Defence Technology and Innovation Strategy

ETID - 2026

STATE SECRETARIAT FOR DEFENCE

Directorate-General for Strategy and Innovation of the Defence Industry

MINISTERIO
DE DEFENSA

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Authorised Public Version of the Defence Technology and Innovation Strategy (ETID 2026)

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Letter of Promulgation from the Secretary of State for Defence

The strategic environment in which our Armed Forces operate is undergoing a profound transformation, marked by strategic competition, accelerated technological evolution, and significant shifts in the global geopolitical balance. Recent conflicts have demonstrated that technological superiority is a decisive factor on the battlefield, where multidomain integration, advanced electronic warfare, operational resilience, and rapid adaptability determine the success or failure of military operations.

In this context, technology and innovation emerge as strategic pillars to guarantee national security. It is not only a matter of possessing advanced systems, but of relying on a national technological and industrial base capable of developing, producing, and sustaining them autonomously, strengthening the sector's depth and reducing critical dependencies that could compromise our freedom of action at decisive moments.

The Defence Technology and Innovation Strategy presented here responds to this strategic reality. It is the guiding instrument that will steer all R&D&I activities of the Ministry over the coming years, setting clear priorities and mobilising resources efficiently to achieve our objectives.

This Strategy is aligned with the National Defence Directive, the Defence Policy Directive, and the National Security Strategy, all of which highlight the need to keep our Armed Forces and the Defence Technological and Industrial Base at the technological forefront, reinforcing European cooperation and promoting coordinated, dual-use R&D&I. It also integrates coherently with the Defence Industrial Strategy, which defines the action lines required to strengthen technological autonomy and enhance the competitiveness and resilience of the defence industry. It therefore provides continuity within this strategic framework, directing R&D&I investment efforts towards the development of critical capabilities for Spain's defence and security.

The new Strategy is guided by two fundamental principles. The first is cooperation as a force multiplier for our capabilities. At national level, this means unifying dual-use R&D&I efforts and coordinating the actions of the Ministry of Defence with other ministries and national R&D&I funding agencies. At European level, it means fully leveraging the opportunities offered by the European Defence Fund (EDF) and the broader set of European initiatives supporting defence R&D&I, positioning Spain as an active partner in building Europe's strategic autonomy. And in the transatlantic sphere, it involves participating in NATO innovation initiatives, such as DIANA, which reinforce our collective security.

The second principle is the balance between stability and agility. We recognise that the development of military capabilities requires long-term, stable programmes, particularly for future systems of systems. Yet we also understand that the current pace of technological innovation demands more flexible mechanisms that allow us to explore emerging technologies, incorporate innovative solutions from non-traditional actors (such as startups and SMEs), and adapt our capabilities rapidly in the face of evolving threats. This dual approach ensures both excellence in major programmes and flexibility in technological uptake.

The increase in defence investment that Spain, together with our European partners and allies, is undertaking represents a historic opportunity that must be managed with strategic responsibility. The *Industrial and Technological Plan for Security and Defence* makes this commitment a reality through a coordinated effort by several ministries and public bodies, allocating unprecedented resources to strengthen our technological and industrial base. The present Strategy establishes the framework to ensure that, in the coming years, these R&D&I investments translate into effective military capabilities and the development of critical technological competencies, generating significant high-skilled employment benefits for our security, our economy, and our society.

Implementing this Strategy will require the commitment of the entire organisation. It is the responsibility of the Directorate-General for Strategy and Innovation of the Defence Industry to lead its roll-out, coordinating the actions of all relevant bodies, defining specific implementation plans, and ensuring monitoring mechanisms that allow us to periodically assess progress and take the necessary decisions to fulfil our strategic objectives.

With the approval of this Strategy, Spain takes a decisive step towards a technologically advanced, industrially resilient, and strategically autonomous defence, capable of guaranteeing our national security and contributing meaningfully to European and transatlantic collective security.

