EDF-2021-AIR-R: Next generation vertical take-off and landing systems

Proposals are invited against the following topic:

EDF-2021-AIR-R-NGRT: Next generation rotorcraft technologies.

Budget

The Union is considering a contribution of up to EUR 40 000 000 to support proposals addressing the abovementioned topic and its associated specific challenge, scope, targeted activities and functional requirements.

Up to one action may be funded under this call.

The importance of rotorcrafts, as principal vertical take-off and landing (VTOL) assets/systems, in military operations is widely recognized. Military rotorcraft are the workhorses of battlefields, fulfilling missions like armed reconnaissance, strike, combat search-and-rescue (CSAR), MEDical EVACuation (MEDEVAC), utility, air assault and close aerial support (CAS), which are critical for the success of military operations.

Beyond their pure military role, military helicopters are also key assets for a better civilian security and protection and EU-internal resilience, with critical contribution to disaster relief, civilian search-and-rescue, and sanitary crises.

As such, rotorcrafts bringing the unique ability to take-off and land from almost anywhere, are considered powerful multi-domain operations enablers.

Future combat theatres will mainly take place in congested urban environment – to be expected 65% of population in 2040; moreover most of those congested urban clusters will be in the littoral regions. Thus, potential threats may require moving further away from sea- or land-placed operational bases. Reduced time for intervention will be key, not only to reduce fatalities (faster CAS, MEDEVAC, CSAR...), but also to increase impact of direct actions (faster troop mobility, counter “fait accompli” attempts during hybrid warfare scenario). With major uncertainty on potential 2030+ fields of operations (geographical environment, but also on confrontation intensity), troops may need to operate more swiftly and more autonomously, with VTOL weapon systems offering multiple capabilities for the range of multi-domain (Ground/Air/Naval) missions.

At the same time, advances in systems of systems (SoS) approach, collaborative combat (distributed sensors and functions among collaborative platforms), vehicle and materials features (new helicopter architectures for higher speed and longer range, ballistic protections, signature/detectability reduction) as well as avionics and systems technologies (e.g. big data processing, artificial intelligence, next generation and augmented vehicle, more precise sensors) will create major breakthroughs in combat helicopters capabilities.

Capability assessment in EU and NATO frameworks confirms the need to prepare future rotorcraft systems, with hundreds of NATO/EU helicopters to be replaced from 2035 and beyond 2040. To bundle efforts, the proposals should be consistent with European defence agency and NATO capability working groups.

Specific challenge

To answer this future environment, EU armed forces will require an aligned perspective of the future operating environment (FOE) and research future operating concepts (FOC) of military VTOL-systems including:

- Operability and operational flexibility
- Affordability both in procurement and life cycle cost
- Survivability , up to potential Peer nations high intensity conflict
- Sustainability and Operational readiness
- Interoperability for joint and combined operations and collaborative combat
- Resilience, with reduced dependency on critical installation and materials

Scope

The scope of this topic concerns research on future technologies and the future operating environment (FOE) and future operating concepts (FOC) of military VTOL-systems.

In particular the proposals must address:

- The ends to draw the outlines of the future operating concepts. These outlines are based on the future operating environment (FOE) as well as the role and purpose of VTOL-systems.
- Once the outlines are set, the research activities can be focused on the future operating concept (FOC). This conceptual approach concerns all levels of warfare: strategic, operational, tactical and technical. But also logistic and maintenance concepts such as predictive and/or condition-based maintenance, logistical footprint, supply-chain management, acceptable life cycle costs and a flexible/affordable airworthiness certification process with common European (military) certification specifications.
- Based on a common perspective on the future (military) operating concept, the required capabilities can be derived, which in turn defines the means: the required military capacities, the required governance to develop and exploit these military capacities and the interoperability requirements. Almost all future military scenarios involve using information to optimize operations. This involves network centric operations in which envisaged future vertical lift obtain information from networks, distribute information on networks and operate closely with other parties to attain intended effects.
- Pre-feasibility studies of possible architecture and operational concepts for high performances military VTOL platforms. Those studies will rely on:
    - Fundamental work on EU Defence community needs on vertical lift, based on reference combat missions scenarios to be defined, technical and operational studies, concept of operation (CONOPS) definition, battlefield simulations, interactions with advanced vehicle concept designs scalability and applicability to various military missions.
    - Research on rotorcraft conceptual design: assessment of various vehicle formula scalability and applicability to EU military missions and EU operational requirements. Coordination of technology acquisition efforts to integrate key future capability streams since early concept phase (e.g. modularity, survivability, design-to-cost).

