative budget:** EUR 40 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Nowadays, unmanned aerial systems (UAS) (or remotely piloted aerial systems - RPAS) are used to support an extended spectrum of military missions. Their involvement in the future, notably with the next generation air combat systems, is expected to increase. However, these UAS may be limited to operate in segregated airspace or within visual line of sight, especially when the need arises for their safe simultaneous operation together with other manned and/or unmanned assets.

To overcome these limitations, all manned and unmanned air assets need to be integrated safely and effectively in non-segregated airspace, notably in the context of the Single European Sky.

Detect and Avoid (DAA) systems are technologies that allow UAS to integrate safely into airspace including civil airspace, avoiding collisions with other aircraft. These systems observe the environment surrounding the UAS, detect traffic, informs the pilot, assess risk of collision and when appropriate generate a new flight path to avoid collision.

As a key enabler for air traffic integration (ATI) of UAS, DAA effectively provides the remote pilot with the ability to perform the required duties regarding safety hazard of conflicting airborne aircraft. Through collection and fusion of sensor data, the remote pilot obtains awareness of traffic, while assisted by collision avoidance (CA) and remain well clear (RWC) functions, preventing the unmanned aircraft to be involved in a collision hazard or, if so, allowing manoeuvre to avoid a collision even in case of lost pilot action.

Therefore, the general objective of this topic consists in reaching a consistent level of maturity allowing to integrate the envisioned European DAA capabilities into the maximum possible UAS within the various Member States and EDF associated countries (Norway) fleet in order to allow for UAS operation in the airspace anywhere and at any time.

Specific objective

The specific objective of this topic is to take the necessary steps towards a standardised, qualified and certified DAA solution to be integrated in many different UAS, hence allowing a full integration for civil and military airspace and U-space[89] services where applicable, and operational use of current and near-term platforms to be used, such as MALE RPAS.

Scope and types of activities

Scope

The scope of the topic is to provide a fully standardised, qualified and certifiable DAA solution for UAS. The DAA solution should aim at fully integrating RPAS in the general airspace (A-G classes) without any limitations regarding operation in the airspace including in TMA[90]. This is to be achieved by involving all the relevant key-stakeholders regarding airspace integration in Europe (i.e., EUROCAE[91], EASA[92], EUROCONTROL[93], SESAR[94], ANSPs[95], pilot organisations and ICAO[96]).

The outcome should be a standard for DAA systems emanating from a fully developed DAA solution. This solution must be validated by simulation and under real flying conditions, allowing integration in various UAS, including MALE RPAS and tactical RPAS.

The overarching scope of this topic will be to push the DAA solution (conflicting airborne traffic) for UAS into designs for full operational capability without any UAS specific

[89] Set of services and procedures to support safe, efficient and secure access to airspace for Unmanned Aircraft Systems (UAS).
[90] Traffic Monitoring and Analysis.
[91] European Organisation for Civil Aviation Equipment.
[92] European Union Aviation Safety Agency.
[93] European Organisation for the Safety of Air Navigation.
[94] Single European Sky ATM (air traffic management) Research.
[95] Air Navigation Service Provider.
[96] International Civil Aviation Organisation.

restrictions in European airspace including in TMA. The designs must be European standardised and recognised in Europe by relevant authorities and stakeholders. The DAA solution must be designed to be integrable for both MALE and tactical RPAS classes. The DAA solution design must be made for aeronautical use on aircraft and as such be subject to qualification and certification.

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)

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

- Studies:
    - establish an inventory of past and existing projects and solutions worldwide for the DAA function, analyse their strengths and weaknesses in order to make sure DAA will come to state-of-the-art solutions;
    - specification of facilities, test conditions, measurements, instrumentation, analysis of ongoing and future regulation requirements, data analytic capabilities, environment, engineering development sites and analysis processes, which better serve the testing, prototyping, qualifying and certifying procedures to follow;
    - specification of the system integration procedures which facilitate the accommodation of system updates and the integration of new innovative functional capabilities;
    - assessment of the possibility to define a common site for demonstration, testing, analysing and training purposes, using the same or interoperable facilities;
    - study collision avoidance manoeuvre dedicated to low-speed performance RPAS;
    - provision of drawings, reports, analyses, certification plan and data in view of future approval and certification of the system by supporting Member States and EDF associated countries (Norway) authorities.
- Design:
    - preparation of a detailed test and evaluation master plan;
    - elimination of deficiencies identified and incorporate possible new features to upgrade the configuration accordingly;
    - defining system architecture to make a consistent set of sub-functions of the DAA solution for MALE and tactical RPAS;
    - feasibility of tactical RPAS applications:
        - DAA adaptions to tactical RPAS operations;
        - certification considerations for tactical RPAS;
    - sensors:
        - minimising the weight/volume of the sensors/system applying a SWaP[97] approach;
    - provide validation and standardisation of DAA;

[97] Size, Weight, and Power

- provide resources to obtain European standards;
- standardisation:
  - support the standardisation in terms of maintaining the already available standards based on the feedback from testing;
  - complementing standards with new elements stemming from the activities.

- System prototyping:
  - definition and build/update of the "engineering development model" version of the pre-production prototype, to evaluate the performance of the system;
  - prototype the system with environment constraints level (e.g. vibrations, temperature, RTCA[98]/EUROCAE DO160) corresponding to different RPAS classes (e.g. MALE RPAS, Tactical RPAS, rotorcraft UAS as optional).

- Testing:
  - testing of the system as a unified whole, in terms of performance, compatibility, reliability, maintainability, availability and safety;
  - system performances and behaviour tested and validated in environments of European air traffic and international air traffic including relevant parameters;
  - validation of the DAA solution;
  - verification of system components to prove feasibility;
  - checking that the software meets the system requirements and its compatibility with the hardware;
  - execution of simulations, to evaluate the performance, effectiveness and compatibility between the prime defined mission and specific oriented segments of the system;
  - execution of field tests in a realistic operational environment, to verify the system's performance in different realistic scenarios including collision avoidance scenarios;
  - verification of interoperability with the remoted pilots, in terms of data link characteristics, communication protocols and human-machine interfaces efficiency;
  - diagnostic on discrepancies, faults and non-conformities with the wished system requirements and behaviour and quick response by a remedial plan of actions.

[98] Radio Technical Commission for Aeronautics

- Qualification:
    - checking that the system meets its operational requirements to effectively accomplish its mission and user needs;
    - evaluation of all elements of the system on an integrated basis;
    - evaluation of all major interfaces among the different subsystems or subfunctions of the DAA;
    - assessment of the possible impact of the DAA system to other closely related operating systems of the UAS;
    - derivation, evaluation, and application of possible upgrading changes to the system's configuration;
    - provision of evidence for further environmental qualification;
    - final identification of detailed plan for certification of UAS equipped with DAA;
    - obtain full recognition of the DAA solution and DAA related standards including regulatory conditions, AMCs[99] or other MOC[100].

In addition, the proposals must substantiate synergies and complementarity with activities described in the call topic EDIDP-ISR-DAA-2019 targeting the *development of a European Detect and Avoid (DAA) function based on new sensors and processing for RPAS integration into air-traffic management*, as well as the European Defence Agency's Mid-air collision avoidance system (MIDCAS) project and SESAR.

Functional requirements

The proposed product and technologies should meet the following functional requirements, in line with capability requirements as jointly agreed by supporting Member States and EDF associated countries (Norway):

- a DAA solution to allow operation in all airspace classes (including TMA) and at any time without UAS specific restrictions;
- a DAA solution that can be certified (military and civil) for the intended operation with involvement of relevant stakeholders for respectively certification and scenario definition;
- fulfil every given requirement resulting from the standardisation efforts in cooperation with the relevant stakeholders in ATI in Europe;
- identify and assess detailed additional common requirements in accordance with needs of EU Member States and EDF associated countries (Norway) while ensuring the

[99] Acceptable Means of Compliance.
[100] Means of Compliance.

harmonisation of international requirements and potential military specific requirements on DAA systems;

- enable UAS navigation in airspace without constant inputs from remote pilots, thanks to an agreed and final version of a standard for detect and avoid;
- enable participation of UAS to the same operation with other manned and unmanned aircraft;
- detect and avoid cooperative and non-cooperative traffic by providing traffic information, as well as, when appropriate, providing alerts and guidance, and performing avoidance manoeuvres while not creating another dangerous situation with other aircraft;
- ability to execute either CA or RWC manoeuvres. Alerts and guidance of RWC manoeuvres as a second layer of conflict management, when separation is the responsibility of the remote pilot. Execution of collision avoidance as third and last layer of conflict management, to protect the aircraft from collision in an imminent collision hazard;
- provide interoperability with CA systems (ACAS[101]/TCAS[102]) on manned and unmanned aircraft;
- execute manoeuvres complying with the existing rules and regulations for manned aircraft;
- operate without interfering or counteracting the normal execution of ATC[103];
- an intruder detected by different sensors to be processed in a way that it is only displayed to the pilot as a single intruder following sensing data fusion;
- use miniaturised non-cooperative sensors for smaller UAS compatible/compliant with minimal operational performance standards (MOPS);
- support coordination with other DAA hazard detection systems to assure appropriate actions when different hazards are present at the same time;
- fulfil civil and military requirements for different categories of RPAS with initial focus on MALE and tactical RPAS;
- be integrable (minimising the customisation process) in different categories of RPAS;
- perform its intended functions in en-route and Terminal Manoeuvring Area (TMA);
- obtain system performances and behaviour validated:
    - with models representative for European air traffic and international air traffic including relevant parameters. (e.g. Monte Carlo simulations);

[101] Airborne collision avoidance system.
[102] Traffic collision avoidance system.
[103] Air Traffic Control

- in environments of European air traffic and international air traffic including relevant parameters (man-in-the-loop simulations).

Expected impact

The outcome should contribute to:

- UAS/RPAS access to civil and military airspace with full operational capability regarding DAA for the hazard of conflicting airborne traffic without any UAS/RPAS specific restrictions in European airspace including in TMA;
- new and more flexible uses of UAS operational exploitation, due to the drastic safety margins increase;
- improved civil / military cooperation to airspace management;
- availability to the European industry of an improved toolbox of DAA functions, for the purpose of airborne conflict management;
- improved UAS radar and electro-optical (EO)/infrared (IR) sensor detection, tracking and identification capabilities;
- European standardisation of RPAS/UAS DAA technology for the benefit of the EU and EDF associated countries;
- increased European industrial capability and competitiveness in UAS and autonomous systems.

2.5.5. EDF-2023-DA-SENS-GRID: Sensor grid

- **Indicative budget:** EUR 27 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Driven by the changing geopolitical situation, Europe is facing new and evolving threats that are smaller, faster, and more diverse, with increased manoeuvrability, in greater numbers and with denial-of-service capabilities. There is a strong need to detect and characterise challenging targets. Those include small size, high speed, low signature (stealthy) targets and targets in congested and contested electromagnetic environments, e.g. urban environments. There are various examples of such challenging targets that necessitate different configurations and range of active and passive sensors to be detectable such as UAS, hypersonic or ballistic missiles, stealth targets, swarms, etc.

Most of our potential adversaries have gained technological and operational knowledge in a number of sensor's capabilities, including both active and passive sensing. It is obvious that the technological lead in sensors will provide a definite technological advantage for the fast and accurate shaping of situational awareness and battlefield management.

Moreover, European standards for the Concepts of Operations and Rules of Engagement aim at achieving positive target identification before any use of weapons to reduce fratricide and avoid unintended casualties or destruction. Optimal use of sensors in an architecture could increase the level of confidence to have accurately recognised and (if possible) identified a real threat with a low false alarm probability.

Specific objective

The EU Member States and EDF associated countries (Norway) already own or are developing a variety of high-end sensor equipment and weapon systems for defence against challenging targets. However, in most cases even at national level and most importantly at European level, existing systems still follow stand-alone concepts, that is not considering fusion of data from distributed networks of sensors and especially not cooperation between sensors. For the specific application of naval surveillance, efforts are addressing the exchange and fusion of plots of targets created by the different sensors, through domain-specific communication systems (e.g. through call EDF-2022-DA-NAVAL-NCS). There is the necessity for complementary efforts.

Indeed, facing new and challenging threats, requires building an even more collaborative real-time sensor network, where particular sensors' capabilities will be optimally combined through a flexible architecture.

Such an integrated sensor network solution should encompass passive and active surveillance techniques based on different types of sensors working in different bands of the electro-magnetic spectrum (electro-optical and radio frequency) in order to collect information in a broad spectrum. Advantages of both stationary and mobile sensor platforms could be exploited, e.g. through sensor dynamic resource management. Information processing suitable for detection of new threats should be supported both close to the sensor and – after transferring the data – at a more central processing unit, where signal and data fusion could create a complete situational picture.

This approach is expected to considerably improve the military capabilities in detecting, tracking, recognising and eventually identifying novel challenging targets in the battlespace by increasing the probability of target detection, as well as track stability and creating a continuous real-time situational picture. This will provide a technologically competitive advantage in the fields of situational awareness, mission planning, support of decision making and eventually even fire control.

Scope and types of activities

Scope

The proposals must address the establishment of a European Architecture Framework for multiple interoperable and collaborating sensors. Efforts should aim at overall sensor performance optimisation (e.g. in terms of coverage, accuracy and efficient use of electromagnetic spectrum) against diverse and evolving challenging threats. The Architecture Framework should enable the integration and optimal use of EU Member States and EDF associated countries (Norway) sensor assets that exist or are under development and collaborative use of the sensors data.

The architecture framework must be capable of integrating radar sensors and it should be capable of integrating other types of sensors such as electro-optical, acoustic or others with

various modes of operation, such as ground-based and airborne, passive and active, stationary and mobile. The proposals may not include efforts on the integration of space assets that would create unnecessary duplications with ongoing and planned projects but may prepare the future combination of the different research and development results in the future.

The proposals should include aspects of flexible architectures and dynamic asset and resource management for real-time planning of sensor grids adaptable to different tasks, threats and situations. The proposals may not address the development of new sensors.

The proposals should address aspects of data exchange and data fusion between sensors and command centres. The proposals may provide the creation and maintenance of a shared common picture of available sensors and effectors.

The proposals must address surveillance tasks and tracking and aim at improved accuracy of threat detection, tracking and classification of targets. Activities proposed may extend to the field of fire control to advanced effectors in a network. The proposals must be suited to support Integrated Air & Missile Defence (IAMD) operations. Additionally, the proposed architecture framework should be capable of addressing other types of targets or domains of application (e.g. drone detection, swarm detection).

The proposals must address cybersecurity aspects as integral part of the architecture consideration.

In addition, the proposals must substantiate synergies and complementarity with foreseen, ongoing or completed activities in the field of Integrated Air & Missile Defence, notably those performed or foreseen in the context of the PESCO initiative TWISTER and the call topics EDF-2021-AIRDEF-D-EATMI and EDF-2022-DA-SPACE-SBMEW, as well as other projects in the field of radar technologies, e.g. in the EDA framework.

The proposals should take into account projects with related challenges concerning the integration of heterogeneous sensors, such as the call US-03-2019 of the Preparatory Action on Defence Research, which addressed the integration of heterogeneous drone-carried sensors, and the establishment of a collaborative surveillance network such as in the call topic EDF-2022-DA-NAVAL-NCS, by aiming at complementary outcomes. The proposals should also ensure compatibility with ongoing projects in other frameworks, in particular efforts to establish surveillance networks in the NATO context.

The proposals may not particularly focus on the use of over-the-horizon radars using sky-wave propagation as addressed by the call topic EDF-2021-DIS-RDIS-OTHR.