Secretary of State for Defence

Introduction by the Director-General for Strategy and Innovation of the Defence Industry

The security environment faced by our Armed Forces today is defined by growing complexity and an unprecedented pace of change. Recent conflicts have reshaped the strategic landscape and confirmed that technological superiority is decisive for operational success. This reality demands multidomain integration of advanced systems, continuous tactical adaptation, and, above all, industrial resilience to sustain long-duration operations. The challenge lies in rapidly incorporating cutting-edge technologies, especially those with disruptive potential, while applying rigorous criteria of maturity and suitability for defence systems, through a comprehensive vision that spans the full cycle: from identifying the operational need to deployment, certification, and sustainment.

In this context, the Defence Technology and Innovation Strategy (ETID 2026) takes on its full meaning as an operational and management framework that guides the Ministry's R&D&I effort and synchronises technological policy with industrial policy. Its purpose is to ensure that innovation is not an end in itself, but a means of linking applied research with industry and with the needs of the Armed Forces, guaranteeing that solutions can be produced, scaled, and sustained effectively and securely. The ETID also strengthens our technological sovereignty and freedom of action by aligning priorities, instruments, and capabilities within a clear pathway that accelerates the transition from the laboratory to operational capability. This framework is further complemented by the Defence Industrial Strategy (EID) 2023, with which it maintains a direct and coherent coordination. While the EID sets the overarching lines for strengthening and expanding the Defence Technological and Industrial Base, the ETID ensures that R&D&I progresses in harmony with these priorities, enabling technological development and industrial capability to evolve in a mutually reinforcing manner.

Building on this integrated approach, the Strategy is based on three pillars that guide action coherently and consolidate a robust, sustainable innovation model over time.

The first pillar underpinning this Strategy is the prioritisation of resources. This means concentrating investment on technological objectives with the greatest operational and industrial impact, combining established technological areas with lines of high disruptive potential through research and technological development projects that facilitate their transition into the systems used by the Armed Forces in their missions.

The second pillar is cooperation, conceived as a multiplier of capabilities. At national level, the ETID structures collaboration with other ministries and funding agencies to align instruments, share information, and coordinate priorities. Internationally, it promotes participation in European and transatlantic initiatives with the aim of securing technological return, gaining access to capabilities beyond our national reach, and ensuring a competitive position for our industry within strategic value chains. This approach integrates the Armed Forces, the Defence Technological and Industrial Base, and all bodies responsible for technological and industrial development policies and their funding, fostering dual-use innovation as a means to achieve competitive advantages and sovereignty.

The third pillar is continuous improvement, driving the transformation of processes, instruments, and working models to make them more agile, transparent, and efficient. It also entails reinforcing governance, programme monitoring, and multi-annual planning, thereby lending stability to investment, ensuring consistency in decision-making, and providing long-term visibility for industry and the scientific-technological ecosystem.

The coming years will be decisive for Spain's technological and industrial development. With the *Industrial and Technological Plan for Security and Defence* as a financial lever, our responsibility is to transform investment into effective capabilities. The ETID directs this effort towards specific technological priorities and energises the industrial base through high-impact projects.

Finally, I would like to acknowledge the work of the Ministry of Defence personnel who have contributed to this Strategy, in particular the Deputy Directorate-General for Planning, Technology and Innovation (SDG PLATIN). Its success will depend on rigorous implementation and the loyal collaboration of the entire ecosystem. With this foundation, ETID 2026 will be the instrument that transforms technological ambition into effective military capability and into a stronger, more innovative, and more sustainable national industry.

Director-General for Strategy and Innovation of the Defence Industry

Table of contents

1. Ministry of Defence R&D&I Policy

The Ministry of Defence's R&D&I Policy, under the responsibility of the Secretary of State for Defence, contributes to achieving the objectives established by the Defence Policy and, therefore, to the development of the capabilities resulting from the Defence Planning Process, regulated by Ministerial Order 60/2015 of 3 December.

This public policy is governed by Law 14/2011 of 1 June on Science, Technology and Innovation, as amended by Law 17/2022 of 5 September. Consequently, any action must be carried out within the framework of the Spanish Strategy for Science, Technology and Innovation (EECTI 2021–2027)[1] and coordinated with the competent ministries, as a common framework for promoting scientific and technical research and innovation.

