2.1.11. EDF-2022-RA-UWW-UTS: Underwater manned-unmanned teaming and swarms

Budget

The Union is considering a contribution of up to EUR 25 000 000 for this topic under the call EDF-2022-RA

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

Objectives

General objective

This topic addresses research for future capabilities addressing moving subsurface threats using manned-unmanned teaming and swarm technologies, possibly including surface and air platforms and components, particularly in confined and shallow waters (CSW). This System- of-Systems (SoS) should enable enhanced operational efficiency and performance. The actions in this topic should address state-of-the-art, and beyond, swarm control solutions. This includes analysis of centralised, distributed, and hybrid control models. Swarm control may employ control scheme with a global or local approach and their optimised combination. The control-scheme should adopt to mission type changes as the operation evolves from one phase to another. Guidance and control strategies for the swarm are also to be considered, where inductive and swarm internal cognitive-like self-control needs to be analysed.

Specific objective

The aim is to develop swarming technologies up to at least TRL 4 and validated in seawater. The expected result of the research activities performed with the support of this call is a better mission performance result than the one obtained by an individual UxV or platform alone. This should take into account data sources of opportunity. The main challenges or factors to be solved to enable this are the following:

-        The SoS shares a common objective for all the individual components

-        The SoS can be composed of systems, vehicles, and platforms of different nature and capacities

-        The architecture and functions need to be derived and controlled by the task or mission aim that has been defined.

-        The SoS architecture and protocols enables it to utilise resources outside the cooperative system.

Scope and types of activities

Scope

The proposal for research on swarm aspects of unmanned systems and the collaboration policies that govern it, performing underwater missions, in CSW, shall address, among others, the following aspects:

(1)   Mission or task-based performance by the swarm and all its components. The definition, and management of the collaborative system, dependent on the architecture defined, will aim to

optimize the use of every individual to better obtain the common objective. This will require planning and control with a focus on at least the following:

a. Coordination and cooperation inside the system to share a defined space/environment and also the information obtained. Interoperability of the system within a defined architecture (centralized/decentralized).

b. Adjust to changes in the environment and optimise accordingly, while maintaining mission objective.

c. The cooperation of heterogeneous vehicles will involve the integration of a large amount information provided by different sensors.

d. The information obtained about the environment or operation must be combined, analysed and disseminated in real time in order to provide feedback to the system through interoperability standards, which should be consistent with relevant NATO standards.

e. Communication: A Shared link between vehicle and control station must be robust and reliable. Relevant protocols, such as JANUS underwater communications protocol must be taken into consideration.

f. Providing the HMI-infrastructure to control the system, taking into account different levels of autonomy.

g. The definition of the behaviour model of every individual inside the system and of different swarm collaborative models, e.g.: One mission shared by the platforms of the swarm; or swarm split in two or more squads with their own missions

(2)   Participation of vehicles with different characteristics: The use of different platforms will allow the use of different capacities taking into account several aspects such as:

a. Level of autonomy and combinations of different levels

b. Movement (kinetic) characteristics

d. Types of platforms (UUV, USV, sonobuoys, gliders etc.)

e. Enabling systems installed such as detect and avoid (DAA) systems (below and on the surface)

f. Command, Control, and Communication Systems

g. In-swarm localisation, communication and coordination

h. Payloads, such as sensors and effectors

The proposed solution must give due consideration to the need to cooperate with other platforms to achieve a common goal (interoperability, information processing, security in operation, communication, detect and avoid, etc.). The resulting cooperation policies need to integrate all the existing with the new challenges arising from this kind of operation.

The proposal must give due consideration to techniques of cooperation between unmanned autonomous systems when acting as a swarm, namely task allocation/mission/route optimisation algorithms. Other, novel methods are also encouraged and invited to this topic.