Targeted 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

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	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)

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

- Studies:
    - define operationally realistic use cases (i.e. threat descriptions, sensor grid constellation, communication network requirements…) and define adequate performance indicators;
    - definition and modelling of objectives, tasks and threats to determine assignments and settings of sensors, and optionally effectors;
    - execute and analyse performance simulations to evaluate the potential added value of the architecture;

- investigate a concept for sensor planning and dynamic resource management on different command levels, based on available or new dynamic resource management solutions.

- Design:
  - integrate sensor planning and dynamic resource management in the architecture framework;
  - describe the top-level architecture;
  - define the communication network architecture and requirements;
  - establish the required Quality-of-Service needs for contributing sensors;
  - define the timing and geographic positioning needs for operating a sensor grid;
  - include or establish a protocol enabling flexible integration and elimination of assets from the network;
- System prototyping:
  - prepare a prototype implementing the architecture;
- Testing:
  - perform a demonstration of the added-value of the architecture using various European assets;
  - analyse the results in terms of quality of service and key performance indicators.

Additionally, the proposals should cover the following tasks:

- Studies:
  - to investigate modern signal processing, advanced sensors and data fusion and decision support (e.g. using artificial intelligence, machine learning) to achieve better target information extraction and complementarity between different sensors;
- Design:
  - adaptation of existing C2 interfaces.

The proposals may also cover the following tasks:

- Design:
  - to design the necessary algorithms to achieve better target information extraction and complementarity between different sensors, using modern signal processing, advanced sensors and data fusion and decision support;

- System prototyping:
    - establishment of new user interfaces.

Functional Requirements

The proposed development should meet the following functional requirements:

- the architecture should be able to incorporate information from sensors being used within the Member States and EDF associated countries (Norway);
- the architecture should use the available information to optimally set up its attached sensors, given a certain task and taking into acount sensors' spatial diversity, complementary sensing geometries and measurement error statistics;
- the architecture should have a certain level of control over its attached sensors (e.g. concerning their modes of operation);
- the solution should enable data fusion from multiple and possibly moving sensor nodes as well as information transmission to multiple potentially mobile military command centers;
- the architecture should be scalable and be able to establish small networks (a few sensors locally) to large networks of sensors (large amount of sensors placed in multiple countries);
- the architecture solution should be able to assess its current performance;
- the solution should allow dynamic and real-time planning of the integration and configuration of heterogeneous sensors to adapt the sensors grid to the mission;
- the solution should be able to adapt the network and sensors' settings to optimise the performance of each sensor by taking advantage of information gathered by other sensors. Each sensor of the grid should be able to compensate some of the detection and discrimination limitations of the others, thus offering better overall performance;
- the solution should improve the detection, classification, identification and continuous tracking of single and multiple airborne, ground and seaborne threats (such as small size, high speed, low contrast, camouflaged, in degraded visual environment, in an urban environment, UAS/UAV/Drones, hypersonic/ballistic missiles, stealth targets, cruise missiles, etc.);
- the solution should be adaptable towards future threat evolutions;
- the solution should be in line with operational doctrines and systems of EU Member States and EDF associated countries (Norway). The resulting architecture and standards need to be open for all EU Member States and EDF associated countries (Norway);
- the solution should be compatible with efforts to establish surveillance networks in the NATO context;

- the solution should support efficient electromagnetic spectrum management;
- the solution should mitigate performance limitations caused by intentional or non-intentional interference in the electromagnetic spectrum, e.g. through the use of multiple sensors and communication systems operating in diverse spectrum bands, through adapting sensors settings, etc.;
- the architecture framework should take into account cybersecurity;

Optionally, the solution may be able to make use of threat libraries to support different types of sensors to detect and classify targets.

Expected impact

The outcome should contribute to:

- enhancing information superiority and situational awareness at European level by achieving effective, robust and efficient target surveillance and reconnaissance;
- performing a major step towards a European Integrated Air & Missile Defence (IAMD), contributing to European strategic autonomy and complementing capabilities of NATO allies;
- enhancing the cooperation of armed forces of EU Member States and EDF associated countries (Norway) and increase the interoperability among different sensors at European level.

2.5.6. EDF-2023-DA-CYBER-CSA: Full-Spectrum Cyber Situational Awareness for enhanced Cyberspace Operations Support

- **Indicative budget:** EUR 20 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

According to the EU Military Vision and Strategy on Cyberspace as a Domain of Operations[104], cyberspace comprises the distinct but interrelated physical layer, logical layer and cognitive layer, which cannot be considered independently, but is one facet of the triad cyberspace, electromagnetic environment and cognitive environment. Pointing to the same direction, NATO's doctrine for cyberspace operations described cyberspace in terms of three layers: physical, logical and cyber persona, where Cyberspace Operations (CO) always include the logical layer, but may also include activities or elements from the other two layers.

Military activities in cyberspace may comprise two overarching missions: to protect and defend their own cyberspace (national level, EU level, Coalition level, etc.) and conduct COs. In this context, Cyber Situational Awareness (CySA) describes the capability of perceiving, reasoning and projecting knowledge of the elements in the battlespace necessary to make

[104] ST11926/21 (16.09.2021)

well-informed decisions, putting emphasis on the cyber situations and their propagations to planned missions. Commanders need to acquire CySA at strategic, operational and tactical levels in order to make informed decisions on how to operate in cyberspace towards enhancing mission assurance and achieve cyber effects to support mission objectives. On the other hand, a holistic and human-understandable representation of the whole situation is needed.

Specific objective

Previous national and EU initiatives have addressed the conceptualisation and development of technologies for the acquisition of situational awareness by focusing on the logical sub-layer of cyberspace (software, services, networks, interfaces, etc.) but there is a raising demand of military-focused solutions able to holistically understand the cyberspace as a whole, taking into account all the layers.

The military operations in cyberspace possess complexity intrinsically linked to the challenge of understanding in real time the state of the different data processing planes in which its various actors coexist, as well as the relationship with the lines of effort, tasks and objectives of the missions they enable, where allies, enemies, unknown and neutral entities may coexist. These military operations extend the scope of the conventional understanding of situations in Cyber-Physical Systems (CPS) towards covering the understanding of the dependencies between the cyberspace and the COs context, the latter comprising Lines of Operation (LOOs) and their dependencies, Decisive Conditions (DCs) and how effects triggered by cyber situations may be derived on them, cyber Centres of Gravity (CoGs), missions in or through cyberspace, mission-enabling capabilities linked to cyber assets, etc., and impact/effect dimensions related with kinetic battle domain (air, land, space, sea) or hybrid propagations (information, political, economic, social, environmental, etc.). Developing mission-centric CySA capabilities able to assist human decision-makers while preserving the commander's intent is considered a challenge, which is amplified by the difficulty of understanding the different sub-layers of cyberspace as a single environment and considering the hybrid effects consequent of cyber situations.

Scope and types of activities

Scope

The proposals must focus on developing capabilities for mission-centric CySA, which as a System of Systems (SoS), must comprise independent enablers able to act jointly towards facilitating human decision-making through synergies between them. The proposals should address challenges in all the following areas:

- Full-spectrum cyber situational awareness:
    - facilitating human decision-makers understanding of the cyberspace spectrum as a whole, including physical (hardware, geographical, Electromagnetic Spectrum, etc.), logical (software, networks, etc.) and cyber persona (Human-Machine Interfacing, cognitive, psychological, social) assets, conditionings, impacts and effects.
- Decision, command, and control support:

- identification and assessment of creative and flexible options (CO's Areas of Operation (CoAs), countermeasures, etc.) and opportunities to accomplish missions in or through cyberspace. The proposals should bring CySA to assist decision-making under full-spectrum operational friction, including uncertainty when faced with a thinking and adaptive enemy, which may operate on conventional but also hybrid measures. CySA also facilitates understanding the effect and stress of COs on human actors;

- associating full-spectrum cyber situations and opportunities with objectives, strategies and initiatives of actors operating within the CoAs (considering features such as interest, responsibility, influence, etc.). Among others, this includes assessing the status of mission essential assets, recognition of players in the operational environment, or developing a joint Situational Awareness (SA). . As part of the characterisation of the mission, all instruments of power should be taken into account (approaches such as PMESII[105] or PESTLE[106]). Mission Engineering (ME) may be considered with a view to help determining and analysing the composition and status of decisive cyber conditions that support or impact own missions, while assisting the assessment of opportunities on neutral/adversarial missions, centres of gravity and CoAs;

- capability orchestration enabling deployability within joint forces, and adapted to decision-makers at all war levels. This includes adapting to collaborative environments like joint and/or combined operations at the national, EU and NATO levels. Capability to dynamically adapt to the operational context in agreement with different human intervention profiles.

– Interoperability:

  - the results should enable interoperability with EU-level and NATO-level C2 initiatives.

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)

[105] Political, Military, Economic, Social, Information, Infrastructure (PMESII).
[106] Political, Economic, Sociological, Technological, Legal and Environmental (PESTLE).

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 (Optional)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes (Optional)
(h)	**Certification** of a defence product, tangible or intangible component or technology	Yes (Optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (Optional)

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

- studies and design of a holistic CySA enabling solution able to orchestrate EU cyber defence-related capabilities towards achieving full-spectrum awareness for assisting COs in or through cyberspace, on a mission-centric perspective;
- studies and design of specific CySA capabilities to discover and assess opportunities in or through cyberspace in the context of multi-domain operations, and to support commanders to benefit from them;
- studies and design of specific CySA enabling capabilities for an easy full-spectrum understanding of cyber frictions, adversarial postures and their effects according to the commander's intent, with emphasis on mission characterisations, analysis and implementation;
- System prototyping: demonstrators on the previous area’s points.

In addition, the proposals should cover the following tasks:

- testing of complementary large-scale demonstrators supported by national and EU end-users on tactical, operational and strategical storylines;
- explore the recent advances of edge processing in order to ensure independent functionality and partly-offline reduced human intervention especially at the tactical level as MSOCs and MNOCs often use low quality air gapped networks.

The proposals must also substantiate synergies and complementarity with activities described in the call topics EDIDP-CSAMN-SSS-2019 and EDF-2021-CYBER-R-CDAI, and in other relevant EU ongoing activities.

The proposals must give due consideration to design principles and implement a specific ethics-focused approach during the development, deployment and/or use of AI-based solutions, e.g. by the Assessment List for Trustworthy AI (ALTAI), in order to develop procedures to detect and assess the level of potential ethical risks and address them.

Functional requirements

The proposals must be supported by a set of capability requirements as agreed by a group of Member States or EDF associated countries (Norway). The proposals must give evidence of coherence between the proposed activities and the requirements by the Member States and EDF associated countries (Norway).

The proposals should aim to provide:

- a full-spectrum Recognised Cyberspace Picture (RCyP), combining cyberspace, electromagnetic environment and cognitive environment, that is able to assist human decision-makers from a mission-centric perspective;
- capability to analyse RCyP information and forecast combined effects for Cyberspace Operations, based on monitored, collected, shared and fused data from multiple sources and authorities, and derived from different battlespace dimensions;
- ability to share information and cooperate with different stakeholders prior, during and after mission execution;
- interoperability with EU Cyberspace Operations;
- capabilities to discover, track, identify, and assess both threatening situations (for mitigation) and mission-centric opportunities (for exploitation), in order to make successful Cyberspace Operations.

Expected impact

The outcome should contribute to:

- a stronger, more competitive and technologically independent European Defence Technological and Industrial Base (EDTIB) when it comes to solutions for cyber defence capabilities, cyberspace operations and Cyber Situational Awareness;
- improved situational awareness, resilience and security of EU Cyberspace Operations;
- reduction of the minimum reaction time for deployment and increased feasibility of EU military missions;

- improved interoperability and future capabilities of EU Member States and EDF associated countries (Norway) forces in the area of cyber defence for cyber mission planning and execution;
- improved interoperability of C2 systems;
- better cooperation of EU Member States and EDF associated countries (Norway), research and industrial actors towards defining a common vision on Cyberspace Operations.

2.5.7. EDF-2023-DA-CYBER-DAAI: Deployable Autonomous AI Agent

- **Indicative budget:** EUR 26 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Artificial intelligence (AI) begins to transform cybersecurity. Recent advances in machine learning (ML) techniques could enable ground-breaking capabilities in the future, including defences that automatically interdict attackers and reshape networks to mitigate offensive operations. ML combined with AI could shape cyber operations in ways that drive more aggressive and destabilising engagements between state actors. Therefore, it is valuable to anticipate how adversaries might adapt their tactics and strategies, and to determine what challenges might emerge for defenders.

The field of AI is at a critical crossroad. Globalisation and industrialisation of AI is intensifying, while the ethical and regulatory issues of these technologies are multiplied. AI has moved from an emerging technology to a mature technology, which is no longer dealing with a speculative part of scientific research, but instead something that has real-world impact, both positive and negative. The importance of AI in cyber operations has been noticed by many nations. AI is a strategic technology that could prove incredibly consequential for the competitiveness of the EU, its Member States and EDF associated countries (Norway).

Specific objective

Today's conversations on AI in military affairs concentrate on various variants of "narrow" artificial intelligence. Current discussions on AI often primarily concentrate on ML, which is the process of using algorithms to learn from data. Much of the most exciting progress in recent years has leveraged deep learning, a technique that involves the use of layers of artificial neural networks, which are inspired by the structure of the human brain.

At a basic level, AI involves software that leverages data for learning but also requires hardware to harness the power of significant computing capabilities to enable that process. It is inherently challenging to define what AI is or can achieve when the field is so dynamic and evolving so rapidly. For the time being, AI/ML techniques are often limited by the availability of data, although this may change with advances in the use of synthetic data, real-life cyber exercises, data lakes and techniques that leverage reinforcement learning, such as the capability to learn from self-play alone.

The main challenge of this topic is to establish an investigative approach on an area of autonomous deployable AI creation, with the intention to broaden artificial intelligence perspective in cyber defence in the EU.

Scope and types of activities

Scope

The proposals must focus on the development of an autonomous and adaptative deployable AI agent. All proposed activities must ultimately support the creation of an AI agent that is able to conduct automated and semi-automated incident management on different cyber defence systems for the entire process of the incident management cycle. The solutions must support human operators, analysts and decision-makers at technical, tactical, operational, strategic and political level. In addition, solutions are expected to contribute to enhanced cyber situational awareness, increased military infrastructure resilience and improved protection against AI-based and other advanced cyber threats.

The work should identify gaps for achieving an autonomous AI agent for military systems. The final result should build on a general-purpose AI agent that can be deployed in different operating environments.

The work should also address the gap of learning data sets through the use of live-fire exercises, data lake concepts and self-learning algorithms. Access to the data sets should be planned in a decentralised way to allow the solution to be deployable. This implies, that new architectures and solutions should be considered in achieving decentralisation, utilising and enhancing for example AI-powered edge computing.

The assessment of the proposed solution must be evaluated during live-fire exercises with a method allowing comparison of the developed AI agent against actual defending teams. This means using learning data from different exercises, but also data feeds from the exercise itself, where the AI agent is competing.

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	Yes (mandatory)

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

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

- Studies:
    - the proposed activities must include feasibility studies drawing upon real-world scenarios and live-fire exercises in order to ensure that developed solution and techniques are fit-for-purpose.
- Design:
    - the proposed solutions must include creation of AI-based techniques for detecting and understanding adversarial activity;
    - the proposed solution must include creation of AI-based techniques for building knowledge about own protected ICT systems (e.g. a “cyber record” with current and historical information). This must include collecting, linking and fusing different kinds of information about the system hardware, software, and the relationship between them. Previously used analysis should enhance the more generalised AI solution.
- System prototyping:

- the proposed solutions must demonstrate the creation of AI-based information collection and storage systems that dynamically adapts its collection and storage strategy to the situation as continuously analysed and perceived by the system;
- the proposed solutions must be able to conduct automated and semi-automated incident management on different cyber defence systems for the entire process of the incident management cycle.

