EDF-2021-AIR-D: Avionics and advanced air combat

Proposals are invited against the following topics:

EDF-2021-AIR-D-CAC: European interoperability standard for collaborative air combat

Budget

The Union is considering a contribution of up to EUR 41 000 000 to support proposals addressing the abovementioned topics and their associated specific challenge, scope, targeted activities and functional requirements.

The budget earmarked on 2021 appropriations for this action will be completed by an amount of EUR 109 000 000 from 2022 appropriations. This complement is subject to the adoption of a separate financing decision.

Several actions, addressing different topics, may be funded under this call.

European air forces share the aim to have highly integrated multiplatform mission management capabilities:

- To enable the variety of different assets, manned and unmanned, to operate during an air operation together jointly and synchronized (including interoperability with NATO, and potentially other coalition situations);
- To share efficiently sensors and effectors resources of manned and unmanned assets;
- To share data and information (e.g. situational awareness), leading to informational and ultimately decisional superiority.

These capabilities objectives imply the deployment of connected collaborative combat which endorses the fact that the systems ensure several properties: to ensure the interoperability of heterogeneous systems (different types of aircraft for example), to enable secure and standardised exchanges of data and resources, to easily incorporate changes in mission system software to take into account operational needs (modification of existing functions, tactical needs, evolutions of rules of engagement, add on of new functions....).

To satisfy those challenges at the level of European air combat, design rules, compliant with existing standards when needed, and applicable standards definition to future mission and collaborative air combat systems or to evolution (new functionalities) of the existing mission systems have to be defined in the European industry landscape on the basis of operational realities and user requirements.

The need and relevance of those standards has to be concretely demonstrated through focused end-to-end connections as well as the seamless integration of a maximum of allied weapon systems to a networking environment and their interaction, thus illustrating all the benefits of advanced collaborative combat. This will pave the way for future European collaboration at the operational level with improved capabilities.

Specific challenge

The key challenge is to jointly build a European perspective enabling the Member States to address at middle and long term collaborative air combat capabilities combining future air combat systems, manned or unmanned platforms, legacy platforms and their evolution, including sensors and effectors. Nowadays, European air forces are built on a wide variety of heterogeneous systems. This variety brings the challenge of interoperability on the functional, software and hardware levels. With the plausible introduction of unmanned systems into air combat, future interoperability requires a far deeper interconnectedness that can be provided with new generation of tactical data links.

This implies the development of interoperability standards enabling collaborative combat to provide for a common entry point of proprietarily developed systems. These standards would address IT evolutions (communication, dissemination, services sharing, cybersecurity) and take them to the next level, with all participants agreeing to the related details.

Different mission systems on board different Nations' assets would benefit from a service-oriented architecture among them. This approach enables all Nations to operate as a whole without the need to use the exact same equipment or assets. It indeed specifies the functional interfaces between assets without imposing specific systems within those assets. The definition of such a service-oriented architecture and its relying standards is a key milestone for modernization of the capabilities of EU military fleets.

Another effort axis consists in studying, as a consistent system approach, the integration of platforms and effectors.

Edge-computing on board new generation manned or unmanned assets can bring new capabilities, relying on mission computers with vast amounts of processing power, storing capacities. On their basis, several mission management functions can be implemented or improved, like the closely integrated operation of manned and unmanned assets through collaborative mission management or smart processing of heterogeneous sensor data (radar, optronics and electronic warfare) across heterogeneous assets. Equally, formation, communication, information or weapon management can be revolutionized, even for legacy systems. Mission management and sensors collaboration improvements allow for an overall better operational performance of each asset and a better perception of their tactical environment. Scalability of those mission computers would be a key element as well.

An optimized usage of resources in the combat air domain would facilitate the increase of mission effectiveness. In such more cooperative environment, standards and common way of sharing information among assets are necessary, with impact on the way to design mission system functions. To enable those capabilities, the definition of data formats –a common referential– for those applications is necessary for the nations, as well as common processes to share them –common languages–.

This implies also to address the evolutivity of the mission systems to enable adaptation to new tactics, concepts and collaboration standards, definition of design rules applicable to legacy systems evolution and futures systems. This will lead to exploit key technologies such as artificial intelligence for instance to enable some collaborative services among air platform.

Existing and futures open standards (e.g. like ECOA[1], IMA ...) need to be addressed to cope with the challenge of harmonizing the software footprint of all kind of equipment on board military aircrafts and could be a good starting point.

