2.2.1. EDF-2022-LS-RA-DIS-AC: Innovative technologies for adaptive camouflage

Budget

The Union is considering a contribution of up to EUR 15 000 000 for this topic under the call EDF-2022-LS-RA-DIS.

Number of actions to be funded: Several actions, addressing different solutions, may be funded for this topic.

Objectives

Camouflage is an important measure to protect soldiers and military platforms. The adaptation of the camouflage characteristics to the conditions, such as encountered sensors, environment and threat level, could bring this protection to a new level. Both the performance of the adaptive camouflage and material characteristics, including its passive properties (e.g., fire/electric shock protection and camouflage), will influence the impact of this technology on military capabilities. This topic complements ongoing projects, in particular following the PADR call on research in technology and products in the context of Force Protection and Soldier Systems.

General objective

The threats' fast adaptation, hybridization, proliferation of innovative technologies, and increasing lethality of threats, highlight the importance of enhancing the Land Systems (both soldiers and platforms) protection. Lower mass better protected military platforms and soldiers are easier to operate at reduced risk for injuries.

An important measure to protect soldiers and military platforms is camouflage in a wider spectral range, also including radar frequency bands

Specific objective

A good camouflage coverage changes the appearance or signature respectively and prevents from being detected, recognized or identified, and furthermore from being, attacked, hurt, killed, damaged or destroyed. Various camouflage measures have been used in many conflicts and have led to partially astonishing and impressive results. Legacy camouflage techniques and means are normally passive materials with fixed technical properties and with no possibility to adapt or change them. Hence, the signature remains unchanged if the background changes due to movement for example. These conventional techniques are being used in nearly all military situations, missions, scenarios and environmental conditions.

At the same time, available military and commercial sensors, drones, detectors and cameras in combination with sophisticated signal or image processing and analysing software algorithms (such as artificial intelligence-based routines) increase the probability to detect, to recognize or to identify such conventionally camouflaged objects. An increasing threat consists of (more) affordable high-tech sensors, airborne (e.g., drones) and ground based, operating in the spectral bands mentioned in footnote 16, including emerging sensor technologies (such as lasers scanning and quantum) and multi and hyperspectral sensors.

Improved and new Camouflage, Concealment, Deception & Obscurant (CCD&O) solutions and operating procedures are required to prevent land systems (including their weapons) to be detected, identified or their intentions disclosed. Potential countermeasures include passive

camouflage, mobile systems, weapons, active camouflage, including smart materials, deception methods, obscurants, and deceptive technologies.

A promising contribution to this challenge is adaptive camouflage techniques and devices that are able to adapt their signatures to the background, to the surveillance sensors (mainly when active), different weather and daytime conditions and threat level hence reducing the ranges of detection, tracking, recognition and identification increasing the survivability of soldiers and platforms. Military platforms or soldiers equipped with adaptive camouflage measures are able to change the signature and to adapt it to the actual background or to deceive sensors in different spectral bands. In order to provide protection against future sensor technologies, development of new materials and concepts have to be investigated. The current development of electromagnetic detection tools like Foliage Penetration Reconnaissance, Surveillance, Tracking and Engagement Radar pinpoints a need for wider spectral range protection, also including radar frequency bands, to protect moving soldiers or military platforms under trees. A combination of camouflage in the optical and radar spectral bands will ensure the highest level of protection, reducing the risk of being targeted.

In that sense and in line with both 'Ground Combat Capabilities' CDP priority and 'Soldier Systems' CARD Focus Area, this topic aims to push the undergoing technological effort addressing adaptive camouflage for protection of land systems.

In particular - and in compliance with European Defence Agency (EDA)'s Overarching Strategic Research Agenda (OSRA) results, including TBB "Passive and active protection for Land Systems" and TBB "Camouflage and Signature Management Technologies" - this topic will contribute for closing the technical gaps directly related with the following capabilities:

- Upgrade, modernize and develop Land platforms to adapt to operational environment– upgrade of current and development of next generation's armoured platforms.

- Enhance protection of forces.

- Improve individual soldier equipment.