- Testing:
  - the proposed solutions must be tested in a live fire-exercise against real defenders.

In addition, the proposals should cover the following tasks:

- Studies:
  - the proposals should reuse previously created reference systems or develop new ones and appropriate test cases to generate training data and evaluate the efficacy of different solutions, both with and without human operators interacting with the system.

- Design:
  - the proposed solutions should include creation of AI-based techniques for detecting and understanding adversarial activity tasks on:
    - analysing and triaging alarms, conducting forensics, utilising external information with varying levels of trust (e.g. threat intelligence);
    - leveraging behavioural analytics, performing kill-chain detection and analysis, assessing potential attacker intentions;
    - monitoring applications and communication activities, analysing malware;
  - the techniques should be intended for both real-time and non-real-time detection and analysis, involve multi-disciplinary approaches, use data from endpoints, networks and the cloud, and leverage distributed computing and data processing for real-time scalability;
  - the creation of AI-based techniques for building knowledge about own protected ICT systems (e.g. a “cyber record” with current and historical information) should utilise previously used analysis to enhance the more generalised AI solution;

- AI agent architecture should consider decentralised data sets with new state-of-the-art hardware;
- the proposals should include functional modules for mapping threat actors based on common frameworks like MITRE and RICHDATA.

The proposals must also substantiate synergies and complementarity with activities described in the call topicsEDIDP-AI-2020, EDF-2021-CYBER-R-CDAI, and with other relevant EU ongoing activities.

The proposals must give due consideration to design principles and implement a specific ethics-focused approach during the development, deployment and/or use of AI-based solutions, e.g. by the Assessment List for Trustworthy AI (ALTAI), in order to develop procedures to detect and assess the level of potential ethical risks and address them.

Functional requirements

The proposals must be supported by a set of capability requirements as agreed by a group of Member States or EDF associated countries (Norway). The proposals must give evidence of coherence between the proposed activities and the requirements by the Member States and EDF associated countries (Norway).

In addition, the intended final outcome should at least:

- be able to work autonomously in the deployed environment, but also allow manual interruption and reasoning of the decision process;
- be able to create AI-based information;
- be able to collect and store needed information in dynamic big data and data lake concepts in a decentralised manner;
- be deployable and it should be possible to deploy the solution in different environments with all needed components;
- Use CTI (Cyber Threat Intelligence) and technical information exchange platforms (such as MISP, HIVE) in order to enrich data sets and information of ongoing cyber activities.
- include an architecture that is open, modular, scalable, resilient and highly available.

Expected impact

The outcome must contribute to:

- a stronger, more competitive and technologically independent European Defence Technological and Industrial Base (EDTIB) when it comes to solutions for next generation cyber defence capabilities;
- enhanced security for the EU, its Member States and EDF associated countries (Norway) by ensuring capable defence measures against AI-based cyber attacks;
- alleviating human resource availability problems;

- advanced preparedness to counter emerging threats for critical infrastructure providers and to enhance military mobility.

2.5.8. EDF-2023-DA-SPACE-SSA: Initial operational capacity for Space situational awareness C2 and sensors

- **Indicative budget:** EUR 100 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

European cooperation on military space situational awareness (SSA), including the development of a common Space Surveillance Network (SSN), interoperable military SSA Command and Control centres, exploitation tools and new SSA sensors, is recognised as a key solution to enhance Space Domain Awareness (SDA) of EU Member States, EDF associated countries (Norway) and the EU. A SSA capability, based on the capabilities of the Member States and EDF associated countries (Norway) and taking into account interoperability and standards developed between NATO members, is crucial to assess the space situation. This capability, focused on the needs and requirements of the EU Member States and EDF associated countries (Norway) defence end-users, is required to characterise and identify intentional threats against the EU, its Member States and EDF associated countries (Norway) space infrastructure and may also, as a side effect, complement and extend current and future EU Space Surveillance and Tracking (EU SST) services provided by dual-use sensors.

The main challenges faced by a European approach of military SSA are:

- to harmonise the requirements for a shared Recognised Space Picture (RSP) among supporting Member States and EDF associated countries (Norway) (sMS) focusing on defence users' needs thus increasing cross-country military coordination;

- to characterise space activities which represent potential threats against sMS space systems, thus contributing to the deterrence of space attacks and to the support to space operations;

- to achieve a larger degree of European autonomy on military SSA and to safeguard European interests in space.

General objective

The general objective of this topic is to develop interconnected military SSA centres with their respective sensors to foster a larger degree of European autonomy with respect to awareness of the situation in space in order to contribute to a RSP, and support space operations, taking also benefit of relationships which may be established with other partner nations and organisations and their capabilities.

Specific objective

The specific objective of this topic is to develop military SSA sensors, command and control centres and Space Surveillance Network initial operational capability among the sMS.

Scope and types of activities

Scope

The proposals must address the development of a military SSA capability broken down into two components:

- sensors and data processing for detection, tracking, identification and characterisation of space objects in LEO, MEO and GEO orbits;
- Space Situational Awareness Command and Control (SC2) centres, able to manage the sensors and the processing of collected data, including fusion of data processed at sensor level, and a space surveillance network (SSN) interconnecting military SSA C2 centres allowing the sharing of data;

able to:

- allow SSA sensor planning, data management, processing and sharing inside and between military Space Situational Awareness C2 Centres of sMS in accordance with an agreed data policy up to SECRET level;
- provide the basis for a shared, and consequently enhanced RSP and support space operations through added-value services to sMS;
- share data with military Space Situational Awareness centres of NATO allies.

The proposals must cover at least the following sensors:

- ground-based optical sensors. This item should include:
    - photometer;
    - spectrophotometer;
    - laser ranger;
    - high frequency imager;
    - polarimetric imager;
    - adaptive optics;

  This may also include multiband imager (from visible to IR).
- ground-based RF sensors. This item should include:
    - radar sensors in monostatic configuration, including tracking and surveillance radars with characterisation capabilities;
    - radar sensors in multistatic configuration;
    - Inversed Synthetic Aperture Radar (ISAR) imaging radars (considering multidimensional imaging);

- passive radio-frequency;

- space-based sensors as hosted payloads for big satellites and small satellites and as only payloads for small satellites for LEO, MEO and GEO. This item should include:
  - optical, including multi-band/hyperspectral imaging systems;
  - radar;
  - passive radio-frequency.

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)

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	Yes (optional)

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

- the further development of military SSA C2 systems (including qualification for some functions) able to operate in an environment up to SECRET;
- the further development of military SSA ground-based sensors both optical and RF (including qualification for some of them) and definition of formats of data that are common to each type of sensors and compatible with the SSA C2 / SSN;
- under the framework of an agreed data policy, increase the modularity of the system architecture, flexibility of use, and responsiveness of the SSN (including qualification for some functions) through the combination and optimisation of resources (sensors and processing services), with the ability to handle data and/or information up to SECRET;
- further study and design of new space-based SSA sensors interoperable with SSA C2 systems.

In addition, the proposals should cover the following tasks:

- as part of testing, the interconnection of a sub-set of highly matured sensors with the above-mentioned SSA C2/SSN systems, to provide the basis for the creation of a shared RSP;
- the testing of SC2, SSN and selected sensors in an operational environment, involving at least two military SSA centres located in two EU Member States or EDF associated countries (Norway);
- for SSN, development (design, prototyping, testing) of high added-value tools to support joint multinational and multisensor planning, operations, data sharing and simulation activities;
- for photometer, further development, prototyping and test;
- for spectrophotometer, further development, prototyping and test including, developing observation strategies, testing in multiple sites, training of the machine learning capability based on measurements;
- for laser ranger, further development, prototyping and test allowing automation, compliance with laser safety regulation, remote control, availability of a European laser source, daylight operations and simulations;
- for high frequency imager, further development, prototyping and test allowing improved image quality, a more automated system and daylight operations;
- for polarimetric imager, further development, prototyping and test;

- for adaptive optics for high resolution imagery, further development, prototyping and test, including robustness increase, calibration automation and exploitation ease;
- for imaging radar, further development, prototyping and test including hardware and software development of a multistatic architecture;
- for tracking and surveillance radars with characterisation capabilities, further development, prototyping and test of characterisation modules, also through simulation;
- for passive radio-frequency, further development, prototyping and test allowing maximum coverage (both through antennas and bands monitoring);
- for radar sensors in multistatic configuration, further development, prototyping and test also with the objective to evaluate, also through simulation, the number and the geographical distribution of sensors;
- study and design of space-based SSA systems and missions in different orbits (LEO, MEO and GEO) with different sensors (optical, radar and passive radio-frequency);
- the development of technologies and assets increasing efficiency across the lifecycle (e.g. lower production, operational, maintenance, repair and overhaul or disposal costs) for the sensors, SC2 and SSN;
- the testing, in a real operational and multinational environment, of some of the integrated military SSA/SSN solutions, composed of interoperable C2 capabilities, exploitation tools and sensors.

The proposals must substantiate synergies and complementarity with foreseen, ongoing or completed activities in the field of SSA, notably those performed or foreseen in the context of the call topics EDIDP-SSAEW-SC2-2020[107] and EDIDP-SSAEW-SSAS-2020[108], as well as in the context of the EU SST framework[109]. The proposals should also, where relevant, substantiate synergies and complementarity with the activities foreseen within the call topic EDF-2023-RA-SPACE-PSA.

Functional requirements

Military SSA capabilities to be developed should contribute to the following main functions:

- detection, surveillance and tracking of objects from, to and in space with a focus on the timely detection of anomalous/potential hostile manoeuvres and threats;
- identification, characterisation, including behaviour/pattern of life recognition, and classification of objects and activities (such as active spacecraft, rocket body, debris, etc.) from, to and in space, including resident space objects and, where possible, launching activities through RF, thus enabling attribution of space actions or behaviours;

[107] Advanced Space Command and Control (SC2) capability to process and exploit SSA data generated from sensors and catalogues to provide a complete space picture (edidp_call-texts-2020_en.pdf (europa.eu)).
[108] Enhanced SSA sensors for accurate identification and characterisation of existing Geostationary Earth Orbit (GEO) and Low Earth Orbit (LEO) public and private assets (edidp_call-texts-2020_en.pdf (europa.eu)).
[109] https://www.eusst.eu

- sharing of data between military SSA centres allowing the establishment of a more complete RSP;
- delivery of services to military space operators (e.g. support to threat surveillance and protection of space-based assets).

Expected impact

The outcomes should contribute to:

- making military SSA Command and Control (SC2) centres and sensors for EU Member States and EDF associated countries (Norway) available and their assets interoperable;
- ensuring consistency of the SC2 centres with existing national SSA C2 centres;
- enhancing cooperation between undertakings across Member States and EDF associated countries (Norway);
- achieving better performance while reducing costs and avoiding unnecessary duplications.

The expected outcomes of military SSA systems are to:

- contribute to the security and defence of the space domain and space assets that support the EU, its Member States and EDF associated countries (Norway) operations and missions;
- enable secure space operations;
- contribute to the protection of military, national and EU security interests (Common Security and Defence Policy, military operations, protection of populations);
- support the Member States and EDF associated countries (Norway) that are operating launching sites and/or military satellites.

2.5.9. EDF-2023-DA-MATCOMP-MJR-CBDIN: Technologies and processes for maintenance, joining and repair through an innovation test hub

- **Indicative budget:** EUR 30 000 000 for this topic under the call EDF-2023-DA-CBDIN. Beneficiaries should provide financial support to third parties (FSTP) in accordance with the conditions provided below. The support to third parties can only be provided **in the form of grants**. The maximum amount to be granted to each third party is EUR 60 000. Up to EUR 3 600 000 of the total call topic budget may be allocated as FSTP. The FSTP in the proposals should target but not exceed 12% of the requested EU contribution.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.
- **Conditions related to FSTP:** conditions for selection of third parties receiving financial support:
    - 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.

- Should include various entities from different Member States and EDF associated countries (Norway) 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;

- The maximum amount of financial support that can be paid to a third party must not exceed EUR 60 000 per project (can be split over several FSTP calls). Financial support to third parties should be issued in the form of lump sum grants;

- Financial support to third parties should be issued in up to two distinct calls with a target from minimum 10 and up to 30 beneficiaries per call;

- 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:

    - Feasibility studies on alternative solutions, life-cycle analysis (LCA) as well as life-cycle cost analysis (LCCA);

    - Preparation of sample repair, joining, maintenance technologies to be tested;

    - Analysis support;

    - Measurement capacities;

    - Manufacturing capacities to support the testing or the sample preparation;

    - Support of multi-disciplinary design optimisation.

Objectives

General objective

The increasing requirements for future military systems demand not only improved performance but also economic and ecological improvements. In order to meet these requirements in the area of structures and construction methods, modular and multi-material designs or the integration of functions are considered as particularly promising. For example,

the combination of different materials such as fiber composites and metals shows a very high potential for performance enhancement with simultaneous economic and environmental advantages. To exploit the potential of such new material technologies in military systems, suitable, high-performance and technically mature joining technologies are required. Additionally, new sensorised materials might enable new certification procedures for joining technologies.

Given the harsh environment in which military systems have to operate and the increase risk of damage during operation, the operability and survivability of platforms depend on fast, efficient and reliable repair methods. The advantages of new materials technologies can only be fully exploited if adequate repair technologies are available and could, ideally, be used in the field.

Due to the complexity of today's systems not only the procurement is capital-intensive but the maintenance also generates considerable costs and the need for significant logistic support. Developing new methods that can decrease the effort to fullfil the operational needs without any negative effect on safety will result in advantage for both civil and military operators. Advances in repair and maintenance technologies will also reduce the environmental footprint of defence equipment. An example for new concepts of maintenance, are technologies involving the use of in-structure or on-structure health monitoring sensors, such as those addressed by the call EDF-2021-NAVAL-R-SSHM. To make such concepts useable for future military systems they need to be matured, repair and maintenance aspects should be taken into account and most importantly, the technologies need to be tested and qualified.

There are several technologies under development in national and European projects addressing the area of maintenance, joining and repair. Research and Development projects often lead to a technology readiness level (TRL[110]) of approximatively 4, meaning that new technologies show potential for use in future military applications and have been validated in a lab. However, these technologies have not yet been tested at demonstrator level (TRL6/ 7) and therefore cannot yet be considered useable in military products. The gap between technological proof-of-concept and (at least partially) qualified solutions is often difficult to overcome for innovative solutions. New sources of funding must be found, as further maturation efforts can often not be covered by research funding. At the same time, connections must be established with certification entities, planned defence projects and potential end users, often still unaware of the new technological oppportunities. Because of these challenges, summarised as 'valley-of-death', new defence products are often delayed in their transfer into new defence products or even abandoned, although the technologies show large potential for future applications. Specific support to overcome the valley-of-death will enable the use of (partially) qualified and certified technologies in next generation military systems to produce, operate and maintain them at a fraction of cost of current systems.

Specific objective

This topic will provide support to collaborative development activities to setup demonstrator platforms and test candidate technologies for maintenance, joining and repair, in order to propel those technologies' maturity and allow them to be approved and/or qualified.

