EDF-2021-SENS-R: Optronics and radar technologies

EDF-2021-SENS-R-RADAR: Advanced radar technologies

Budget

The Union is considering a contribution of up to EUR 38 000 000 to support proposals addressing any of the abovementioned topics and their associated specific challenge, scope, targeted activities and functional requirements.

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

Nowadays, wide range of sensors, which are based on radar technologies, are applied during military operations. Radars are commonly used for supporting multi-domain operations: incl. air and air defence missions, as well as ground/maritime operations. Those technologies are crucial for space/airborne based, as well as ground/maritime based surveillance systems. Radar technologies are also used in various sub-systems of other purpose (*e.g.* engagement or logistics) military equipment.

Recent advances in digital signal processing and computing, radiofrequency (RF) and microelectronic technology have paved the way for the proliferation of active and passive radar technologies in a number of military applications. Management of the electromagnetic (EM) spectrum has also become more important year after year, and the usage of communications and internet of things (IoT) applications – which require more and more EM spectrum – generate increasing challenges during military operations. In addition, we must pay high attention to the strong technology push for the development of modular, smaller and state-of-the-art sensor applications, which are able to provide more functionality for the user in one device, are significantly less energy intensive, and can meet more operational needs.

Modern surveillance sensors have to comply with an unprecedented wide spread of operational requirements. A list follows hereby, which is not exhaustive:

- Provide steady and reliable surveillance (detection, tracking, classification, identification) everywhere, at every time, at various environmental conditions – for every domain, with guaranteed low level of false alarm probability;
- Addressing various types of standing installations and moving platforms (ground based, shipborne, airborne, space borne), both manned and unmanned;
- Covering broad spectrum of applications:
    - Civilian, e.g. ATC[1] and weather forecast and monitoring, humanitarian (e.g. immigration, crisis management, like disasters, natural and caused by mankind), platforms' autonomy, space situational awareness, etc.;
    - Military information superiority assurance: airspace, maritime and land traffic control; radio navigation; localization of our blue/red forces and resources; autonomous platforms; precision guided weapons; electronic warfare (EW).

[1] Air traffic control

Specific challenge

State-of-the-art military radar solutions must face challenges of modern battlefield, for instance:

- Defence against very low RCS[2] targets (e.g. fast moving–fast manoeuvring, drones, hypersonic threats, stealth aircraft);
- Detect long (strategic) range tactical ballistic missile (TBM) since boost phase, and wide spread of engagement means: rocket, artillery, RAM[3], loitering munitions;
- Underground inspection, through the wall/vegetables surveillance;
- Space surveillance and tracking: localization, classification and mitigation of space debris, enemy's space assets;
- Able to operate in a limited EM spectrum resource (which today is a commodity) also complying with international and security regulations;
- To be open to operate as multi-role (radiolocation, communications, EW – electronic attack, non-cooperative target recognition, radar imaging etc.) systems;
- To be resilient to harsh EM environmental conditions, with extensive jamming;
- Go beyond the extraction of usual information to get intelligence from the measurements;
- Use common/interoperable hardware (HW)/Software (SW) architecture and signal processing to support multi domain operation;
- Cooperation and EM compatibility with other systems within a common recognized picture (battlefield situational awareness);
- Coordinate and operate sensor management online/on the fly for joint improved performance.

Scope

Proposals should address the development of new concepts, technological blocks, sub- systems and/or systems in in order to realize a new class of sensors with remarkable sustainable characteristics in all domains (sea, land and air). They should include active and passive radars or radar sub-systems, as well as new system architectures of hardware building blocks and software modules designed to enable build up mission specific complex radar sensors and multi-functional radar solutions – eligibly in compliance with European Defence Agency's CapTech Radiofrequency Sensors Technologies' Overarching Strategic Research Agenda and its results (including TBB[4] in-depth analysis and their roadmaps), as well as previous EU funded activities.