Building on this regulatory framework, the Ministry of Defence's R&D&I Policy is structured to drive the development of technological capabilities among the sector's actors, which throughout this document will be referred to collectively as the national Defence Technological and Industrial Base (DTIB). The ultimate aim is to ensure that these actors can sustainably maintain the ability to supply the Ministry of Defence and the Armed Forces with the most technologically advanced systems and equipment, which will enhance military capabilities and contribute to the success of operations.

Mission, Vision and Values

The Defence R&D&I Policy pursues two fundamental objectives:

- To contribute to the **development of military capabilities**, providing advanced technological solutions that help deliver **operational advantage** in their use.
- To contribute to **strengthening the national technological and industrial base**, ensuring it possesses the essential capabilities required for defence and enabling **freedom of action** in the employment of military capabilities.

These objectives define the core **Mission** of defence R&D&I, with which the specific objectives established in this Strategy, as well as the plans and programmes developed for its implementation, must align.

The **Vision** focuses on enabling a defence R&D&I system capable of leveraging both the Ministry's own capabilities and resources and the external opportunities accessible through national and international cooperation. It must be able to operate across the full spectrum of technological areas relevant to the missions of the Armed Forces and at different levels of technological readiness, so that results can be integrated into the acquisition processes of future

[1] https://www.ciencia.gob.es/InfoGeneralPortal/documento/1f4e85ac-9e50-49b4-a978-6c15a5195c88

weapon systems and so that the national DTIB can provide a sustained response to current technological needs as well as to the challenges that the future may bring.

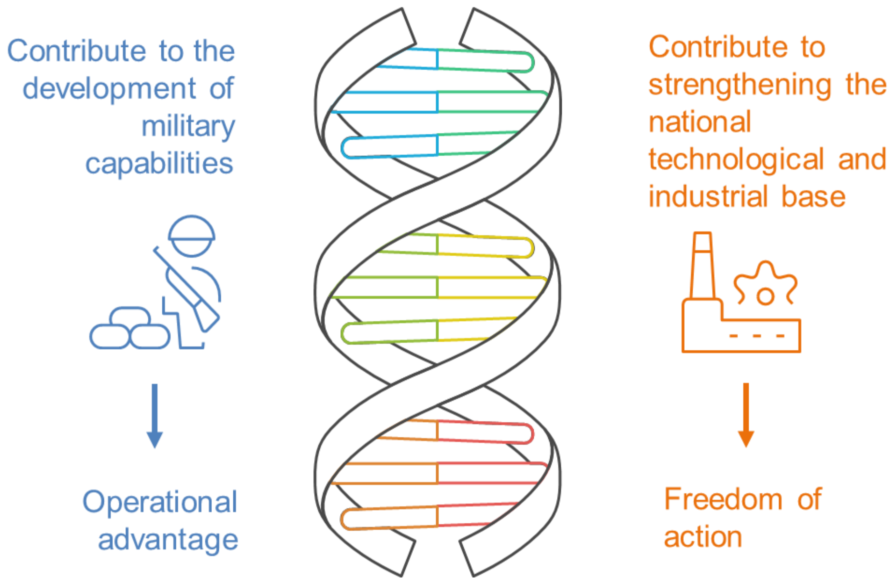

Figure 1. Objectives of the Defence R&D&I Policy

Defence R&D&I is guided by a set of **Values** that shape all of its actions and help address many of the challenges facing our society.

Responsibility:	**Values:**
To the Armed Forces	- Commitment to serving the Armed Forces.
To other public bodies that fund scientific and technological research at national level	- Shared commitment to supporting the development of the national technological fabric and economic growth.
To the Spanish DTIB	- Equal opportunities for all types of entities. - Receptiveness to innovative ideas and proposals that promote technological progress within the Armed Forces.
To society	- Contribution to addressing the major security and sustainability challenges faced by society. - Transparency in all actions. - Use of public resources in accordance with the principles of economy, effectiveness and efficiency. - Ethical principles as an integral part of all activities.