[110] Definitions of Technology Readiness Levels can be found in the context of Horizon 2020 work programmes, e.g. https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

There will only be a limited number of innovative technologies directly available within a selected consortium. Therefore, the consortium will be requested to reach out to third parties across the EU and EDF associated countries, in particular SMEs, including start-ups, to test a broad spectrum of technological solutions and give those innovative players the opportunity to demonstrate the potential of their ideas to relevant players in the defence application field. As a tool to enable this open innovation approach, funding for financial support to third parties (FSTP) will be integral part of the awarded grant. The consortium will be required to organise calls to third parties to select and award start-ups and SMEs. The selected third parties will be offered the opportunity and financial support to test their solutions, receive technical mentoring and other relevant acceleration services for a specific time period.

Therefore, the specific objective of this topic is twofold. The first is the development of a new test environment for testing and the improvement of technologies up to certification level. The second is the creation of a cross-border defence innovation network that encompasses players that would otherwise not have the means to accessEDF actions, thereby further enhancing innovation capacity and competitiveness of the European Defence Industrial and Technological Base.

The consortia responding to the call may include a large variety of entities, such as military or civil test centers, research institutes, universities, industry, certification authorities, accelerators or incubators as well as other organisations that can play a role in the establishment or certification of new technologies for repair, joining and maintenance or that can support the associated innovation support measures targeted towards third parties receiving financial support.

Scope and types of activities

Scope

This topic aims at supporting the technological maturation of various joining or repair or maintenance technologies, including the associated processes.

The proposals must address the setup of a suitable demonstrator platform as a test environment which offers the possibility to test, qualify and certify technologies covering the fields of joining, repair and maintenance. This may include the establishment of adequate test protocols. The platform may be focussing on one of the defence application domains air, land or naval or the combination of land and naval domains. The demonstrator platform should be a generic system suitable for this domain (e.g. a plane, a ship, a truck, etc.). The proposals may involve the set-up of a new platform or the partial modification of existing systems to be used as a demonstrator platform, e.g. by replacing individual parts and components or by integrating additional functions, sensors, etc. In addition, various parts or components may be manufactured multiple times to cover different technologies.

The proposals must test various joining or repair or maintenance technologies or combination of them. The considered technologies should have reached the stage of experimental proof-of-concept (TRL 3) or, preferably laboratory validation (TRL 4) but may also have been already validated in a relevant environment (TRL 5). The proposals must address the technological maturity of promising technologies to lead them towards qualification and certification. This must encompass all tests and approvals to achieve the demonstration of the technology in a relevant or operational environment (TRL 6 or 7). The considered technologies must encompass technologies that are not available within the consortium. Technologies must be

relevant for military applications but may include technologies originally developed for civil applications. Technologies adequate for 'in-field' repairs should be considered.

The proposals must describe how entities with expertise on the relevant technologies know-how will be supported, including the proposed implementation conditions for FSTP.. Beneficiaries of FSTP that contribute with a joining or repair or maintenance technology must receive financial support to prepare a sample of their technology, to attend and support the testing of their technological sample, and to technologically improve their solution. FSTP may also be provided to entities that contribute with analysis and measurement capacities, technology-specific expertise, innovative tools, or support the manufacturing of technology test samples or components necessary for testing. The proposals must include technical mentoring for the selected beneficiaries of the FSTP as well as the set-up of additional measures to support the beneficiaries business case.

Although the proposals may consider joining and repair technologies that are applicable and involve the use of additive manufacturing processed parts, the proposals must not focus on the improvement of additive manufacturing processes themselves, as those are covered by the call EDF-2021-DIS-RDIS-AMD. The proposals may not target minor improvements of technologies not having achieved a proof-of-concept (below TRL 3).

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 (mandatory)

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

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

- Design:
    - design of a test environment to test and certify technologies for joining, repair or maintenance, including the demonstrator platform;
    - design of components based on innovative technologies for joining, repair or maintenance to be integrated in the demonstrator platform.
- System prototyping:
    - prototyping of a demonstrator platform for various joining or repair or maintenance technologies or combination of those.
- Testing:
    - testing at component and demonstrator level of various joining or repair or maintenance technologies or combination of those that may be developed by entities selected through a call for FSTP at component level.
- Qualification:
    - preparation of documentation and reviews necessary for qualification of the technology or component, e.g. TRL reviews.

In addition, the proposals should cover the following tasks:

- Design:
    - design of digital mock-up or digital twin and simulation of manufacturing and assembly.
- Qualification:

- qualification of joining or repair or maintenance technologies.

The proposals may also cover the following tasks:

- Design:
  - partial testing of samples of innovative technologies at component level to prepare their integration in the demonstrator platform;
  - support of multi-disciplinary design optimisation;
  - adaptation of the platform design in accordance with the outcome of a call for FSTP.

Concerning the implementation of the FSTP, the proposals must cover the following tasks:

- Integrating knowledge:
  - technical mentoring of beneficiaries selected through sub-calls to receive financial support to third parties.
- Studies:
  - screening and identification of landscape of suitable candidates from various sectors, including those that have not been active in the defence sector before, for the sub-calls organised by the consortium providing FSTP;
  - preparation of the call documentation to issue up to two sub-calls for FSTP;
  - organisation of up to two sub-calls for FSTP;
  - selection and award of beneficiaries for FSTP;
  - offering of an entrepreneurship class on doing business in the defence domain to beneficiaries of FSTP calls;
  - setting up of collaboration and networking activities for beneficiaries of FSTP and other SMEs.

Functional requirements

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

- The demonstrator platform should be modular in order to integrate different technological alternatives for the same or different components or parts;
- The technologies and processes should cover a broad range of innovative solutions. It should cover at least 4 out of the 6 following technologies, without being limited to those:
  - novel materials and multi-material constructions in particular the combination of fiber composites with other materials;

- multi-functional structures with embedded and integrated sensors (e.g. optical fibers), antennas, vents or any other structure combining mechanical performance and additional functionality;
- joining technologies applicable for the combination of similar and dissimilar materials, in particular co-bonding, adhesive bonding and welding;
- repair methods for multi-material and composite structures, e.g. patch-repair, cold-spray process…;
- inspection technologies applicable during maintenance and for in-situ measurement during the use of a product, like structural health monitoring (SHM);
- maintenance, repair and operation processes with a high degree of automation covering defect analysis, repair process and quality inspection.

- The technologies considered in the proposals should meet the following requirements:
  - the technologies should have the potential to reduce the production costs or the total costs of ownership by reducing the costs and efforts for maintenance and repair;
  - processes considered should have the potential of a high degree of automation, of a high rate of digital data handling and of information storage and availability at production, maintenance and repair stages;
- The FSTP should:
  - be organised in one or two calls to third parties selecting a target of minimum 10 and up to 30 entities per call, depending on the industrial landscape of the targeted domain, whereas each third party may be supported with up to EUR 60 000 for a maximum 6-month long acceleration programme that encompasses the associated tasks;
  - provide the third parties the opportunity to demonstrate their knowledge, technologies, capabilities and products;
  - foster the posibilities for future involvement of these third parties in the European defence community;
  - provide the third parties with necessary knowledge on doing business in defence domain, in particular with respect to protection of IPR, IPR strategies, export control and other specificities of the defence sector;
  - provide networking and collaboration activities that facilitate collaboration amongst innovators and between innovators and end-users (including industry and public bodies) throughout the maturation of their product or technology;

- be accompanied by a clear methodology allowing to measure the FSTP's contribution to the innovation performance of the supported SMEs in the short-term, e.g. via indicators such as numbers of new or significantly improved products (goods and/or services), processes, new marketing methods, or new organisational methods, and to its impact on resource efficiency and/or turnover;
- aim at a wider impact on innovation performance of the supported entities in the medium-term.

- The proposals should clearly delineate the expected contributions from the main beneficiaries as well as from the third parties, to ensure their coherence and impact.
- Concerning the organisation of FSTP, the proposals should include a description of:
  - the method for calculating the exact amount of the financial support requested by the third parties;
  - the payment arrangement options to third parties;
  - the possible types of activities for which a third party may receive financial support;
  - the potential results to be obtained;
  - the roles and responsibilities of the consortium with regard of the management of FSTP.

Expected impact

The outcome should contribute to:

- increased technological maturity of new processes and technologies to be implemented in future military systems to improve their performance, reliability and competitiveness;
- faster development of new systems including an improved flexibility for usage;
- reduction of repair and maintenance costs and increased lifetime for defence systems;
- reduction of logistics footprint, involving actions of transport, maintenance and repair, in particular for operations in harsh environment;
- reduction of the environmental footprint of defence systems throughout their life-cycle;
- strengthening of the European industrial leadership by reinforcing value chains that integrate innovative solutions from SMEs, including start-ups, along and across existing value chains;

- improvement of the business environment and collaboration opportunities for innovative start-ups and SMEs in the defence domain by supporting open innovation and involving innovative actors and customers from different sectors and countries;

- leveraging and complementing support for innovation which may be provided by national or regional authorities and/or by private investors (as follow-up investments) and fostering cross-fertilisation between sectors.

2.5.10. EDF-2023-DA-AIR-STFS: Smart technologies for next generation fighter systems

- **Indicative budget:** EUR 30 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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 generation manned and unmanned military aerial platforms require enhanced avionics able to support new architectures and functions, while providing higher performances, safety and cyber resilience.

Against this background, new solutions regarding, for instance, hardware (HW), software (SW, including operating systems, middleware, system services, etc.) and framework, need to be defined in order to comply with new requirements for processing, network, interfaces, storage, power supply, etc.

Military aerial platforms, from fighters to helicopters and other specific mission platforms, could benefit from the application of civil technology breakthroughs and standards. However, they require dedicated solutions to comply with specific military requirements (e.g. SWAP[111], multi-level security data flow, real time reactive response, etc.).

In particular, modular architectures for avionics are widely recognised as key to reduce development cycles and costs and to increase interoperability in multi-industrial collaborative development, compared to classical federated systems. Therefore, the concept of core integrated modular avionics has been already defined in the civil aviation market.

However, the next generation military aerial platforms, both manned and unmanned, will operate through a system-of-systems approach which implies much higher data sharing and processing needs than in the civil market, as well as new specific requirements in terms of development cycle (cf. need for faster adaptability of mission solutions applying DevSecOps[112] type of development, but also involvement of more industrial entities) and in terms of defence-related missions.

The general objective is then to exploit the knowledge and solutions conceived for civil purposes in the application of such technologies on various military platforms in accordance with defence requirements.

[111] Size, Weight, and Power.
[112] Development, security and operations concept, which integrates security aspects into every phase of the development life cycle.

Specific objective

The challenge of this topic is to study, design and demonstrate, within a 3-year timeframe, key components for a next generation military integrated modular avionics (NG-MIMA) for various military platforms able to operate in the tough digital battlefield as foreseen in the future.

Scope and types of activities

Scope

The proposals must address the study and the development of key technologies supporting the next generation of military integrated modular avionics (NG-MIMA). The proposals should consider multiple military aerial platforms that should operate in a defence air cloud context, both manned and unmanned, including other than fighters.

Use cases analysis and identification of the NG-MIMA key technologies must be addressed and possible future architectures, including possible applicable methodologies and processes, should be described.

In addition, the proposals should include proofs of concept, demonstrations and even prototyping of a selection of the envisioned key technologies to be determined according to the studies to be performed, hence paving the foundations for future development actions in this area. The proposals may consider simulations and model-based system engineering.

In any case, the use of EU and EDF associated countries (Norway) technologies without restrictions from non-associated third countries must be highly prioritised, leveraging on sovereign European technological components, systems and know-how.

The proposals should target at least TRL 4 (component and/or breadboard in laboratory environment) for the key technologies addressed.

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 (optional)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (optional)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes (optional)
(h)	**Certification** of a defence product, tangible or intangible component or technology	Yes (optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (optional)

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

- Studies:
    - perform gap analysis to identify the standardisation needs beyond the international standards already widely used in this domain or beyond ongoing activities conducted at national, multinational or EU level;
    - provide a use case analysis and identification of requirements, including regarding the key technological components identified for possible future architectures for NG-MIMA. This task should consider other related initiatives at national or EU level;
    - provide a list of requirements and KPIs[113] for new generation computing architecture (e.g. performance, low SWaP[114], cyber resilience, etc.), exploring segregation of military avionics, as well as flexible and hot reconfiguration capabilities;

[113] Key Performance Indicators.
[114] Size, Weight and Power.

- study multi-level computing solutions to be able to run all functions including safety critical and highly demanding computing requirements, such as AI[115]-based functionalities;
- study certifiable multi-level real-time operating systems oriented to these new levels of manycore computing solutions;
- study the process, framework and tools required for NG-MIMA.

- Design:
  - include HW[116] and SW[117] architectures and interfaces able to execute not only different levels of safety critical functionality but also mission functionality;
  - include on-board deterministic high-speed data buses and consolidated backwards compatible with legacy ones;
  - include high-performance graphics capability for the computing solution and its interfaces;
  - include packaging, powering and connecting technology requirements and solutions.

In addition, the proposals must substantiate synergies and complementarity with relevant activities described in the call topic EDF-2021-AIR-D-CAC on *European interoperability standard for collaborative air combat*.

Functional requirements

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

- Multi-functional avionics should:
  - be based on a scalable reference architecture to pave the way for standardisation of interfaces and stacking avionics systems;
  - include high-speed and performing data buses and protocols, including packaging standards;
  - provide the capability regarding high-speed data sharing and regarding assets interoperability throughout the EU as well as with NATO air defence arsenals;
  - include real-time operating system for on-board safety and mission (both critical and non-critical in terms of safety) systems, with multi-level capabilities;
  - include HW and SW complying with multi-safety and multi-mission (both critical and non-critical);

[115] Artificial intelligence.
[116] Hardware.
[117] Software.

- be purposely built with a view to comply with security classification with multi-level security segmentation;
- allow for integration into supportive HW that would facilitate certification by military authorities in the future (cf. machine learning, in particular deep learning algorithms);
- provide for real-time computation and sharing capability orchestration, e.g. including process, tools and framework to support the development in a multi-industrial workshare and taking into account DevSecOps type of upgrade;
- provide a high integrity deterministic avionic network with the necessary redundancy to connect various computing nodes and consider solutions when different platforms are engaged;
- provide a sufficient level of compatibility in order to operate a variety of heterogeneous assets, manned and unmanned, during air operations.

- The system should include data processing and visualisation capability with:
  - state-of-the-art high-performance and ad-hoc HW and SW infrastructure, that allows processing, interfaces and visualisation of tactical data in real time.
- The embedded data processing and networking capacity may:
  - integrate HW with high data processing, notably through AI applications;
  - provide AI-based functional standard interfaces and system monitoring.

Expected impact

The outcome is expected to contribute to:

- significantly reducing the number of computer packages in an aircraft, hence leading to a decreased SWaP;
- the creation of a European ecosystem for next generation integrated modular avionics for defence platforms, hence fostering the development of European technological sovereignty in this area;
- enhancing the ability to trigger modern and faster innovation towards a European air cloud, currently bottlenecked by the absence of a common NG-MIMA concept;
- increasing platform flexibility and modularity with a common open architecture, fostering the use and integration of new disruptive technologies;
- reducing time and costs for iterations of services that require underlying new integrated modular avionics, such as multi-domain mission systems, enhanced collaborative situational awareness and real-time tactical information sharing.

2.5.11. EDF-2023-DA-AIR-SPS: Self-protection systems

- **Indicative budget:** EUR 33 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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 main objective of the next generation self-protection systems (SPS) is to increase survivability of fixed-wing and rotary-wing, combat or non-combat aircraft in hostile environments.

SPS is to face a wide, heterogeneous and evolving spectrum of hostile and directly threatening systems of surveillance, as well as to prioritise risks in the operational area and select the proper reaction mode through a network of distributed capabilities exploiting sensor nodes of various type inter/intra platforms. It should be reconfigurable depending on the mission and the platform targeted. It should also be able to self-adapt while operating, based on scenario monitoring and mission assets availability.