Proposals that envisage unmanned and autonomous systems to work together as a squad - rather

than as a swarm- (i. e each system/platform is performing a different task) are also welcome. Then the task allocation problem must be solved as well as the automatic re-tasking of the whole squad or group and each single unmanned asset. It should then also propose a solution for the automatic reconfiguration of the squad. The method of hierarchical task networks, or the method of intelligent software agents for implementing cooperation between systems/platforms can be used, but any other, alternative method can also be proposed.

An analysis and the elaboration of policies of cooperation between unmanned systems (swarming) should be described in detail in the proposal.

Appropriate level of human control must be respected also in proposals containing solutions with autonomous features.

The proposal should address SoS architecture, control, and guidance solutions of unmanned systems (swarming) and/or unmanned and manned systems in the underwater domain. This includes:

-        Combinations of autonomous sub-swarms or squads of heterogeneous unmanned vehicles that cooperate and collaborate to complete different types of missions (for example anti-surface warfare ASuW, anti-submarine warfare ASW, intelligence surveillance and reconnaissance ISR, MCM, Mine-laying and transport).

-        An analysis of the general aspects of the operation of a cooperative system of unmanned vehicles and platforms, where the SoS may draw upon resources available to it from systems outside the cooperative system.

Types of activities

The following types of activities are eligible for this topic:

	Types of activities (art 10(3) EDF Regulation)	Eligible?
(a)	Activities that aim to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence (**generating knowledge**)	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 (**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 proposals must include generating knowledge, integrating knowledge, and studies activities. The proposal may include design activities.

The proposals must substantiate synergies and complementarity, while avoiding duplication, with concepts and architectures developed in complementary ongoing European work streams and projects where relevant.

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

-        Articulation, and if necessary, development, of relevant military scenarios, that will form the basis for development of solutions.

-        Improvement and creation of knowledge by in-depth research in the form of studies that address the most critical technology gaps to enable capabilities for swarms to function in dynamic underwater environments while performing military tasks. Also research topics that address other specific shortfalls of manned-unmanned teaming in the context of swarms with autonomous features must be addressed.

-        The feasibility of developed solutions based on the in-depth research must be explored through technological demonstrations, trials and/or simulations in relevant military scenarios. The demonstration must include seawater (underwater) tasks for relevant parts. A final demonstration will serve as an instrument to show the industrial state-of- art performance to the military community, visualize the results of the targeted research activities, present potential military value and identify technology shortfalls that need to be addressed in subsequent activities in nations and EU

Functional requirements

The solution should enable swarm configuration optimisation taking into account mission and task, resources, environment, military scenario and threat.

The swarm, sub-swarm, individual and node control solutions should enable obstacle detection and avoidance, reconfiguration in case of failure of individuals or nodes, behaviour in case of loss of communication.

The solution should facilitate swarm control and guidance for swarm sizes up to several hundreds of individuals in multiple sub-swarm configurations.

The solutions should enable mission performance with loss of individuals, communication and control.

The solution should enable functionality in GNSS degraded and cyber contested environment.

The solution should enable in-swarm localisation and coordination. The solution should be interoperable with existing standards when relevant, including NATO standards.

Collaborative systems composed by multi domain platforms (UUV, USV, sonobuoys, gliders, etc.) operating together may face several challenges. The solution should enable:

-        Ensuring bidirectional communications link between the subsea units and the mother ship

or ground control station.

-        Ability to use own sensors (such as towed SSS/deployable sonars, etc.) to carry out the mission of subsea monitoring, while being able to cooperate with other platforms and systems

-        Ability for USV to carry on board a set of UUVs to be rapidly deployed in a certain surveillance area at relevant distance from the ship.

Expected impact

It is expected that the outcome should:

-        Strengthen the European defence technological and industrial base (EDTIB) on technologies related to unmanned and autonomous swarming technologies that operate both above and below the water.

-        Generate knowledge to fill capability gaps in use of underwater manned –unmanned teaming and swarms in support of naval operations

-        Contribute to the interoperability and future capabilities of European forces in the area of swarm solutions for mission execution in the naval domain, including in particular the underwater domain.