Table 1. Values of Defence R&D&I

Characteristics of Defence R&D&I

Defence R&D&I is characterised by a distinctly applied and mission-oriented nature, whereby the constant objective is to transfer the latest technological advances to current and future systems that contribute to the development of military capabilities. This linkage between defence-focused R&D&I and end systems shapes the way all activities are conceived and carried out, regardless of the Technology Readiness Levels (TRLs)[2] from which they start or those they aim to reach.

In this context, as a general principle, the Ministry of Defence directs its actions towards addressing defence needs that involve significant technological challenges, either through the adaptation of existing technological solutions or through the development of technological niches where private-sector activity does not meet the specific needs of defence. This approach fosters the development of dual-use technologies and prevents duplication with R&D&I efforts intended solely for civilian purposes.

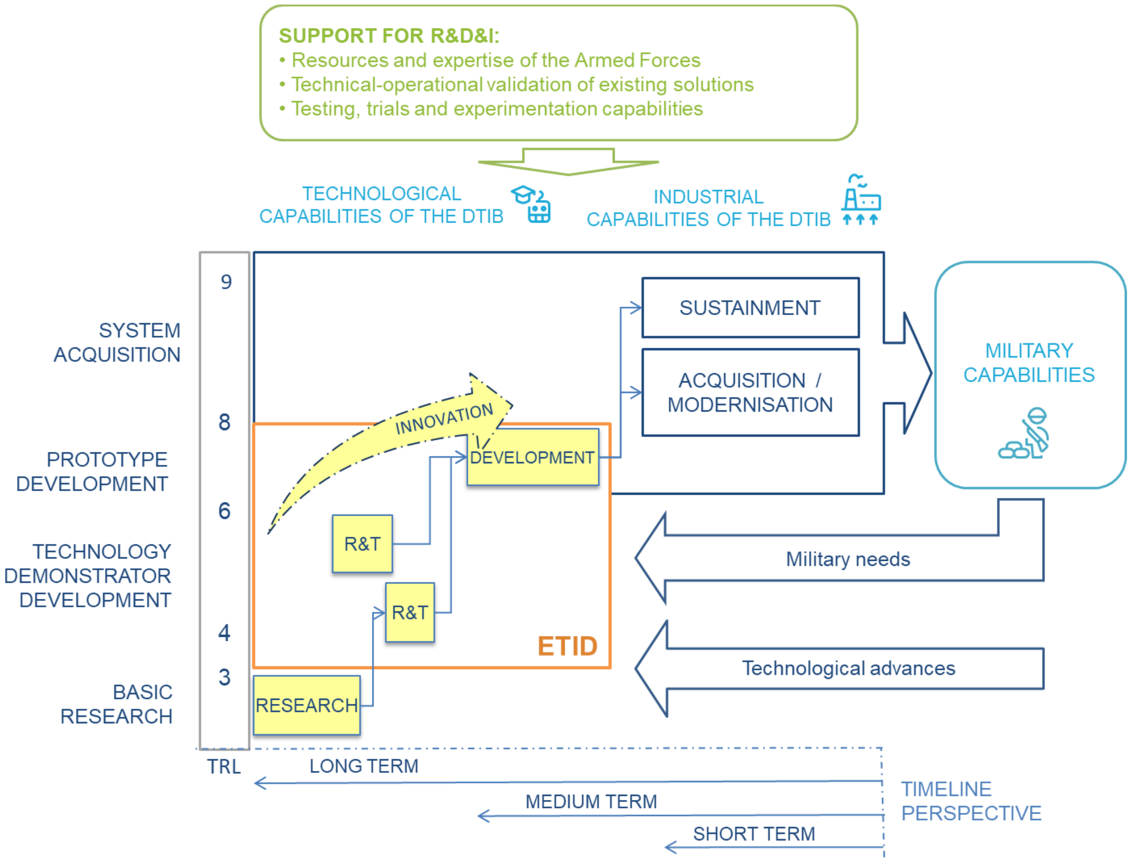

Figure 2. Defence R&D&I

[2] *Technology Readiness Levels*. This concept, as well as others used throughout this document, is addressed in Annex C.

