

EDF-2021-AIRDEF-D: Protection against high velocity aerial threats

Proposals are invited against the following topic:

EDF-2021-AIRDEF-D-EATMI: Endo-atmospheric interceptor – concept phase

Budget

The Union is considering a contribution of up to EUR 28 000 000 to support proposals addressing the abovementioned topic and its associated specific challenge, scope, targeted activities and main functional requirements.

The budget earmarked on 2021 appropriations for this action will be completed by an amount EUR 72 000 000 from 2022 appropriations. This complement is subject to the adoption of a separate financing decision.

Up to one action may be funded.

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 challenge

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 TBMD¹.

Scope

The proposals 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. 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.

¹ Theatre Ballistic Missile Defence

Targeted activities

The proposals must cover the following activities as referred in article 10.3 of the EDF Regulation, not excluding upstream and downstream 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.

In particular, the proposals must address:

- **The iterative definition of interceptor detailed requirements**, based on:
 - The definition with cooperating Member States 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 characterization of the relevant threats to be addressed by the future interceptor;
 - The selection with cooperating MS 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 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 cooperating Member States and characterization 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 roadmaps for these elements at the horizon 2035+, and with Member States' 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-DoF²) 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;

² Degrees of freedom

- The physical and functional integration aspects of the candidate interceptor concepts on the relevant platforms and launchers identified with the Member States, 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 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).
 - The maturation level raised through the present concept phase must be sufficient to allow the most critical technologies and equipment to reach TRL6 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 TRL6 for most critical technologies and equipment.

Functional requirements

Proposals must 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' 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' 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.

LOR³, EOR⁴) 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:
 - BM⁵ up to 3500 km of range, including those with the ability to significantly modify the atmospheric part of their trajectory;
 - ASBM⁶ up to 2500 km of range;
 - Hypersonic glide vehicles released by TBM⁷ up to 3500 km 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 weapon systems, the candidate interceptor solutions should address performance against the following threat set, keeping in mind that the primary design optimization must aimed at the high-level threat set mentioned above:
 - Sub- and supersonic cruise missiles;
 - Air breathing targets (fighter, aircrafts, UCAV⁸, HALE⁹...);
 - Sub- and supersonic 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' activities and/or EU-funded activities (e.g. through the European defence industry 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 characterized:
 - 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, IMU¹⁰, GNSS¹¹, ...), to physical integrity (thermal load, ...), and terminal accuracy (miss-distance, CEP¹²);
 - Manoeuvrability and penetration aid (PEN AIDS) devices and/or tactics;
 - Generic model for each type of threats;
 - Vulnerability and functional / physical destruction criteria;

³ Launch on remote

⁴ Engage on remote

⁵ Ballistic missile

⁶ Anti-ship ballistic missile

⁷ Theatre ballistic missile

⁸ Unmanned combat aerial vehicle

⁹ High altitude long endurance

¹⁰ Inertial measurement unit

¹¹ Global navigation satellite system

¹² Complex Event Processing

- 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.
- 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 optimization 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 and its Member States:
 - 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, 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.