Scope and types of activities

Scope

The main scope is to investigate suitable adaptive innovative camouflage techniques, taking also into account usability, and to demonstrate this with a technology demonstrator in real applications. Especially the problem of a good adaptation to the background and to the observing sensors in different spectral bands should be at the heart of the activities. Proposals should address the development of new concepts, technological blocks, sub-systems and/or systems. Technologies for commercial, civil applications and concepts of previous projects that have been publicly presented should be taken into account.

In order to understand the prioritisation of adaptive camouflage techniques, the activities should contain a threat analysis, which explores and ranks risk areas on military platforms or soldiers and ranks spectral range threats to be treated. These considerations should reflect night-time and daytime scenarios, situations of degraded visual environment given in woodland, arid and snow situation. The abovementioned threat analysis should also contain reference on the physics of camouflage for each spectral band.

The activities shall further focus mainly on research on state-of-the-art and innovative adaptive

camouflage techniques and devices in the different optical and radar spectral bands, on arranging and combining them in a common structure (layers, mosaic), on realizing a demonstrator (rigid panel display, elastic shield or flexible textile) and on testing and assessing it. The aim is to have the ability to change the signature (intensities and patterns) in different spectral bands at the same time without deteriorating the signature in any other spectral band. A concept and proposal to develop a self-adapting closed loop with the help of sensors (either embedded or as part of the material) detecting the surrounding environment and its own signature should also be planned. Materials for signature management in spectral bands listed in footnote 16 not deemed as threats should be studied on a more basic research level (TRL 1-4). Moreover, a development of bi-recyclable textiles and flexible elements (e.g., smart glass, optical fibres, etc,) with widest possible anti-radar properties should be investigated.

The adaptive camouflage techniques considered should address the integration with the platform or soldier C4I technology and should consider power source appropriate for the platform or soldier energy budget.

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 (**prototype**)	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 following tasks must be performed as part of the mandatory activities of the project:

- Generating knowledge

(1) threat analyses to prioritise object areas for each spectral band

(2) selection of suitable and development of innovative camouflage techniques and principles in the different spectral bands

(3) design of the materials or components with the aim of reducing the target's signature in all the considered spectral bands proposal for a new assessment methodology for an adaptive demonstrator

(4) laboratory testing, to determine the properties of the camouflage materials and coatings. Research should be performed on:

- mechanical and thermal properties;
- resistance to external factors (water, dust, fire, weather);
- chemical resistance to e.g., lubricants, disinfectants;
- spectral characteristics and measurements, and,
- evaluation of gloss and contrast.

(5) Development of a concept of a self-adapting closed loop:

- collection of surrounding environment flux in the considered spectral bands
- specification and assessment of different technical possibilities;
- selection of suitable feedback sensors in different spectral bands, and;
- analysis of a digital based control unit with an interface to allow integration into an overall system concept.

(6) definition of the energy budget for each active adaptive camouflage technique considered, including analysis and evaluation of alternative power sources for generating and storing electricity and creating conditions for an autonomous mode of using electricity.

(7) Technology demonstration on a military platform or soldier using standard-like surrogate targets; as for example a human body dummy and vehicle dummy.

- Integrating knowledge

(1) establishment of a concept of combining and integrating different, active and passive adaptive techniques in a mixed structure (layers, mosaic), including but not limited to ECPs, LEDs, NIR-diodes and flexible electrochromic display, optical fibres and new fibres based on dual technologies, transparent paintings, digital printing for active and passive camouflage, cooling elements, layers with spacers, etc. Biologically inspired materials and structures could be considered as well;

(2) analysis of the technical feasibility, requirement specification, trade-offs and concept definition for an operational use case.

- Studies

(1) study of novel materials with potential to improve signature management beyond state-of-the-art;

(2) study on the development of easy to scale-up technologies of elastic elements, as well as production of textile, preferably recyclable materials, with specific camouflage properties;

(3) analysis of industrialization and technology maturation needs at EU level;

(4) analysis of the disruptive potential of specific solutions for adaptive camouflage.