Traditionally, the main efforts of defence R&D&I have focused on the stages of applied research and experimental development, with the aim of transferring their results to the Ministry's acquisition processes. To this end, two types of activities are considered (see Figure 2):

- **Research and Technology (R&T)**. Applied research activities aimed at developing expertise in new technologies that may be incorporated into future weapon systems and equipment, as well as verifying these technologies through technological demonstrators.
- **Development (D)**. Application of the knowledge and results obtained during the research phases to the design, development and validation of new products or to the substantial improvement of existing ones, through the acquisition of prototypes with functionalities close to those of the final systems. This type of activity may be linked to a research and development project or to the design stage of the execution phase of an armament and materiel programme.

In recent years, marked by technological acceleration and a rapidly evolving geopolitical environment, **technological innovation** in defence has consolidated its role as an essential complement to traditional R&D approaches based on the structured development of medium- and long-term capabilities. This introduces a more agile and adaptive logic, centred on the early incorporation of enabling, emerging and disruptive technologies. Such an approach enables faster responses to immediate operational challenges by leveraging the potential of dual-use technologies developed in the civil sphere.

Basic research activities that may have a dual-use nature, although not the primary focus of defence R&D&I, are of increasing interest due to their potential to shape the scientific foundations on which future critical technologies will be built. These activities make it possible to explore disruptive concepts at early stages of technological readiness, opening new opportunities for defence in the medium and long term. They also strengthen the technological capabilities of the DTIB by fostering the role of incubator-agents, such as universities, research centres and technology-based startups, which act as seedbeds of knowledge and scientific talent essential for technological sovereignty.

Synergies with Other Policies

From a broader strategic perspective, the R&D&I Policy set out in the ETID and the **Defence Industrial Policy** established in the Defence Industrial Strategy (EID)[3] constitute two complementary and coordinated pillars of Defence Policy. While the former directs technological efforts towards the development of future capabilities through investment in advanced and innovative technologies, the latter defines the concept of Strategic Defence Industrial Capabilities (CIEDs) and identifies and describes the Essential Capabilities for Defence, while seeking to consolidate a competitive and sustainable national DTIB. This complementarity ensures that technological priorities are aligned with strategic industrial needs, generating synergies that reinforce both the operational autonomy of the Armed Forces and the country's technological and industrial sovereignty.

[3] The version in effect at the time of publication is the EID 2023.

This relationship is further strengthened by the fact that both policies draw upon the two fundamental dimensions of the DTIB: its technological dimension and its industrial dimension. From the perspective of the ETID, the focus is on the DTIB's **technological capabilities**, understood as the ability of universities, R&D&I centres, SMEs and innovation-oriented large companies to undertake projects with a high research and development component. These capabilities are essential for anticipating and developing the critical technologies underpinning strategic autonomy. For its part, the EID emphasises the DTIB's **industrial capabilities,** its ability to produce, commission, maintain and evolve final systems, as well as to provide strategic services. Coordination between both strategies ensures that the technological advances driven by the ETID translate into sustainable industrial capabilities aligned with the operational needs of the Armed Forces and with the sovereignty and competitiveness objectives of the defence sector.