Specific objective

When operating in semi-permissive or even non-permissive environments, fixed- and rotary-wing platforms face a large spectrum of hostile systems of surveillance and direct threats, which are continuously improving their technology and effectiveness.

Recent events in Ukraine and Syria clearly call for not neglecting any high intensity scenario and question the current self-protection capabilities of fixed- and rotary-wing, combat and non-combat platforms. Surface-to-air and air-to-air missiles with a wide range of guiding systems (RF[118], optronics) and a wide range of associated surveillance/warning systems are to be considered, as well as hostile fires and unmanned aerial vehicles (UAV).

The specific objective is to develop an enhanced SPS able to protect against:

- direct threats (e.g. missiles, loitering munition, RPG[119], etc.);
- indirect threats (e.g. surveillance/acquisition/tracking systems also with Low Probability of Intercept (LPI) radar capability;
- new proliferating types of threats, such as those in the field of loitering munitions, directed energy weapons (DEW) and cyber electromagnetic activity (CEMA) capabilities.

Scope and types of activities

Scope

The proposals must address the design, prototyping and testing of a new generation of integrated self-protection system, designed to protect both fixed- and rotary-wing, combat and

[118] Radiofrequency
[119] Rocket-propelled grenade.

non-combat platforms, with very high efficiency, in view of allowing the usage of these platforms for mission accomplishment even in contested airspace.

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 (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)

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

- design of a detailed self-protection system (Critical Design Review - CDR);

- prototyping and testing (on board of existing end-user platforms) of a self-protection system modular version, integrating sensors and effectors of sufficient technological maturity (e.g. full wideband digital radar warning receiver, multispectral threat warner);

- testing to be conducted either on a large and fixed wing aircraft or on a medium size helicopter in order to demonstrate:

    - versatility of the system architecture on fixed- and rotary-wing assets;

    - ability of the proposed system to meet the high-level requirements as jointly agreed by the supporting Member States and EDF associated countries (Norway);

    - feasibility of collaborative self-protection capability allowing the exchange of data with cooperative platforms, to perform sensing and jamming, in order to achieve better performances than a stand-alone platform, taking into consideration the possible level of classification of such data;

- technical maturation of lower technological readiness level (TRL) sensors and effectors, leading to at least TRL 7.

In addition, the proposals must substantiate synergies and complementarity with activities described in the call topic EDIDP-ACC-SPS-2020 *Self-protection systems for fixed and rotary wing aircraft*.

Functional requirements

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

1) The system should:

- be designed to equip both fixed-wing and rotary-wing aircraft with appropriate modularity to cope with specific threat list/platform signature/platform kinematics/platform installation and integration constraints;

- be based on an open architecture and international standards widely used in this domain (hardware interfaces, software interfaces, protocols and communication links);

- protect its own sensitive data and software (e.g. from cyberattacks);

- embed compatibility management features to ensure compatibility with other emitters and receivers on board the platform and/or other aircraft involved in a mission;

- have ways to remove any doubt concerning the source of the alleged hostile system, before alerting the crew;

- provide for, but not limited to, an automatic mode elaborating suggested countermeasures, including coordinated countermeasures (e.g. manoeuvres, expendables and jamming) that can be implemented without a man in the loop if automatic mode is selected;

- be compatible with new-generation platform systems architecture (e.g. next generation rotorcraft, future mid-size tactical cargo) and legacy platforms.

2) Regarding protection against direct threats, the system should:

- detect that the aircraft or other aircraft they are flying with, are being engaged by direct threats and provide warning to the mission and/or avionics systems of the aircraft;

- protect the aircraft from direct threats providing identification of such direct threats and elaborating the appropriate coordinate countermeasures;

- provide features to counter the direct threats elaborating the most appropriate combination of countermeasures (e.g. expendables, jamming, directed energy weapon and manoeuvres);

- detect incoming threats, perform classification and suggest optimal combination of reactions in terms of countermeasures and escape manoeuvres considering assets available on the single platform and considering the availability of collaborative platforms;

- gather intelligence regarding the direct threats characteristics and fire posts locations and be able to detect changes in those characteristics and locations;

- classify threats, to support sensor system behaviour in complex, congested, cluttered, contested, connected and constrained operational electromagnetic environment.

3) Regarding indirect threat detection and protection, the system should:

- gather and record indications that the aircraft or other aircraft they are flying with, are detected by any hostile surveillance systems and provide warning through the mission and/or avionics systems of the aircraft;

- detect that the aircraft or other aircraft of the group are being tracked by any hostile systems and provide warning to the mission and/or avionics systems of the aircraft;

- provide features to disturb the detection and tracking by both passive and active surveillance systems of the enemy;

- suggest, considering the availability of collaborative platforms, the optimal combination of disturbances to interrupt the acquisition chain of enemy sensors;

- gather intelligence regarding indirect threats characteristics and locations and be able to detect differences with expected Electronic Order of Battle (EOB) or changes with reference to previously recorded EOB;

- perform collaborative self-protection with the ability to share collected information with cooperative platforms in networked operations, exchanging ESM[120] and ECM[121]

[120] Electronics Support Measures.
[121] Electronic Countermeasures.

data with other platforms to achieve a faster and more accurate operational situational awareness than with a single platform, taking into account the possible level of classification of such data;

- classify indirect threats during the development of the system, to support sensor system behaviour in complex environment.

Expected impact

With reference to currently available self-protection systems, the outcome is expected to contribute to:

- increasing coverage in term of threat types (e.g. new generation seekers, multiple homing threats, networked LPI radar systems, new generation directed energy weapons and loitering munitions, hostile fires/small calibre, RPG);

- ensuring EU autonomy in the survivability capability;

- versatility by covering a wide range of platforms and saving costs in integration, installation and maintenance, as well as specific development through modular design.

2.5.12. EDF-2023-DA-AIRDEF-CUAS: Counter unmanned aerial systems

- **Indicative budget:** EUR 43 000 000 for this topic under the call EDF-2023-DA.

- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Unmanned aerial system (UAS), including cheap commercial off-the-shelf (COTS) and easy to assemble UAS components are widely available and their popularity is even growing. Traditional surveillance systems often fail to cope with these flying objects because of their characteristics. Indeed their low speed make them challenging to detect with conventional radars. Their low altitude allows them to hide amongst trees or behind natural or artificial obstacles, and their very small radio-frequency (RF)/radar cross-section (RCS), as well as their thermal and acoustic signatures make them difficult to detect. Additionally the high manoeuvrability of some machines makes their movement hard to track once detected, and their increasing on-board processing capabilities (e.g. automated and vision-based navigation, use of artificial intelligence) makes them more resilient to some counter-UAS (C-UAS) systems that rely on RF detection and jamming.

In addition, current C-UAS technology is largely ineffective against military grade UAS (such as loitering munitions), swarms and flocks of drones and threats that may emerge in the short to medium term, also considering that the use of cellular networks (4G, 5G or beyond) will increase the speed, stability and immediacy of intercommunication between aircraft and control stations. Moreover, while some systems may be effective against a variety of UAS threats, the costs of engagement may be prohibitive to counter large-scale attacks.

Specific objective

The specific objective of this topic is to:

- tackle safety and security concerns (e.g. malevolent users attempting deliberately hostile missions such as the use of explosive payloads, ISR[122]);
- consider the various threats in their environmental and operational context as mitigation options may vary from different scenarios (e.g. depending on the size of the area to protect, the value of the unit to protect, the reaction time required and the need to minimise fratricide and collateral damages);
- provide a suite of solutions to comply with a broad set of rules of engagement (ROEs), each adapted to the surrounding environment and the operational scenarios (including the transition from peace-time to war-time), including from a sensing perspective;
- cover fixed (i.e. continuous protection of Forward Operating Bases (FOB), critical infrastructures, 24/7, at reasonable operational and maintenance costs), deployed (i.e. quick deployment with minimum logistic support, as well as rapid integration of additional sensors and effectors within a recognised open architecture, for tactical military activities as well as civil events) and mobile (i.e. protection of mobile units/elements) applications;
- include a set of various C-UAS capabilities, such as navigation systems spoofing, RF jamming, kinetic effectors (soft/hard with lethal or non-lethal effects), catch or hit-to-kill by a swarm subset or direct energy weapons (e.g. high-power lasers and/or microwaves);
- improve identification and classification capabilities of the system.

Scope and types of activities

Scope

The proposals must address the development of a C-UAS system, from a detailed design (i.e. critical design review) up to a system prototype to be tested and qualified in relevant defence operational scenarios, demonstrating its ability to:

- with a selection of passive and active sensors, detect, track, classify, identify, support decision making and counter class I[123] UAS (single and/or multi-UAS) through an optimal selection and activation of relevant effectors using multiple technologies;

[122] Intelligence, Surveillance, Reconnaissance

- ensure effective protection of critical defence infrastructure, installations and assets;
- operate with limited impact on existing communications or position and navigation infrastructures.

In addition, the proposals may address other operational scenarios, if deemed relevant.

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 (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)

[123] Cf. Classification referred to in NATO STANAG 4670 Minimum training requirements for unmanned aircraft systems (UAS) operators and pilots

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	Yes (optional)

The proposals must cover at least the following tasks as part of the mandatory qualification activities:

- the proposals must address the qualification of the prototype to be developed, based on use cases jointly agreed by the supporting Member States and EDF associated countries (Norway);
- in particular, the proposals must address the provision of drawings, reports, analyses, certification plan and data in view of future certification of the system by the supporting Member States and EDF associated countries (Norway) authorities.

In addition, the proposals must substantiate synergies and complementarity with activities described in the call topic EDIDP-CUAS-2020 *Counter Unmanned Air Systems (UASs) capabilities*.

Functional requirements

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

1) The C-UAS system should include battlefield management features, providing for the following capabilities:
   - ensure effectiveness of the protection of moving units and assets (e.g. ground formations, convoys, ships located in the vicinity of a harbour or coastal patrolling);
   - facilitate the interaction of C-UAS system with security and defence systems for fixed, deployed and mobile assets;
   - consider non-static, effector-dependent danger areas in order to reduce risk of blue-on-blue or collateral damage, when protecting groups of moving objects (e.g. convoys, formations);
   - ensure robustness and high availability, without being saturated in case of multiple threats (i.e. either single or multiple UAS units, either uncoordinated or operating as a team or as a single system, including swarms);
   - provide an extended range of operational performances (e.g. extended ranges for surveillance, detection, identification and neutralisation) to face possible improvements of UAS threats;
   - require minimum operator effort for decision making;
   - neutralise the threat with focus on semi-autonomous (or even manual) technical solutions (HITL);

- in critical scenarios, where extremely high tempo and/or high threat volume prohibit the use of human sound judgement, provide options for temporarily allowing automatic C-UAS engagements with specified effectors in defined areas, within the LOAC[124] and relevant ROE;
- offer all-weather, 24/7 operational capability, in a wide variety of climate conditions;
- provide simulation and training features in realistic scenarios;
- provide real-time playback functions for mission analysis, training and other purposes;
- require limited logistic support for deployment and maintenance.

2) Regarding command and control (C2), the C-UAS system should be able to:

- plan and monitor subsystems missions and conditions;
- merge information from heterogeneous sensors;
- report about any internal or external elements that could affect the system performances;
- evaluate the possible engagement approaches to the operator, coordinate the engagement approach selected by the operator and report on the resulting outcomes;
- balance the autonomous processing of information across the adopted sensors and timely report to a central Battle Management/C2 system in order to reduce operational manpower load and bottlenecks;
- generate, disseminate and update real-time operational picture and alerts;
- integrate multilayer C2 system with cross-security-domain approach;
- allow subsystems dynamic deployment and multi-instance integration;
- provide a range of selective engagement and mitigation alternatives with the ability to evaluate mission success probabilities and potential resulting drawbacks;
- compute success probability, time to complete the neutralisation and drawback probabilities, depending on the characteristics of the effectors, for each of the possible neutralisation approaches;
- integrate and connect all the sensors and the effectors in a local C2 station;
- implement data fusion and automatic procedures and rules in order to focus human operations on action, resources coordination and cooperation. A user-friendly interface should be provided.

3) Regarding sensors, C-UAS should:

[124] Law of Armed Conflict

- enable omnidirectional detection (e.g. rotating or staring) while also being capable of limiting the detection to a sector of choice;

- include the capability of detection for non-cooperative UAS, including autonomous, in the suite of sensors, as well as various technologies for detection and tracking (e.g. EO[125]/IR[126], RF[127], acoustic);

- provide dynamic scalability of sensors and effectors using communication protocols that allow plug-and-play deployment.

4) In terms of data and information processing, the proposed solution should:

- enable machine learning to allow using recorded signals or signatures in order to enhance the performance of target recognition and identification;

- integrate, process and display different information sources for classification/identification (e.g. sensors information, ACO[128], civil UTM/ATM[129] information…).

5) In terms of interfaces and interoperability, the C-UAS system should:

- be based on an open, flexible, modular and scalable architecture based on a plug-and-play component approach which allows deployment of specific configurations adapted to the threat scenarios;

- provide standard interfaces and interoperability with relevant foreseen UAS systems (e.g. U-space[130]) and higher air defence C2 elements or other units.

Expected impact

The outcome should contribute to:

- consolidating and validating doctrine and CONOPS[131] in the field of C-UAS;
- developing a comprehensive C-UAS capability for the EU and EDF associated countries;
- reducing the minimum reaction time compared with current systems;
- enhancing situation awareness and protection of critical areas and strategic assets;
- ensuring interoperability with existing security and defence systems in order to easily adapt to current monitoring systems;

[125] Electro-optical.
[126] Infrared.
[127] Radio-frequency.
[128] Airspace control order.
[129] Unmanned Aerial Traffic Management/Air Traffic Management.
[130] Set of services and procedures to support safe, efficient and secure access to airspace for Unmanned Aircraft Systems (UAS).
[131] Concept of operations.

- further increasing the effectiveness of C-UAS technologies/systems to be able to better counter the current and future UAS threat (including the use of MOTS[132] UAS and swarms).

2.5.13. EDF-2023-DA-GROUND-MBT: Main battle tank platform systems

- **Indicative budget:** EUR 20 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.

Objectives

General objective

Main Battle Tanks (MBT) remain a pivotal element of land military manoeuvre, especially in a conventional warfare context, thanks to their unique combination of protection, mobility, and firepower. Nonetheless, MBTs currently numbered in the fleet inventories of the EU Member States and EDF associated countries (Norway) are either ageing or obsolete and, therefore, the latter face the compelling need to modernise their in-service platforms and replace those of them approaching the end of their operational life. Against this background, the upgrade of current and development of future main battle tank technologies capable of outstanding operational effectiveness and mission success in all possible future scenarios are highly necessary.

Specific objective

To this end, it is of key importance for future European MBT systems to:

- be designed to operate in all environments, including urban and symmetrical high intensity warfare, counter peer or near peer and asymmetrical threats, by operating dispersed in the context of multi-dimensional operations;
- have a higher level of protection, enhanced stealth capability, enhanced survivability in all environments against symmetric and asymmetric threats, and resilience against cyber- and electronic warfare-attacks;
- have a higher capability of detecting and identifying threats at greater distances;
- be operated by a smaller crew, compared to present/today's designs, allowing the system to be lighter, more compact, and agile;
- be equipped with advanced command and control system that supports the crew with situational awareness, target acquisition, target engagements, target handover, battle space management, data- and information sharing;
- be able to cooperate with adjacent manned and unmanned robotic assets;
- rely on a superior firepower to engage and win symmetrical duels, as well as to conduct urban and asymmetrical operations successfully;

[132] Modified Off-The-Shelf.