- This assessment will include flights with higher speed & longer range VTOL technology demonstrators as necessary, as well as the use of available ground flight simulators. Flying technology demonstrators may be employed to assess new capabilities for military missions, understand key features (e.g. manoeuvrability along the flight domain, IR/EM/noise signatures) and potentially as flying test-beds of technologies. First fly-tests, supported by ground flight simulators, should allow EU MoD helicopter specialists to have a pragmatic hands-on insight on the capabilities brought by new high speed / long range / low (reduced) consumption helicopter concepts, when needed for various kind of military missions.
- Research on key technologies for next generation VTOL platforms

This part consists in screening all relevant European technologies available in 5 or 10 years, characterize innovation and technological breakthrough/turnkey challenges fitted to VTOL, and research technological solutions in order to meet future objectives in terms of operability, interoperability, affordability, sustainability and survivability.

Targeted activities

The proposals must cover the following activities as referred in article 10.3 of the EDF Regulation:

- Studies, such as feasibility studies to explore the feasibility of new or improved technologies, products, processes, services and solutions.

The targeted activities must include the initial phases of the concept of operations, operational solutions supported as well as assessing selected technologies, in particular:

- Study of the future operating environment (FOE) and the role and purpose of military VTOL-systems in this as SoS.
- Study the future operating concept (FOC) including all levels of warfare: strategic, operational, tactical and technical;
- Technological support to the evolution of state-of-the-art current helicopter/rotorcraft systems (including EU tilt-rotors and compound rotorcraft). To secure the neutral nature of research in this phase, these widespread studies on potential new systems to come is meant to be in use also for any helicopters/rotorcrafts models associated to European Members States.
- Study the required military capacities, the required industrial activities to develop and exploit these military capacities and the interoperability requirements.

Functional requirements

The proposals must fulfil the following functional requirements:

- The study must include a collection and analysis of CONOPS and cost objective complete life-cycle of European armed forces for future rotorcrafts in the 2035/2040+ horizon.
- The study must include an assessment of alternatives between conventional helicopter and different high performance (i.e. speed, range/endurance, payload) rotorcraft/VTOL innovative architectures/concepts in terms of operational benefits (e.g. long distance deployment, persistence in the area, minimum time-to-target etc.) associated to

different types of missions, constraints and impact on cost of operations; it must also propose recommendation and technical solutions to EU armed forces in accordance with operational requirements.