More specifically, the command and control of manned and unmanned systems from an airborne combat asset perspective, as well as the handling and exploiting of the wealth of information generated by distributed sensors across collaborating assets, will require the application of dedicated AI technologies in a variety of technical and operational domains. Making sure this "digital partner" outputs are trustable and do not jeopardize the human responsibility in military action is paramount. In this regard, identified AI work streams could include (without being limited to) with a specific focus on airborne combat asset use cases:

- Flight Certification and airworthiness issues with AI based functions on board
- Identification, selection and usage prototyping of engineering tools and methods enabling the sovereign use of protected AI Data and algorithm libraries

This topic also has to take into account relevant outputs and results of ongoing and potential future European projects (for example, but not limited to: EDIDP, EDF, multilateral projects...), as well as future combat programmes, and pursue a maximum level of compatibility, compliance and interoperability.

Scope

The scope of this topic is to propose solutions supported by demonstrations when relevant on the major axis presented above, thus providing air collaborative combat standardised solutions, mission systems evolutivity, standardised effectors interfaces and European sovereignty over AI technologies (tools, methods and libraries).

The targets are twofold: first, medium-term outputs to be implemented as standardised collaborative mission management enhancements for existing or upcoming European operated platforms, on the basis of commonly agreed standards and requirements of the participating Nations to favourably influence the construction of future European air combat capabilities. Potential implementations on existing platforms are not part of this project but are likely to be specified based on developed standards for an implementation in the respective national perimeter.

The proposals must consider manned and unmanned combat platform assets/concepts operated by the participating Member States, from current or upcoming ones to future air combat systems in Europe within an interoperability incremental approach. Future air combat scenarios require to rethink collaboration which is inseparable from an extended interaction between combat aircraft and a diversity of collaborative assets contributing to air combat operations also interfacing with any other domain (air, land, sea, space, cyber, ...) (e.g. mission aircraft, tanker, JTAC...). This includes the need to consider interoperability with system of non-EU origin, to provide for compliance with NATO and other coalition situations, to be identified through the high-level operational requirements definition.

The proposals must consider scenarios for air combat operations in contested and highly contested environments at least geographically located in geographic Europe, Northern Africa

[1] European Component Oriented Architecture

and Middle-East. This could be complemented (e.g. Air defence and air policing within European airspace) when the common high-level operational requirements will be set up in close alignment with participating Member States' representatives.

Targeted activities

The proposals must cover the following activities as referred in article 10.3 of the EDF Regulation, not excluding possible upstream activities eligible for development actions if deemed useful to reach the objectives:

- studies, such as feasibility studies to explore the feasibility of new or improved technologies, products, processes, services and solutions;
- the 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 which may include partial tests for risk reduction in an industrial or representative environment.

In particular, the targeted activities must include:

(1) Air Collaborative Combat: interoperability of heterogeneous systems

- Development of use-cases, high-level operational requirements with end-users to support the consolidation of a common operational perspective with regard to Air collaborative warfare for EU capabilities, manned and unmanned.
- Functional architecture and technical architectures principles of airborne combat asset mission systems for standardisation and interoperability scope,
- Definition of required Interoperability standards for mid- and long-term platforms from existing aircrafts manned or unmanned to the new generation of platforms, communications, security, data/services: analysis of existing and emerging standards, gap analysis, existing standards evolution or new ones
- Definition of standards for Services Oriented sensors interfaces: analysis of existing and emerging standards, gap analysis, existing standards evolution or new ones
- Machine to machine collaboration (architecture principles for interoperability of heterogeneous assets, definition of information transfer protocols)
- Human – System collaboration (socio-technical aspects): impact of AI implementation in military assets, operational (SA and decision making, effects delivery), ethical and regulatory aspects.
- Demonstrations (Proofs of Concepts through simulations, ground/flight demos...), implementation of existing and envisaged standards on ground and/or demo platforms, illustrating concrete benefits of collaboration between connected assets taking part in an air operation. This could be envisaged on existing platforms.

In a transversal way, activities must be lead with attention paid to:

- Identification of quick wins, based on existing EU technologies, open standards and initiatives, taking into account operational, technical and legal boundaries and limitations, and national specifics, etc.
- Cyber resilience aspects and data protection.