- rely on advanced mobility (e.g. higher speed, better manoeuvrability in all terrains, new operating modes such as silent mode), a lower fuel consumption, greater operational range and autonomy, and supply the increased electric demand of on-board equipment and weapons;
- be prepared to be operated unmanned in the future.

Scope and types of activities

Scope

The proposals must address studies and design for the upgrade of current and development of future main battle tank technologies, including enabling and green technologies, leading to a system level, capable of outstanding operational effectiveness and mission success in all possible future scenarios. Furthermore, the proposals must take into account aspects such as mobility, deployability, autonomy, firepower, protection and cybersecurity.

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)

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)

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

- Studies:
    - Assist supporting Member States and EDF associated countries (Norway) in the definition of the Concept of Operation (CONOPS), feasibility study and architecture definition;
    - System Specification (SSS[133] and SSDD[134]) providing a detailed system and sub-systems description;
    - System Requirement Review (SRR).
- Design:
    - Preliminary Design Review (PDR).

Functional requirements

The proposed activities should focus at least on a subset of functions for MBT (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, with the minimum possible degradation of performance due to extreme environmental conditions and types of terrains, as defined in the relevant standards. Operations in Chemical, Biological, Radiological and Nuclear (CBRN) conditions should be considered in the design too;
- feature a maximum speed of at least 80km/h on paved roads, at least 50km/h on smooth and rugged terrain (apart of paved roads) and an operational range of not less than 600km averaged on different types of terrains;
- feature a wading depth without preparation > 1.20m, a wading depth with snorkel > 5.00m, a trench crossing capability > 3.00m and a climbing capability > 1.10m;

[133] System/Sub-system Specification.
[134] System/Sub-system Design Description.

- feature a high operational availability to be capable to perform the assigned mission in at least 85% of calls to duty;
- provide direct firepower to engage modern MBT at greater distances with precise "fire-on-the move" capability than current systems;
- provide firepower to engage modern MBT under BLOS conditions;
- support smart/programmable ammunition;
- automatic threat detection, identification and tracking, including ability to handle multiple threats, and target distribution across the military network enabling sensor-to-effector allocation;
- real-time and unified information and data presentation, provided by the sensors deployed on the platform and from external networks with low latency times;
- advanced Positioning, Navigation and Timing (PNT) system in order to ensure trusted PNT for the platform even in challenging GNSS[135] 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 are also to be considered;
- feature an optimised trade-off between mobility, firepower, and protection;
- provide protection against the following threats: mines and Improvised Explosive Device (IED), Rocket Propelled Grenades (RPG) (including those with a functionality like RPG-30), "High Explosive Anti-Tank" (HEAT) munitions, "Anti-Tank Guided Missile" (ATGM; including 3rd generation ATGM with high angle of attack), loitering ammunition and Unmanned Aerial Systems (UAS), Electronic Warfare (EW) and cyber-attacks, and at least 125mm "Armour Piercing Fin Stabilised Discharging Sabot" (APFSDS) and other direct threats likely to become known over the whole duration of the project;
- feature an Active Protection System (APS) capable to counter direct threats, including ATGM and APFSDS (125mm) ammunition, also with the aim to reduce weight of passive and reactive armour;
- feature sophisticated counter-UAS (C-UAS) / counter-swarm capabilities to perform platform protection;
- 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. by using hybrid engines) and take into account other aspects of green technologies (e.g. total life CO_2 footprint, use of other materials, recycling);

[135] Global Navigation Satellite System.

- operate in silent mode and extended silent watch with low thermal signature;
- store and supply high density and power of electric energy for sensors, effectors and weapons;
- not exceed for the complete vehicle (i.e., hull and turret), in full combat order, the following maximum acceptable weight and overall dimensions: 70 tons, 2.5m (H) - 10.0m (L) - 3.8m (W) - 0.55m (ground clearance) meters (hull length: 7.0m);
- meet transportability requirements and constraints due to EU Member States and EDF associated countries (Norway) roads, railways, tunnels and bridges; air transportability/drop should also be taken into account;
- a range between 5% and 10% of growth potential without changing the assigned power/weight ratio;
- ensuring interoperability with unmanned ground platforms and Manned-Unmanned Teaming (MUM-T) with adequate Level of interoperability (LOI), and interoperability with UAS;
- be equipped with technologies for enhanced Situational Awareness (SA), e.g. advanced display devices, “transparent armour” concepts, allowing visualisation of the environment around the vehicle, automatic surveillance, detection, reconnaissance, and identification;
- advanced 360° 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 of the vehicle 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 system data and image processing include search and tracking, and object recognition;
- 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;
- crew environment and support architectures should be adaptive, open and modular to enable the introduction of innovative technologies as soon as they become mature;
- be operated by a crew of not more than three;
- feature static or dynamic on-board simulation for training (embedded);
- reduced lifecycle costs compared to current MBT;
- be designed with crew comfort and ergonomics in mind;
- be able to perform battle damage assessment without compromising survivability;

- integrable and interoperable with a family of similar support platforms (system of systems);
- compliance with NATO requirements and standards.

Expected impact

The outcome should contribute to:

- the defence and security interests of the EU and its Member States;
- the EU level of ambition in terms of strategic autonomy;
- EU resilience and technological sovereignty;
- EU industrial autonomy;
- excellence with the demonstration of a significant advantage over existing products or technologies.

2.5.14. EDF-2023-DA-GROUND-IFS: Long-range indirect fire support capabilities for precision and high efficiency strikes

- **Indicative budget:** EUR 27 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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 increasingly complex geopolitical instability faced by the European Union, its Member States and EDF associated countries (Norway) requires continuous and unfragmented responses. To that purpose, the EDF promotes and contributes to the strategic autonomy and sovereignty of its Member States and EDF associated countries (Norway).

Considering the ongoing geopolitical situation, the objective of this study is to develop European solutions for 155mm (up to 52-calibre) and rocket artilleries adapted to the new threats by increasing the fire range compared to current systems while maintaining interoperability principle. The targeted solutions must be cost-driven based on the assumption of a symmetric high intensity battle.

Specific objective

Future capability and operational challenges in artillery require enhanced interoperability, agility, action range, accuracy, survivability, and security as well as ability to operate in adverse conditions and to obtain scalable effects while ensuring efficient maintainability, high level of operational readiness, and optimised life cycle cost. In this context and during the next coming years, the future generation of 155mm artillery projectiles and rockets (timeframe 2030) will be subject to numerous potential game-changing technologies, which are expected to enhance capabilities significantly.

The proposals must stimulate cross-border cooperation within the EU and with EDF associated crountries and ensure the security of supply and strategic autonomy in a longer-term perspective.

The main objectives of this topic are to address challenges regarding precision, range (155mm shell: 80km with a minimum range of 50km; rocket: at least 150km), terminal effect and operation in stressful environment like GNSS-denied battlefield.

Scope and types of activities

Scope

The proposals must address:

- a study of range-extending technologies;
- a parametric study of long range artillery ammunition requirements regarding further range increase, with identification of the compatibility between studied technologies and these future ammunitions, and identification of technological development roadmaps;
- the modular design of the major technologies including 155mm (up to 52-calibre) long range cargo ammunition;
- the prototyping of sub-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**)	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)

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

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

- **Study** of sub-systems (in particular the propulsion sub-system) of 155mm (up to 52-calibre) artillery ammunition adapted to the existing European artillery guns. This study must include:
    - the parametric study of long range artillery ammunition requirements and limits (in terms of mass, propulsion, etc.) regarding further range increase (beyond the technologies to be designed and prototyped under this call topic), considering both current 155mm (up to 52-calibre) and future artillery guns (e.g. increase of the barrel length and chamber volume). In order to optimise further developments, this study should also include identification of the compatibility between studied technologies and these future ammunitions, and the identification of technological development roadmaps;
    - the provision of a roadmap for subsequent phases (e.g. qualification phase, anticipation of product optimisation during life cycle).
- **Design:**
    - design at sub-system level.
- **System prototyping:**
    - prototyping at sub-system level.

The proposals must substantiate synergies and complementarity with foreseen, ongoing, or completed R&D activities, notably those performed or envisaged in the context of EDF and its precursor programmes (e.g. EDIDP-NGPSC-PGA-2020 and EDIDP-NGPSC-LRIF-2020).

Functional requirements

The proposals should meet the following functional requirements:

- Modularity and interoperability:
    - interoperability between EU Member States, EDF associated countries (Norway) and NATO. Especially, the 155mm ammunition should be compliant with the Artillery JB MOU[136] and be testable in a proven 155mm (up to 52-calibre) artillery;
    - both rocket and 155mm (up to 52-calibre) ammunition should be developed following a modular approach (Canard Actuation System / Fin Actuation System, aerodynamic skeleton, seeker, etc.), with interface specifications and validation;
    - the ammunition should have a range of around 80km for the 155mm shell and at least 150km for the rocket. The minimum range for the 155mm shell is 50km but at least 60km should be pursued;
    - the ammunition should provide a terminal effect with a metric precision below 10m (CEP@50) range, in all weather conditions and in a GNSS contested environment;
    - terminal effect: the ammunition should integrate a high payload warhead that should be effective against soft targets, light vehicles, small building with the ability to attack the enemy (high pay-off targets) in depth, to strike a counter-fire. Accordingly, warhead and terminal effect should be optimised (scalable effect depending on target objectives); the use of insensitive explosive (HE IM[137], MURAT 1*[138]) is requested, as far as possible. When not possible, this has to be justified;
    - the ammunition guidance and navigation should be GPS and Galileo compatible, without creating any restriction of use to EU Member States and EDF associated countries (Norway);
    - the 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 (related to insensitive munition) and STANAG 4187 (related to safety) is expected;
    - the ammunition should be programmable to realise the mission, with minimum interference with the gun system;
    - an integrated in-flight re-targeting capability (including mission change and/or a mission abort) should be assessed for the different categories of ammunition;
    - terminal guidance should be affordable and effective against moving and stationary targets;

[136] NATO Joint Ballistics Memorandum of Understanding (JBMoU).
[137] High explosive insensitive munition.
[138] 1 star marked « Munitions à risques atténués ».

- terminal phase characteristics (i.e. fuse and warhead architecture) should be determined according to the kind of effect considered. Typical options for activation are impact, delayed impact (also against reinforced infrastructure, bunkers, etc.) and predefined altitude;
- high survivability against modern air defence systems;
- the ammunition should present a high robustness against jamming.

- The ammunition should consider storage constraints:
  - The ammunition availability should consider operational needs taking into account storage constraints due to the frequency of use of such type of projectiles (ammunition still effective within a 15-year duration to be compliant with other types of ammunition) with particular attention to:
    - increased capacity of power supply;
    - the robustness of the supply chain.
  - The propellant charges should be studied with the intention of reducing wear, limiting dispersion and yet with increased firing distances.
- Performances should be achieved without modifying the requirement of existing European artillery rocket launchers and 155mm (up to 52-calibre) artillery guns.
- Every technology and component developed to address the above challenge should be capable of being integrated into an artillery rocket. Therefore, technical specifications at all stages should encompass the two categories of ammunition. It is expected that the stress put on compactness and resistance to the extreme thermo-mechanical environment of a 155mm artillery shell will enable technologies and components to withstand the environment of an artillery rocket as well.
- The modular architecture should allow, through flexibility and, if needed, specific subsystems, ammunition compatibility between EU Member States, EDF associated countries (Norway) and NATO countries and especially with existing European artillery rocket launchers and 155mm (up to 52-calibre) artillery guns.

Expected impact

The outcome should contribute to:

- EU strategic autonomy;
- European technological sovereignty:
- the reinforcement of innovation on key capabilities;
- strengthening the European Defence Technological and Industrial Base (EDTIB);
- increasing interoperability and developing potential European standards.

2.5.15. EDF-2023-DA-NAVAL-MMPC: Modular and multirole patrol corvette

- **Indicative budget:** EUR 154 500 000 for this topic under the call EDF-2023-DA.

- **Indicative number of proposals to be funded:** one proposal is to be funded under 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

Naval combat platforms and systems are essential assets to ensure maritime surveillance and presence at sea where needed with deterrent effect to grant maritime security, the respect of International Maritime Law, the defence of the sea lines of communications, and protect the interests of the EU, its Member States and EDF associated countries (Norway).

The main objective of this topic is to generate a new multirole and modular "second line class of vessels"[139], able to increase current EU Member States and EDF associated countries (Norway) navies' interoperability and capabilities mainly in terms of maritime situational awareness, surface superiority and power projection. Such units are due to carry out a large spectrum of naval operations ranging from peacetime and crisis time actions up to wartime operations.

The ambition is to drastically increase the flexibility and cost-effectiveness of that class of vessels, based on a reference core ship (baseline), while addressing the common requirements of the supporting Member States and EDF associated countries (Norway), and the specific requirements of their variants.

Specific objective

The goal of this topic is to pursue the work already addressed in the EDF 2021 work programme under the call topic *multirole and modular offshore patrol vessel* (EDF-2021-NAVAL-D) aiming, this time, to complete the Critical Design Review (CDR), and start the development phase with the production of, at least, the platforms of several variants as prototypes and, at least, one per version.

The proposals should leverage the progress made in the context of the above-mentioned action aiming in particular, at building and structuring a common industrial working environment, and studying and reaching an initial design of the common baseline of the vessel.

Two different versions are considered:

- Full Combat Multipurpose (FCM) corvette equipped with a variety of systems to ensure adequate self-defence in all warfare scenarios and capable of integrating specific additional capabilities based on modular configurations;
- Long Range Multipurpose (LRM) corvette, with an extended endurance (compared with FCM) and equipped with a variety of systems to ensure adequate self-defence in specific warfare scenarios and capable of integrating specific additional capabilities based on modular configurations.

[139] Limited Warship Unit according to NATO terminology.

The main result should be the design of the two above-mentioned versions based on a common mono hull platform (reference core ship), and the integration of a combat system, specific for each variant, to enable the prototyping and testing activities.

Scope and types of activities

Scope

The proposals must aim, based on the work addressed in the EDF 2021 work programme under the call topic *multirole and modular offshore patrol vessel* (EDF-2021-NAVAL-D), to:

- implement, maximise and strengthen the progress made in the context of the preceding above-mentioned action, in terms of common rules and standards;
- reach a mature and detailed design for each variant based on a common baseline (reference core ship) of this innovative class of warship to address the common requirements of the supporting Member States and EDF associated countries (Norway);
- provide digital models of the reference core ship and the two versions (FCM and LRM) with the possibility to add specific variants;
- develop, at least, the platforms of several variants as prototypes and, at least, one per version;
- perform initial trials and testing activities related to each prototype.

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,	Yes (mandatory)

Types of activities (art 10(3) EDF Regulation)		Eligible?
	including partial tests for risk reduction in an 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)

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

- Studies:
    - technical feasibility studies, if needed, to complete the initial design of the common platform;
    - technical feasibility studies related to the integration of the respective combat system including, but not limited to, sensors, processing and effectors, considering physical, combat management, and command and control perspectives in a multi-domain interoperability scenario, while designing a reference core ship as wide as possible;
    - industrial plan, encompassing the full production strategy for all variants.
- Design:
    - integration in the ship design of the technological bricks selected by supporting Member States and EDF associated countries (Norway);
    - detailed design of the reference core ship, platform and combat system integration, addressing the common requirements of the supporting Member States and EDF associated countries (Norway);
    - definition and detailed design of the two versions and specific variants in order to fulfil the needs and requirements of the supporting Member States and EDF

associated countries (Norway). These designs will be completed to enable the production of FoCs[140] of each variant within the class of vessel;

- design of the prototypes;
- digital model of the variants.