- Design

(1) design and testing of the surface structure;

(2) design and build a demonstrator, performing measurements at different environmental conditions in different spectral bands, compare to different background signatures and intensities;

(3) construction of a unified technology demonstrator;

(4) performance verification of the technology demonstrator in laboratory- conditions as well as under field conditions.

Functional requirements

It is essential that the research activities generate new or improved camouflage capability according to requirements generated from the operational needs of the Member States and Norway military forces.

Final adaptation to physical requirements regarding e.g., mobility, size, weight, power consumption, platform integration, and general robustness is not excluded, but more suited for a development program phase. Nevertheless, the proposals should include considerations on how the technology development can be driven with these parameters in mind.

The proposals should meet the following functional requirements:

- camouflage systems for both soldiers and military platforms should be considered;
- the camouflage should be functional in the different spectral bands listed in footnote 16;
- the camouflage should be able to be integrated with the platform or soldier C4I technology and should require power source appropriate for the platform or the soldiers' energy supply;
- power consumption should be minimized because it is critical for many missions (e.g., for all unmounted scenarios). The active camouflage for soldier should possess sufficient electrical independence: reduced power consumption in case of electronic components, as well as a self-recharging system. For vehicle applications power consumption is not as critical;
- all proposed solutions should clearly indicate required power, voltage and current, in order to be able to compare the proposals to the generators or batteries of existing vehicles and batteries of dismounted personnel;
- the active camouflage should be equipped with user protection system preventing from risk of electric shock;
- the most crucial aspect is the compatibility of all the spectral protection measures into a unified compact multitool, applicable for single soldier and military systems;
- the active camouflage control system should automatically generate suitable camouflage patterns ensuring low level of detectability efficiently;
- the active camouflage system must have a cyber security protection to prevent targeting by enemy systems;
- different optical intensities, colours and patterns should be generated;
- different weather conditions (summer, winter, sunshine, night, rain) and different background scenarios (woodland, dessert, urban) should be taken into account;
- the active camouflage material should demonstrate good mechanical properties, such as strength, low weight, compact structure and ease of use, allowing easy transportation and handling;
- the working principle of the control loop and the feedback signals should be defined;
- the possibility to integrate into an overall military system concept for different carriers with

compatibility to other equipment and boundary conditions should be considered;

- for the technology demonstration on a human body, a standard-like dummy target could be considered;
- for the technology demonstration on a vehicle a standard-like target such as the (EDA) STANDCAM could be considered;
- current available assets, as the European Terrain Database (EDA), could be exploited to assess camouflage effectiveness of soldiers and military platforms as well as the effectiveness of sensors in different terrains.

The functional requirements also include the optical properties of an adaptive shield (flexible or rigid) with an arrangement of different adaptive elements in different spectral bands also possessing radar protection. Properties to cover should be (if applicable):

- selection of materials with good performance in terms of their durability, usability, resilience, and low undesirable impact on other spectral ranges;
- increased camouflage effectiveness in spectral bands listed in footnote 16;
- spatial distribution of the emitted light and reflected environmental light, described by the BRDF (Bidirectional Reflectance Distribution Function) should be considered;
- polarization signature should be considered;
- speed of the adaptive change;
- properties of the closed feedback-loop with respect to different sensors, digital hardware, control concept, accuracy and speed.

Expected impact

- Contribute to closing the technical gaps directly related with the capabilities described in the CDP for the priority "Ground Combat Capabilities":
- upgrade, modernize and develop Land platforms to adapt to operational environment;
- upgrade of current and development of next generation armoured platforms.
- Enhance protection of forces with feasible solutions and improve of Land mobility.
- Improvement in military tactics and missions.
- Enabling of mission profiles that cannot be executed using conventional non-adaptive camouflage.
- New materials, new sensing techniques and new production techniques will create a renewed and variety of options in the world of "seek and hide" by combining selected Visible, IR and radar camouflage combinations, according with specific mission needs and requirements.
- Improve individual soldier protection.
- Decreases exposure to the enemy's actions, decreasing the number of combat casualties.