These aimed achievements should be applicable in different kinds of active or passive radar systems (unification between different kinds of platforms desirable) and need to be able to support future military operations and to cope with new generation of unpredictable and unimaginable threats. For this reason, these activities should match with the following main abilities:

- The ability to provide integrated and modular system approach for military specific solutions;

[2] Radar cross-section
[3] Rocket, artillery and mortar
[4] Technological building blocks

- The ability to increase integration of more functions into one system;
- The ability to increase the proliferation of radar-based sensor applications for wide scale of military operations;
- The ability to enable versatile deployment for the large spectrum of military operations;
- The ability to enable high operational availability (e.g. by fault tolerance techniques and relative technologies adoption);
- The ability to apply radar either as a main element or sub-system of one complex equipment regardless of the operational context;
- The ability to use a radar as a node in a more complex network;
- The ability to primarily enable efficient software (HW desired as well) upgrades during life cycle;
- The ability to provide new system test & evaluation (T&E) methods based on rf and/or digital scenario emulators/simulators.

Targeted activities

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

- Activities aiming to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence;
- Activities aiming 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;
- 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 proposals must address the following activities:

(1) Activities aiming to create, underpin and improve knowledge and technologies, including disruptive technologies, which can achieve significant effects in the area of defence:

- Definition and analysis of technology trends and implementation opportunities (desired final parameters and functionalities in particular) of state-of-the-art and future technologies such as: e.g. RFSOC[5] (SIP[6]), compressive sensing for imaging or/and MTI[7], MIMO[8] mode, polarimetry, machine learning for supporting radar signal processing, recognition and classification;

[5] Radiofrequency system on chip
[6] System in package
[7] Multi target indication
[8] Multiple-input multiple-output

- Deep analysis of theoretical basis for a scope of the proposed project.

(2) Activities aiming 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:

- Operational requirements and military usage scenarios, identification of operational benefits and sizing requirements of technological breakthroughs;
- Definition of security, cyber and interoperability needs for future challenges;
- Basis for common standards definition.

(3) Preliminary/feasibility activities and studies to explore the feasibility of new or improved technologies, products, processes, services and solutions:

- Definition and analysis of behaviour and detectability of targets;
- Definition of EW functionalities and technology in radar and communication band;
- Definition of cognitive radar, digital radar and waveforms for increased deployment versatility;
- Analysis regarding the use of software defined radar in order to improve the flexibility of future solutions;
- Definition of CONOPS (concept of operations).

(4) Design of a tangible or intangible defence component/sub-system, system 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 representative environment:

- Top level sensors specifications and high level design (including adaptive digital beam forming, transmitted power, bandwidth, spectral purity, power consumption, production cost...);
- Definition of the functional and physical architectures of the transceiver building block (interfaces, partitioning, type of semiconductor process, packaging...);
- Definition and development of waveforms/data exchange (standardization);
- Development of operational capabilities based on distributed, multi-static configuration (incl. active/passive (both collaborative and non-cooperative illuminators)/mixed mode), or new application methods;
- Development of integrated solutions for time synchronization and multi sensor data fusion (e.g. Concerning time synchronization and platforms geo-localization, especially in GNSS denied zone), data storage and system resource management;
- Development of integrated solutions for microwave high-power generation, for robust and highly digitised receivers, for radar signal generation and its distribution, for adaptive distributed beamforming, for multi-functional array transmitters; a new paradigm by the development of the so-called “chiplet” approach – an integrated circuit block that is specifically designed to work with other similar chiplets to form larger chips that are more complex. This approach can also be used for SOC (i.e. with integration on the same semiconductor substrate) or SIP (i.e. with heterogeneous integration);

- Reduction of PCBs[9] by using hybrid packaging techniques for different semiconductor technologies integration;
- Definition and development of security, cyber and interoperability needs for future challenges;
- Test case as a basis for demonstration, simulation and prototyping;
- Integrated and aligned operation demonstration;
- (cognitive and/or machine learning based) sensor data fusion and complex object/target classification;
- Risk mitigation;
- Presentation of results and execution of a demonstration through one or more test scenarios.