- System prototyping:
  - produce, at least, the platforms of several variants as prototypes and, at least, one per version.
- Testing:
  - of components and system integration of the reference core ship;
  - initial trials of prototypes in harbour and, desirably, at sea.

The proposals may also cover the following tasks:

- Qualification:
  - qualification of the design of the reference core ship in its two versions to ensure consistency with the requirements of the supporting Member States and EDF associated countries (Norway).
- Certification:
  - certification activities of the detailed design of the reference core ship.

Functional requirements

The proposed developments for the reference core ship and its variants should meet the following functional requirements:

- the collection and analysis (technical-operational and value analysis) of each end-user's operational requirements (CONEMP141) to define the needs, including the ones related to the integration of the combat systems for all the variants;
- the demonstration of the completion of a detailed design and the integration of the relevant ship elements including the respective combat system through, for example, the production of technical documentation, drawings, or 3D digital models;
- the detailed design should be approved by classification societies;
- based on the designed reference core ship as a common baseline for the class of vessel, the differences between variants should be minimised as much as possible through innovative solutions like, for instance, the use of flexible areas and modular architectures. As well, in order to increase commonality between variants and to reduce non-recurring costs, the on-board systems should have, as much as technical and economically feasible, standardised functional and physical interfaces, with

[140] First-of-Class.
[141] Concept of Employment.

indication of buffer tolerances in terms of weight, dimensions and features for embarking specific systems or equipment;

- the physical and functional interfaces should be compliant with standards widely used in the naval domain (e.g. NATO STANAGS);
- provide advanced Human Machine Interfaces (HMI) supporting the operators in all their operational, technical and training tasks;
- green aspects should be properly considered to minimise the environmental impact (e.g. reduced global gas emissions, waste disposal) and be compliant with the requirements of most advanced legislation on environmental protection and prevention of pollution from ships.

The platform should:

- integrate innovative solutions, technologies or systems to enhance efficiency and the capabilities of the vessel at sea;
- provide an overall expected displacement of around 3 000 tons, with a draft enabling the ship to operate from minor/tender ports;
- provide a design able to integrate different combat systems for the different variants.

The integration of the combat systems should:

- be based on definition of common interfaces, when possible, between the platform and the combat system of the different variants;
- give due consideration to cybersecurity aspects;
- aim to optimise design, production and in service support costs;
- be able to easily integrate additional capabilities, manage weapon system configurations, interface with external systems through standardisation, and favour reconfiguration and continuous modernisation throughout the ship life-cycle;
- embrace the integration of different unmanned vehicles through standardised systems providing interfaces for sharing information in a collaborative way and based on standards widely used in the naval domain (e.g. STANAG 4817 on Multi-Domain Control System);
- enable the integration of systems to collect and manage information coming from local sensors, cooperative sources and, when applicable, non-cooperative sources.

Expected impact

The outcome should contribute to:

- a joint procurement of a cutting-edge modular and multirole patrol corvette class;
- a widened level of communality, interoperability and standardisation of the variants, maximising their integration at fleet level;
- strengthening the European industrial ecosystem by means of common methods, standards, rules and interfaces;

- enhancing the EU naval sector competitiveness, innovation, efficiency and technological autonomy, while promoting a wider cross-border cooperation in particular as regards SMEs and mid-caps;
- reinforcing trust as regards security of supply in the naval sector by shaping an initial nucleus of a truly European supply chain;
- the EU Green Deal and climate objectives.

2.5.16. EDF-2023-DA-UWW-ASW: Unmanned anti-submarine and seabed warfare

- **Indicative budget:** EUR 45 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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 resurgence of high intensity conflicts at the borders of the European Union, combined with new technologies and hybrid threats, is calling the EU, its Member States and EDF associated countries (Norway) to action. The vulnerability of critical maritime infrastructure, such as undersea cables and pipelines, requires resolute measures to ensure its safety and resillience.

The underwater domain (including the seabed and critical maritime infrastructure) is particularly prone to threats as it is largely unmonitored, uncontrolled and concealed. There is a need to perform an increasing number of operations at the same time to face new generation of silent submarines and drones against the wide array of threats. Current solutions are not sufficient or efficient to deal with these new forms of threats. Unmanned systems are estimated to be the backbone of future solutions enabling European navies to deal with numerous simultaneous missions in larger areas of operations.

Specific objective

The specific objective of this topic is to develop and assess, in a real environment, unmanned platforms and other new assets along with traditional platforms to manage efficiently anti-submarine warfare (ASW) and seabed warfare (SBW) operations to face current and future threats in the new security context.

The aim is to progress in the ASW and SBW with unmanned systems beyond a concept phase to develop and test models or prototypes of UxVs (UAVs, USVs, UUVs, and other unmanned systems) with payloads which will enable ASW and SBW missions. The solution is expected to contribute to and enable an open and agile maritime warfare architecture. The aim is to reach at least a maturity level equivalent to technology readiness level 6 (TRL 6) on at least sub-system level. Higher technology readiness level in the prototyping phase and maturity towards a foreseeable system integration with open architecture are encouraged.

Scope and types of activities

Scope

The proposals must address design, testing and prototyping activities through sea demonstrations of next-generation underwater warfare solutions.

The proposals should contribute to new ASW and SBW concepts and may leverage civil R&D results (synergies through spin-ins). The proposals should build on a System-of-Systems (SoS) approach that allows adaptations and additions beyond the proposed solution without manufacturer-specific restrictions. The proposals should consider collaborative ASW and SBW capabilities that are based on manned and unmanned assets, in a highly scaleable and heterogeneous communication and information network with self-x-properties. Design and prototyping should include relevant simulations.

The areas concerned for development and improvement, and that must be addressed by the proposals are the following:

- new ASW and SBW concepts;
- detection, classification, identification, and tracking of underwater threats in demanding conditions (such as deep and very shallow waters, challenging seabed topography, and noisy environment);
- collaborative, all-node, all-payload, manned-unmanned teaming, including the necessary command, control (C2), and communication (C3);
- decision support for ASW and SBW operations and their enabling systems;
- enabling neutralisation of underwater threats.

Proposed solutions that address these areas should consider some or all of the following features:

- collaborative sensor systems concepts with enhanced capabilities for detection, classification, localisation and tracking of low signature underwater targets;
- UxVs with collaborative behaviour for improved performance in ASW and SBW operations;
- means for monitoring critical infrastructure;
- improving UxVs with, for example, enhanced seaworthiness, energy autonomy, decision autonomy, GNSS-independent navigation and automated payload processing;
- neutralisation solutions for emerging underwater threats, such as UxV:s and swarms;
- new and enhanced self-protection solutions, such as extended anti-torpedo protection using for example decoying or jamming solutions;
- mission autonomy of different degrees with partial or total remote or on-board processing;
- combat system architecture and associated applications (such as mission planning, mission management, situational awareness, tactical aid) for reduced human workload,

enabling operations with manned and unmanned systems, improving connectivity and interoperability with the naval forces;

- underwater battlespace data solution to establish situational awareness in the underwater domain. Data analysis algorithms, including machine learning and AI, are required to manage ever larger volumes of (acoustic) data and support decision making;

- communication systems to operate unmanned systems with manned systems including interworking and interoperability of applications and 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**)	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 (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

Types of activities (art 10(3) EDF Regulation)		Eligible?
		(optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (optional)

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

- Design:
    - the proposals must use the NATO Architecture Framework methodology and digital twin approach to design a European interoperable ASW and SBW SoS;
    - non-proprietary standards on data/information exchange level for mission planning, mission supervision and communication to implement unmanned systems into joint/combined task forces.
- System prototyping:
    - the proposed solutions must be demonstrated under operational conditions.

In addition, the proposals should cover the following tasks:

- Design:
    - new UxV platforms with payloads for ASW missions;
    - new sensors including network topologies for threat detection and identification of emerging threats;
    - new breakthrough navigation and mission autonomy algorithms;
    - low cost solutions to provide surveillance capabilities of choke points and littoral waters.
- System prototyping:
    - the proposed solutions should be demonstrated in various operational environments.
- Testing:
    - the proposed solutions should be tested in a simulated environment;
    - the proposed solutions should at least partially be tested under operational conditions.

The proposals must substantiate absence of duplication of activities and tasks described in the topic *Solutions to detect, identify, counter and protect against mobile manned, unmanned or*

autonomous underwater systems (including those operating at very high depths) of the call *Underwater Control contributing to resilience at sea* under the European Defence Industrial Development Programme (EDIDP-UCCRS-MUAS-2020). The proposals must also give due consideration to sufficient human oversight of autonomous features in the solutions, as addressed e.g. by the United Nations Convention on Certain Conventional Weapons Group of Governmental Experts Lethal Autonomous Weapon Systems (CCW GGE LAWS) 11 guiding principles.

While conforming to all relevant national, EU, and international laws and regulations, the proposals may use available and relevant sources for topic specific standards and regulations. For example the "Safety and Regulations for European Unmanned Maritime Systems".

Functional requirements

The proposals must be supported by a set of capability requirements as agreed by a group of supporting Member States and EDF associated countries (Norway). The proposals must be in line with the proposed activities and the requirements by the supporting Member States and EDF associated countries (Norway).

The outcome should at least:

- provide for enhanced detection, classification, identification, targeting and neutralisation of current and new underwater threats in challenging environments;
- be able to perform missions 24/7/365 in the European maritime waters;
- be based on a modular and agile non-proprietary system-of-systems architecture.

Expected impact

The outcome should contribute to:

- a stronger, more competitive and technologically independent European Defence Technological and Industrial Base (EDTIB) when it comes to solutions for next generation ASW and SBW capabilities;
- enhanced security for EU Member States and EDF associated countries (Norway) and more capable and interoperable forces performing ASW and SBW operations;
- a new European interoperable concept of operations for ASW and SBW.

2.5.17. EDF-2023-DA-UWW-MCMC: Future maritime mine countermeasures capability

- **Indicative budget:** EUR 45 000 000 for this topic under the call EDF-2023-DA.
- **Indicative number of proposals to be funded:** one proposal is to be funded under 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 maritime mine warfare domain is currently facing two critical challenges. On the one hand, uncertain geopolitical context makes it crucial for European navies to retain the necessary capabilities to keep European waters, critical infrastructure at sea, and sea lines of communications clear from an ever-evolving mine threat (such as buried mines, drifting mines, intelligent mines). To secure a sustainable European sovereignty in conventional military capabilities, the European defence stakeholders must understand the threat and develop appropriate interoperable and interchangeable solutions to mitigate the risk due to naval mines and underwater explosive devices and establish local maritime superiority in areas prone to mine warfare.

On the other hand, new technologies, especially the miniaturisation of the sensors and the level of autonomy on-board naval unmanned platforms, are enabling new operational concepts, such as so-called "stand-off" or semi-autonomous concept – that limit human exposure to danger. European navies have already started to embraced this challenge to maximise future interoperability and share the costs of these developments. Many current European mine countermeasures (MCM) systems are facing obsolescence of systems, and rapid evolving technologies in the underwater domain offer new solutions for Maritime MCM. These solutions enable also new operational concepts to be established.

Specific objective

The specific objective of this topic is to enable solutions that are easily deployable both on current (by retrofit) and future naval assets. The focus is on interoperability and interchangeability as from the design phase of the systems, including data-sharing. The aim is to provide capable and cost-effective technologies for MCM operations. These include enabling systems for mine warfare platforms (such as launch and recovery (LARS) and command and control (C2) systems), development of unmanned platforms, decision support, planning, and evaluation tools.

The focus is on improving effectiveness in difficult seabed conditions (such as cluttered seabed and deep waters) and against difficult naval mines (such as intelligent mines, stealth mines, buried and conceiled mines, drifting mines, and rising or mobile mines), and on reducing time (increase efficiency) of the overall MCM operation. Development of unmanned systems and autonomous features are seen as enablers in this regard. Improvements may also be related to automated collaborative behaviour of UxV-based system of systems to benefit both operational quality and efficiency.

The outcome should benefit a European interoperable and interchangeable MCM future system designed with incremental capabilities to build successive systems to counter current and new mine threats consisting of a system of systems (SoS) with evolving and scalable toolboxes, and enhanced intelligent platforms. The aim is to reach a maturity level equivalent to at least technology readiness level 6 (TRL 6) on at least sub-system level.

Scope and types of activities

Scope

The proposals must address design to qualification activities of next-generation MCM solutions which improve the quality and speed of MCM processes. The proposals must cover

operations in demanding conditions. The proposals should consider and contribute to unmanned solutions and concepts.

The areas concerned for development and improvement, and that must be adressed are the following:

- performance of the MCM process in terms of quality and time using decision support capabilities;
- operational effectiveness and efficiency through extended autonomous behaviour and improved endurance of unmanned systems (UxV) both individually and as collaborative system of systems;
- detection and neutralisation of difficult naval mines (drifting mines, buried mines, stealthy mines) through improved sensors and/or vectors;
- extending operational MCM capability in battlespace and time, covering environment and factors such as difficult seabed terrain, high sea state, iced waters, non-permissive electromagnetic environment, in the water column from surface to maximun 1000m;
- improving reliability and robustness.

Proposed solutions that address these areas should consider some or all of the following features:

- decision support using sensor data fusion, big data analysis, data exploitation, and improvement of decision-making algorithms and tactical procedures;
- sensor and effector development utilising forms of Artificial Intelligence (AI) and swarm techniques;
- UxVs (UAVs, USVs, UUVs, and other stationary and mobile drones) complementary or embedded to the MCM organic system and interoperable with other naval force elements;
- UxV deployment, launch and recovery functions implemented for designed or designated vessels, craft of opportunity and shore infrastructure;
- joint multi-level (platform-unit-fleet) MCM mission management tools utilising for example AI and Big Data solutions to manage operations using multiple resources (manned and unmanned);
- communication systems to operate unmanned systems with manned systems, including interworking and interoperability of applications and data;
- digital infrastructure and cyber security by design.

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 (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/No (optional)

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

- Design:
    - the proposed solutions must be interoperable at various levels addressing and using existing or foreseen (known to be under negotiation) European and NATO standards;
    - the proposals must adhere to a technical design review milestone approach:

        - SRR (System Requirements Review) SWSR (Software Specifications Review);
        - SFR (System Functional Review)/SDR (System Design Review) PDR (Preliminary Design Review);
        - CDR (Critical Design Review) TRR (Test Readiness Review);
- System prototyping:
    - the proposed solutions must be demonstrated at sea under realistic environmental conditions with relevant mine targets and in an operational environment.

In addition, the proposals should cover the following tasks:

- Design:
    - the proposed solution should form a comprehensive next generation MCM concept supported by relevant European interoperable standards and architecture.
- System prototyping:
    - the proposed solutions should be demonstrated at sea under realistic environmental conditions with relevant mine targets and in various operational environments.
- Testing and qualification:
    - the proposed solutions should be tested in a simulated or controlled environment representing various use cases;
    - the proposed solutions must at least partially be tested and qualified in an operational environment.

The proposals must substantiate absence of duplication of activities and tasks described in the topic *Solutions to detect, identify, counter and protect against mine threats (including those operating at very high depths)* of the call *Underwater Control contributing to resilience at sea* under the European Defence Industrial Development Programme (EDIDP-UCCRS-MCM-2020). The proposals must also give due consideration to sufficient human oversight of autonomous features in the solutions, as addressed e.g. in the United Nations Convention on Certain Conventional Weapons Group of Governmental Experts Lethal Autonomous Weapon Systems (CCW GGE LAWS) 11 guiding principles.