- The study must translate operational requirements into functional challenge, technology calls and conceptual breakthrough.
- The study must carry on preliminary analysis for the foreseen future rotorcraft/VTOL systems. The results may be used also for upgrades.
- The study must conduct research to technology blocks providing performance advantages, in the following domains/areas:
    - Situational awareness capability including all-weather and degraded visual environment (DVE) flight, GNSS[1] denied or contested navigation, automated detection, identification and priority ranking of threats, collision avoidance for formation flying between manned/unmanned. All these up to 0/0 in high speed very low level tactical flight and all operations. The study should focus at first on rotorcraft/VTOL specifics, leveraging on potential synergies with other potential projects (about e.g. fixed –wing aircraft, drones, and related system technologies);
    - Connectivity, SoS, interoperability capability, including combat cloud and MUMT[2] (e.g. with air/land/naval manned-unmanned platforms), low drag integration of sensors & antennas. In this context, conceptual evaluation of the feasibility of a SoS design to cope with the challenging features of upcoming and future complex combat/operational scenarios, considering - for instance - a mix of air/land/naval manned/unmanned collaborative/non-collaborative assets, with associated functions and enabling technologies (sensor suites, data management and fusion, cyber protection), should be done;
    - Virtual combat mission assistant; Enhanced collision avoidance, navigation and control technologies; ○ Automated air/air refuelling technologies for rotorcraft;
    - Survivability capability requirements on architecture & systems, including structural protection (e.g. ballistic damage tolerance, impact/crash resistance etc.);
    - Advanced aero-structures concepts and technologies, taking into account a balanced approach between performances, costs, EU supply chain future resilience, ease of customization and evolution, easier field maintenance, and built-in environmental protection (sand, dust, salt, water, ice...), with test-cases around modular aero-structures with multifunction components;
    - Self-protection capability;
    - Low signature/detectability (of various type, e.g. acoustic/dB, radar, IR etc.);
    - Comprehensive assessment of future on-board energy/power requirements, including future vehicle sizing, critical on-board systems (e.g. de-icing, directed energy self-protection and weapons), and related energy/power management possible architectures, definition of key R&T directions (e.g. need for high voltage, engine power ratings) and technology recommendations for the EU aeronautic supply chain and research establishments/centres;
    - Power plant greenhouse gases, fuel/exhaust emission and noise/vibration reduction technologies;

[1] Global navigation satellite system
[2] Manned-unmanned teaming

- Preparing Technologies accompanying EU rotorcraft engines evolutions (not excluding possible recourse to hybrid propulsion), for improved performances, easier maintenance and optimization of energy efficiency ;
- Identification of power plant integration supporting technologies (air intakes, nozzles, etc.).

- The study must include demonstration of future operating concepts of military VTOL-systems as SoS and vehicle technologies and architecture candidates to ensure enhanced availability, simplified enhanced modularity (including efficient troops- freight payload trade-off and fast reconfiguration), reliability, testability and maintainability to ensure high time of operations and enhanced (life-cycle cost) affordability, also at long term, compared to current helicopters.
- The study must deliver design recommendations on global system architecture to cope with previous systems capabilities but also ensuring affordability, reliability, sustainability and maintainability, with focus on logistics concepts to support operation and maintenance, securing availability of parts and consumables and taking advantage of digital systems for predictive maintenance, digital twins and simulation of user profile.
- The study must support long-term compatibility of EU rotorcraft to future multi-domain and air combat collaborative systems.
- - Abovementioned capabilities design exploration must encompass potential implementation on brand new and already in-service rotorcrafts. The targeted next generation VTOL systems are thought to be real game-changers on future battlefields. Maintaining the key capabilities provided by VL platforms enabled, in conjunction, by advanced technologies (including SoS related ones), they will boost key operational capabilities such as:
  - Safer mission standards for pilots/crew and lower workloads;
  - Deeper penetration in enemy territory during complex air assault and special operations, inclusive of littoral/naval missions, and shorter time to reach the spot/enhanced survivability for Close Aerial Support;
  - More effective and faster CSAR/MEDEVAC (also for civilian application/use cases);
  - Integration with other defence assets (e.g., drones, land/naval forces, etc.).

Expected impact

This topic is paving the way for future technology and development programs, leading to:

- Prepare 2035/2040+ horizon, building European capabilities for new EU/NATO rotorcraft/VTOL programs, fully compatible to future multi-domain and air combat collaborative systems.
- Upgrade existing platforms when possible.
- Support the competiveness and excellence of the European industry in this domain and the autonomy of EU in the field of military helicopters.
- Increase the efficiency of European Armed Forces.
- Increase strategic autonomy and competitiveness of the European defence community (i.e. industries and Nations, including academia/governmental R&T/T&E entities), aimed and capable to develop new technologies to be embodied into the future EU/NATO rotorcraft programs.