In addition, proposals could cover both HW and SW solutions, of various integration scale (materials, components, sub-systems and systems) in the representative areas as follows:

- Detection, tracking and recognition/identification (including SAR[10]/ISAR[11]/3D ISAR – passive and active imaging techniques) of new and challenging targets, such as made according to stealth philosophy, of low radar cross section, small (drones), fast moving and manoeuvrable (e.g. hypersonic missiles, UAVs[12] etc.);
- Contribution to kill assessment functionality;
- Intelligent radar decoys;
- Intelligent and cognitive resource management;
- Multi-platform, multi-static and multi-functional RF systems for air defence and battlefield (in all domains: air and space, land and maritime) surveillance;
- Specific radar applications, such as e.g. navigational equipment (for airspace management, as well as various platforms situational awareness), missile/artillery munitions radar homing, battlefield radars, ground and vegetation penetrating radars, through-the-wall radars, dual polarization weather radar etc., supported by disruptive technologies for increased system capabilities;
- Electronic warfare capabilities (both defensive and offensive, e.g. low probability of intercept, effective jamming suppression, jamming of netted sensors etc.);
- System maintenance concept and high operational availability (e.g. by health and usage monitoring system (HUMS) and self-healing techniques);
- Design that enables continuous upgrades during the life of the system (e.g. using new software defined radar (SDR) technology);
- Development of system T&E methods.

A preliminary plan (roadmap) for the potential utilization by subsequent development phases should also be presented, with a special focus on the capability needs of Member States, as well as expected improvements in comparison with existing solutions.

[9] Printed circuit boards
[10] Synthetic aperture radar
[11] Inverse synthetic aperture radar
[12] Unmanned aerial vehicles

Functional requirements

Requirements are based on the potential development of a multi-platform RF system which will be able to support directly military operations based on the specific challenges described earlier.

The proposals should therefore meet the following functional requirements:

- To demonstrate better understanding of the new challenges for future operational and tactical environment requirements;
- To provide increased and more operation capability in detection of new challenging targets, objects and (manned-unmanned) swarms, moreover wide configuration opportunity for mission specific tailored applications;
- To provide solutions for multi-mission applications (maritime, land and air);
- To provide solutions compatible with modular and scalable architectures in order to fit different further applications;
- To provide solutions compatible with multi-static and distributed systems;
- To provide designs with low-cost production;
- To provide better performance parameters, especially measurement accuracy (range, azimuth, height) as well as low swap (size, weight and power) for demanding applications (e.g. airborne);
- To decrease significantly the sensor-to-effector lead time;
- To enhance ECM[13] (against radar & communication signal) capabilities against new generation threats;
- To build integrated complex RF applications for one or more mission specific function, like digital beam forming and RF sampling and digitalization of signals at carrier frequencies;
- To provide solutions compatible with software defined methodology for the implementation of sensor functions;
- To push the technological solution scope by investigating dedicated power and mixed-signal technologies;
- To build on high-power front-end components (as developed through the call "materials and components \ advanced radio frequency components";
- To provide deep integration in common configuration and sensor fusion;
- To apply/allow to apply recent achievements of big data, artificial intelligence, machine learning and software algorithm techniques in the signal processing, in the flexible operation support and in the automatized decision-making process;
- To contribute to increasing force protection, resilience, timely decision-making through modern and intuitive user interfaces that support operators in all their operational, technical and training needs;
- To increase sensors mobility and sensor reliability through innovative solutions for thermal management and reliable power supplies development;
- To provide deployment and interoperability with wide range of military systems, effectors.

[13] Electronic countermeasures

Expected impact

(1) From technical point of view:

- Increased application capability for detection, identification of different kind of threats, including new types of increased velocity and hypersonic targets, missiles and field objects;
- Wide range of application opportunities for eu military operations;
- Improved critical awareness as deterrent;
- Increased operation capability in harsh EW environment and under active electronic countermeasures;
- Increased mission specific solutions with the opportunity of multi-mission and multi-function application capability;
- Competitive services with embedded solutions of new approaches and applications of future disruptive technologies, such as artificial intelligence, advanced new materials and structures, additive manufacturing in electronics and antennas or nano-technology, neuro science-based HMIS.

(2) From policy point of view:

- Development of critical enablers for CSDP operations and EU Battlegroup missions;
- Enhanced force protection;
- Increased military capability in joint military missions;
- Improved situational awareness, resilience and security of EU military operations;
- Improvement of one of the key European defence industrial capabilities;
- Strengthening the EU's strategic autonomy in the production of military related RF applications;
- Reinforcement of interoperability between EU Member States' armed forces;
- Reducing the cost of European military missions;
- Reducing the impact of the EM spectrum usage.