(2) Air collaborative combat and mission system evolutivity: Software development standardisation and hardware reference model development

- Dissemination and development/enhancement of existing or new standards for software development (e.g. ECOA, IMA ...): advanced IT technologies should bring a significant advantage for the mission system development and improvement of the mission system capabilities.
- Open-based component oriented architecture is seen as a good candidate to reduce through-life cost and timescales for production and updates of complex integrated system such as an airborne Mission System. Existing standards will be analysed taking into consideration the specific needs. Certifiable plug& play, state-of-the-art system update, self-healing databases mechanisms have to be investigated.
- Tools for supporting the standard definition should be identified and developed if needed.
- Development of references of a hardware model: common architecture principles and standardisation of computer interfaces

(3) Effectors integration on airborne platforms

Future airborne systems will show a deeper integration of platforms and effectors (dataflow, energy supplying...) to answer to operational needs (reactivity, safety, flexibility, LO demands ...). Starting from the existing effectors functions, the study aims at identifying integration strategies between the future portfolios of effectors and aerial platforms at the turn of 2030 and beyond. Existing and future standardisation trends will be analysed and considered in the proposal of integration strategies. As other projects are ongoing (i.e. LSIF), the study will focus on add-on to the current standards to take into account new functionalities required by smart weapons (expendable RC, networked armament,...) and extended operational aspects in addition to physical interface.

(4) AI Technologies

- Formalisation of airworthiness and safety typical issues related to AI based functions on board
- Identification, selection and usage prototyping of AI toolkits (e.g. European alternative to tools like Tenserflow, Pytorch or RLlib), libraries, methods (e.g. machine learning, neural networks, ...) enabling an independent and sovereign use of these technologies by the EU for military purpose Definition at European level, of methods and processes for military qualification of non-safety critical and trustable AI functions
- Demonstration (proof of concept) of tools and processes for the development, certification and validation of "trustable" AI driven operational services (e.g. dynamic tasking of assets, decision-making support, data routing processes) for the purpose of validating feasibility and airworthiness/safety issues

Those activities will be complementary of other studies on AI technologies (e.g. dealing with concerns as Frugal and Robust learning for rapid adaptation of AI systems) having a specific focus on airborne use-cases.

Functional requirements

The collaborative air combat capability must fulfil the following requirements:

(1) The collaborative air combat must improve the interoperability of heterogeneous aerial systems (from existing aircrafts to the new generation of platforms, manned or unmanned), including when in coalition situations with European and NATO forces.

This improvement must be based on the analysis of existing and emerging standards, promotion/evolution of existing standards or development of new standards as well as results of relevant ongoing projects and future combat programmes.

The standards must be applicable for the design of next generation combat assets mission system (new generation fighter, unmanned combat asset) and the upgrades of legacy combat aircraft.

The standards definition activities must cover the following perimeter:

- In order to support collaborative mission management and sensors collaboration between heterogeneous assets:
  - Functional and technical architectures principles
  - Functional services oriented interfaces principles
  - Services oriented architectures and functional services oriented interfaces for mission system
  - Services oriented sensors interfaces
- In order to enable interoperability, secure exchange of resources/information and data sharing with others assets in various coalition situations (NATO, EU and non-EU, national context) while offering a better evolutivity and interchangeability (S/W and H/W level):
  - Communications architecture principles (including cyber issues)
  - Functional interfaces of the different layers of communications architecture (Core Services and Communications Services according to C3 taxonomy)
  - Validation methods and associated means (e.g. functional simulators)

- In order to improve interoperability and development efforts of effectors:
  - Functional and physical interfaces of future effectors (remote carriers and weapons)
- In order to improve mission system scalability and the associated development efforts (easier and faster aerial mission systems development and upgrade):
  - Software development
  - Development of Hardware references

(2) The collaborative air combat should participate to structure and develop a European ecosystem to support AI technology sovereignty for military usages For this purpose, the activities must cover the following perimeter:

- Formalisation of airworthiness and safety typical issues related to AI based functions on board
- Identification, selection and usage prototyping of AI toolkits, libraries, methods enabling an independent and sovereign use of these technologies by the EU for military purpose
- Definition of harmonized methods and process at European level for military qualification and certification of AI based functions

- Validation of feasibility and airworthiness/safety issues through demonstrations (proof of concept) of tools and processes for the development, certification and validation of "trustable" AI driven operational services (e.g. dynamic tasking of assets, decision-making support, data routing processes)

Expected impact

- Shared consolidated European perspective for collaborative air warfare.
- Incremental increase of the interoperability of warfare systems - current and future – so that the participating Member States' armed forces would be able to "plug and fight" in order to operate collectively and efficiently.
- Better usage of resources (single and multiple domains and assets).
- Quick wins identification to be implemented on current or upcoming systems (e.g. ability to associate different generations of assets, dissemination of conception guidance for long-term development of future European air combat system). Quick wins approach would also enable cross-border SMEs to participate in this topic.
- Common European standards for Member States.
- Harmonization of European industrial processes and methods for the development of assets or equipment contributing to collaborative air combat capabilities.