Functional requirements

The proposals must be supported by a set of capability requirements as agreed by a group of supporting Member States or EDF associated countries (Norway). The proposals must give evidence of coherence between the proposed activities and the requirements by the supporting Member States and EDF associated countries (Norway). Development of capability requirements by supporting Member States and EDF associated countries (Norway) may take

into account relevant work done in groups like the PESCO MAS MCM that try to forge a long term vision on the development of an interoperable European MCM Toolbox.

The proposals should develop a capability aiming to:

- provide enhanced MCM processes in challenging environments;
- enable an open, modular, and adaptable MCM system-of-systems suite;
- be able to operate 24/7/365 in the European maritime waters.

Expected impact

The outcome should contribute to:

- a stronger, more competitive and technologically independent European Defence Technological and Industrial Base (EDTIB) when it comes to solutions for next generation MCM capabilities;
- enhanced security for EU Member states and EDF associated countries (Norway) and more capable and interoperable forces performing MCM operations;
- a new European interoperable concept of operations for MCM;
- future extended sea-bed warfare capabilities.

2.6. EDF-2023-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 defined in Commission Recommendation 2003/361/EC) or research organisations. The coordinator of the consortium needs to be an SME. The budget allocated to research organisations cannot exceed 40% of the total requested grant amount.
- **Indicative budget for the call:** EUR 36 000 000 to support one call topic:

2.6.1. EDF-2023-LS-RA-SMERO-NT: Non-thematic research actions by SMEs and research organisations

- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** the requested funding for individual proposals should not 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.

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

- blockchain applications (e.g. for identification of friend or foe);
- tools and applications improving cybersecurity talents screening;
- artificial intelligence and robotic autonomous systems;
- future naval platform control and management;
- smart damage control related to future naval platforms;
- ship signature management;
- secure and reliable underwater communication solutions and interfaces (radiofrequency, acoustic, optic or others);
- measurement and monitoring of physiological and cognitive state of soldiers;
- 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;
- synthetic fuel production from waste and biomass for military 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**)	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 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	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.

2.7. EDF-2023-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:** EUR 36 000 000 to support one call topic:

2.7.1. EDF-2023-LS-DA-SME-NT: Non-thematic development actions by SMEs

- **Indicative number of proposals to be funded:** several proposals may be funded for this topic.
- **Range of EU financial contribution per proposal:** the requested funding for individual proposals should not 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:

- blockchain applications (e.g. for identification of friend or foe);
- tools and applications improving cybersecurity talents screening;
- artificial intelligence and robotic autonomous systems;
- future naval platform control and management;
- smart damage control related to future naval platforms;
- ship signature management;
- secure and reliable underwater communication solutions and interfaces (radiofrequency, acoustic, optic or others);
- measurement and monitoring of physiological and cognitive state of soldiers;
- 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;
- synthetic fuel production from waste and biomass for military 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 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 component or technology	Yes
(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.

3. Action to be funded without call for proposals

3.1.EDF-2023-AIRDEF-EATMI: Endo-atmospheric interceptor – concept phase

- **Targeted type of actions:** Development action.
- **Form of funding:** actual costs grant following a direct award.
- **Beneficiaries:** MBDA France, ArianeGroup SAS, Ge AVIO srl, AVIO S.p.A., C.I.R.A ScPA (Centro Italiano di Ricerca Aerospaziale, Deutsches Zentrum für Luft- und Raumfahrt, Fokker Aerostructures BV, LYNRED, MBDA Deutschland GmbH, MBDA Italia S.p.A., OHB System AG, Office National d'Etudes et de Recherches Aerospatiales, Thales Nederland B.V., Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek TNO
- **Indicative budget:** EUR 80 000 000 to support this topic:

Objectives

General objective

Air Superiority is one of the eleven EU capability development priorities identified as part of the revised 2018 capability development plan. This priority includes specifically A2AD type (anti-access area denial) and BMD (ballistic missile defence) capability shortfalls. The emergence of new threats such as manoeuvring ballistic missiles and hypersonic cruise missiles (including air launched ones) or hypersonic glide vehicles represents an additional challenge for European and NATO ground and naval-based air defence systems. Existing knowledge and technologies in the field of weapon systems and missiles design inside the EU

represent however an opportunity to explore the feasibility of an endo-atmospheric air defence effector able to intercept current and emerging post-2030 ballistic and cruise missile threats.

Specific objective

This topic is an opportunity for Europe to federate efforts under a European design authority to master critical technologies, materials, components and expertise key to develop a state-of-the-art endo-atmospheric interceptor. The concept exploration study of the interceptor will be the cornerstone for possible future European ground and sea-based missile defence systems, able to complement significantly and improve the robustness of NATO BMD and TBMD[142].

Scope and types of activities

Scope

The proposal must address surface-to-air interceptor solutions including interceptor concepts studies, and associated early maturation activities, until an interceptor mission definition review (MDR) and a preliminary requirements review (PRR) approved by the cooperating Member States and EDF associated countries (Norway). The proposals must aim to provide two main results:

(1) the selection of an interceptor solution to counter the post-2030 theatre air and ballistic threat;

(2) the initial maturation of the most critical related technologies.

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,	Yes (optional)

[142] Theatre Ballistic Missile Defence.

Types of activities (art 10(3) EDF Regulation)		Eligible?
	including partial tests for risk reduction in an industrial or representative environment	
(e)	**System prototyping** of a defence product, tangible or intangible component or technology	Yes (optional)
(f)	**Testing** of a defence product, tangible or intangible component or technology	Yes (optional)
(g)	**Qualification** of a defence product, tangible or intangible component or technology	Yes (optional)
(h)	**Certification** of a defence product, tangible or intangible component or technology	Yes (optional)
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	Yes (optional)

The proposal must cover at least the following tasks as part of the mandatory activities:

- **the iterative definition of interceptor detailed requirements**, based on:
  - the definition with supporting Member States and EDF associated countries (Norway) of a set of missions, threats, attack scenarios including salvos or combined attack, and user requirements, the definition of a workable concept of operations (CONOPS), including interceptor association with external lower/upper layer effectors and early warning sensors;
  - the detailed characterisation of the relevant threats to be addressed by the future interceptor;
  - the selection with supporting Member States and EDF associated countries (Norway) of relevant weapon systems (WS), platforms and command and control (C2) architectures to be considered for the interceptor concept and development activities, in consistency with Member States and EDF associated countries (Norway) roadmaps for these elements at the horizon 2035+. Considering the early stage of the interceptor activities, the proposals will favour generic/high-level WS, platform and C2 assumptions;
  - the selection with supporting Member States and EDF associated countries (Norway) and the characterisation of the relevant sensor suites, including fire control radar and early warning sensors, to be considered for the interceptor concept and development activities, in consistency with Member States and EDF associated countries (Norway) roadmaps for these elements at the horizon 2035+, and with Member States and EDF associated countries (Norway) activities related to space-based early warning.

Considering the early stage of the interceptor activities, the proposals will favour generic sensors models, taking into account existing technology and main planned evolutions in the considered horizon;

- the elements coming from concept exploration studies;

- **the concept exploration studies and performance assessment for possible interceptor solutions,** notably regarding:
  - the definition and assessment of the candidate interceptor physical architectures;
  - the definition and assessment of the candidate interceptor functional architectures, including integration within the relevant WS;
  - the assessment of interceptor and global WS performances, in behavioural and accurate (6-DoF[143]) simulations combining physical and functional accurate modelling for the candidate interceptor solutions. In particular, the assessment will include detailed simulations of the main interceptor flight phases, and will take into account generic radar models to estimate the probability of interception against each type of threats for the selected interceptions points;
  - the physical and functional integration aspects of the candidate interceptor concepts on the relevant platforms and launchers identified with the Member States and EDF associated countries (Norway), including safety aspects;
  - the munition management aspects during its complete lifecycle, including transportability, integration to different platforms launchers, safety and integrated logistic support;
  - the testing facilities, for development and qualification;
  - the trainings aspects, including firing tests;
  - the economical (non-recurring and recurring costs) and general risk analysis of candidate concepts;
  - the proposal for a best concept candidate for further maturation and preliminary design phase, based on complete value analysis including performance, costs, risk, modularity, manufacturability, safety, consistency with Member States and EDF associated countries (Norway) operational needs, current/planned platform sensors and lower layer interception means, with jointly defined detailed criteria and hypothesis;
  - the mission definition review (MDR) and a preliminary requirements review (PRR);
- **the early maturation activities key for developing an endo-atmospheric interceptor,** including best suitable propulsion solutions for boost phase, midcourse phase and endgame, notably:
  - activities related to main interceptor functional segments, in consistency/support with functional requirements and concept exploration activities;
  - activities related to interceptor technologies and equipment, in consistency/support with the functional requirements and the concept exploration activities);

[143] Degrees of freedom.

- the maturation level raised through the present concept phase must be sufficient to allow the most critical technologies and equipment to reach TRL 6 within 3 years, by means of the possible following assessment phase which has to be consistent with the scope of the retained concept;
- identification of complementary maturation plan allowing to reach TRL 6 for most critical technologies and equipment.

Functional requirements

The proposal should fulfil the following requirements:

- the candidate interceptor solutions must operate with both naval and ground systems;
- the candidate interceptor solutions must operate with platforms that are consistent with the Member States and EDF associated countries (Norway) roadmap at the horizon 2035+ for European navies and ground systems;
- the candidate interceptor solutions must operate with WS architectures and sensor suites that are consistent with the Member States' and EDF associated countries' (Norway) roadmap at the horizon 2035, including potential space-based early warning system against ballistic and hypersonic missiles;
- the candidate interceptor solutions must provide collaborative engagement capabilities (CEC) at missile level and be compliant with CEC at system level (e.g. LOR[144], EOR[145]) to allow engagements in a multi-system and multi-platform architecture);
- the candidate interceptor solutions must address as a priority following high-level threat set:
    - BM[146] up to 3500km of range, including those with the ability to significantly modify the atmospheric part of their trajectory;
    - ASBM[147] up to 2500km of range;
    - hypersonic glide vehicles released by TBM[148] up to 3500km of range;
    - high altitude hypersonic and supersonic cruise missiles;
- the candidate interceptor solutions must enable self-defence, force protection and area defence against the high-level threat set;
- depending on possible complementarity with other Member States and EDF associated countries (Norway) weapon systems, the candidate interceptor solutions should address performance against the following threat set, keeping in mind that the primary design optimisation must aimed at the high-level threat set mentioned above:
    - sub- and super-sonic cruise missiles;
    - air breathing targets (fighter, aircrafts, UCAV[149], HALE[150]…);

[144] Launch on remote.
[145] Engage on remote.
[146] Ballistic missile.
[147] Anti-ship ballistic missile.
[148] Theatre ballistic missile.
[149] Unmanned combat aerial vehicle.

- sub- and super-sonic sea-skimming missiles;
- other high manoeuvring missiles;

- WS assessment and candidate interceptor concepts sizing must consider following elements for the generic sensor suites:
  - performances achievable by the other Member States and EDF associated countries (Norway) activities and/or EU-funded activities (*e.g.* through the European defence industrial development programme) regarding space-based early warning;
  - key ground-radar requirements, considering technologies upgrade in the radar domain in the 2030+ horizon and relevant frequency bands, and associate a "risk level";
  - provide the generic models and the key sensor suite characteristics to represent the sensor suite for the WS and effector concept(s) assessment;
- following aspects for the abovementioned threats must be characterised:
  - mission and operational CONOPS;
  - flight phases and associated kinematic characteristics;
  - physical characteristics and observability (detectability: signatures in infrared (IR) and radio frequency (RF) bands, plasma effects);
  - trajectory constraints due to guidance means (active/passive/semi-active seekers, IMU[151], GNSS[152], …), to physical integrity (thermal load, …), and terminal accuracy (miss-distance, CEP[153]);
  - manoeuvrability and penetration aid (PENAIDS) devices and/or tactics;
  - generic model for each type of threats;
  - vulnerability and functional / physical destruction criteria;
  - potential users and temporal horizon;
  - possible threats evolutions (2040+ horizon);
- interception performances requirements (interception altitude, range, hit probability, lethality …) must be detailed for each selected threat considering possible threat behaviour (manoeuvres, countermeasures), assets/areas to be defended and combined attacks scenarios;
- interceptor concepts must be sufficiently developed at individual stages as well as complete munition level to assess the feasibility of a single interceptor or a family of interceptor, and to provide specifications and steering for the specific technology, equipment and functional chain maturation topics;

[150] High altitude long endurance.
[151] Inertial measurement unit.
[152] Global navigation satellite system.
[153] Complex Event Processing.

- the studies and initial de-risking activities, including technology/sub-systems demonstration when appropriate, must be included for the following technologies and equipment:
    - high-temperature materials and structures;
    - high-supersonic airframe and thermal management;
    - advanced guidance and control system;
    - high-temperature and very-high performance fins actuation system;
    - solid propulsion and thrust vectoring devices (small to large motor calibres);
    - high-supersonic ramjet (midcourse) propulsion;
    - IR sensor(s), to address the game changing emerging threats (hypersonic cruise missiles, fast ASBMs/TBMs, hypersonic gliders), including sensor window and cover if necessary;
    - RF sensor(s), to operate at all altitudes, but with a more modest level of ambition against the above-mentioned game-changing threats, including covers/radomes;
    - pyrotechnic divert and/or attitude control systems;
    - warhead, and warhead triggering sensors;
    - long-range, high rate and low latency datalink system, including compatibility with existing datalink systems;
- the studies and initial de-risking activities, including functional segment demonstration when appropriate, must be included for the following functional segments:
    - interceptor integration to ground and naval platform, including hanged-fire safety case;
    - midcourse aero-propulsion and controllability of high-supersonic ramjet-based airframes;
    - stages separation and shroud ejection in supersonic regime;
    - threat discrimination, classification and identification;
    - tracking and prediction of possible flight paths for fast and manoeuvrable threats;
    - engagement planning, mid-course trajectory optimisation and guidance against fast, manoeuvrable threat, even with non-predictable future behaviour;
    - multi-mode high-altitude terminal control architectures, and advanced guidance (hit-to-kill) for endgame (IR and RF);
    - high-end threat acquisition and tracking with terminal sensor;
    - enhanced lethality against new high-end threat, including aim-point selection and warhead triggering.

Expected impact

- Contribution to the defence and security interests of the EU, its Member States and EDF associated countries (Norway):
    - contribution to the EU strategic autonomy level of ambition, as defined in the CDP, in particular regarding Air Superiority;
    - increased resilience enhanced protection of critical assets and improved force protection of ground and naval units against post-2030 threats;
    - complementarity between EU and NATO by reinforcing the qualitative and quantitative contribution of the European allies to the NATO missions, in particular the BMD mission.
- Contribution to enhanced interoperability between armed forces of the Member States and EDF associated countries (Norway), stimulation of European doctrine and European standards.
- Contribution to Europe's resilience and European technological sovereignty:
    - contribution to the industrial autonomy and technological sovereignty through the development of concepts, critical functional chains and equipment under a European design authority;
    - contribution to innovation through the investigation of new and disruptive technologies and concepts;
    - support to the European missile systems ecosystem in the long-term and pull up technologies to be reusable in other missile segments (guidance chain, seeker, propulsion, materials…);
    - contribution to strengthening the competitiveness of the EDTIB (European defence technological and industrial base) by creating new market opportunities;
    - contribution to relocate some technologies and expertise, materials and components in Europe under a European design authority in line with the EU industrial autonomy and technological sovereignty ambitions.