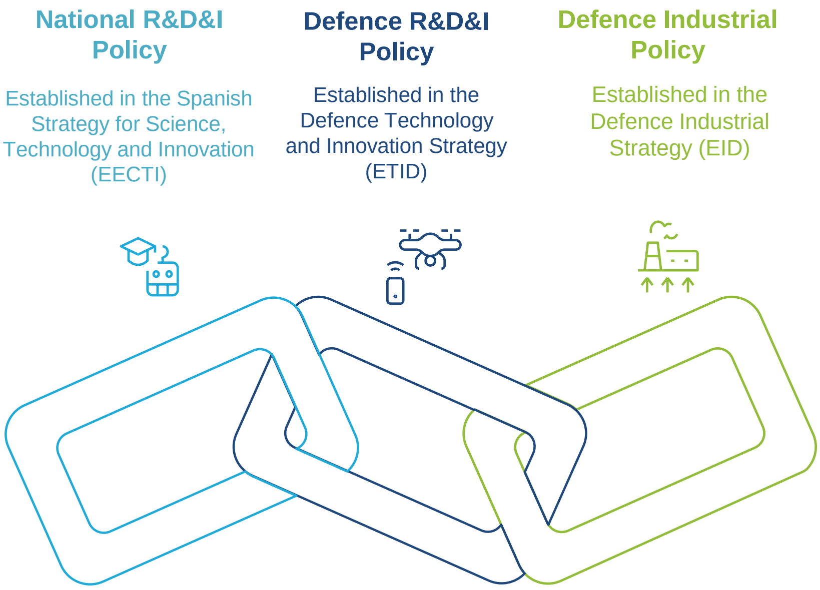

Figure 3. Synergies between Policies

Likewise, defence R&D&I is integrated into the **EECTI**, as well as into the State Plan for Scientific, Technical and Innovation Research (PEICTI), which serve as overarching instruments defining the general objectives for the promotion and development of R&D&I activities in Spain. The Ministry of Defence adheres to their principles and objectives and develops them further for the specific domain of defence.

2. Current Situation and Trends in Defence R&D&I

This chapter provides an overall view of the current situation of defence R&D&I, analysing both internal and external drivers, as well as the main barriers and challenges that must be addressed in order to move towards the desired strategic vision. The objective is to identify the factors that shape the sector's development and the challenges that will need to be overcome to achieve the future vision of defence R&D&I Policy.

The analysis is organised into three main areas: the evolution of military capabilities as a reference for guiding innovation; the impact of accelerated technological progress and its disruptive potential in defence; and the role of the various actors within the science, technology and innovation ecosystem, from the national technological and industrial base to national and international institutions, with the Ministry of Defence itself as the sectoral coordinator.

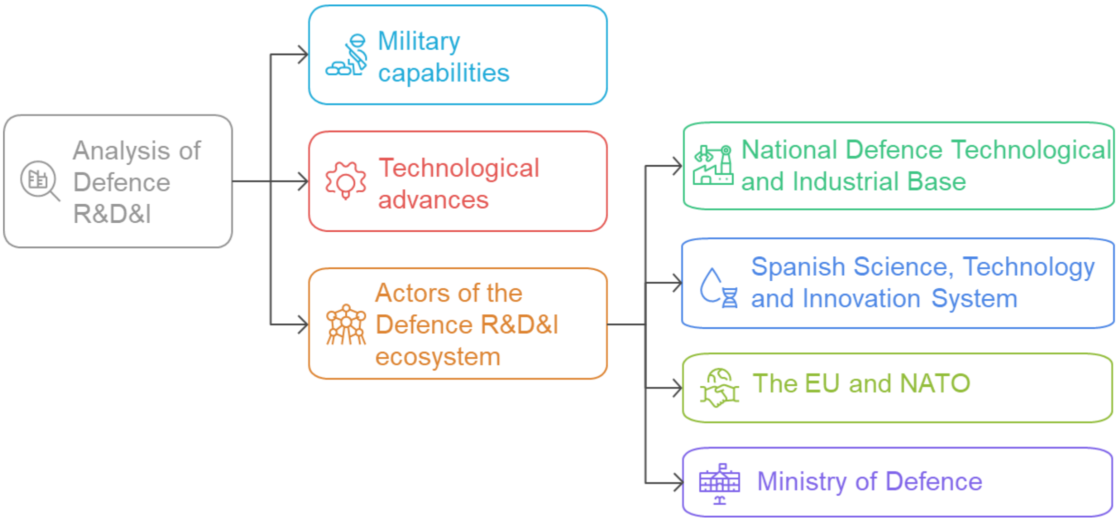

Figure 4. Analysis of the dimensions affecting the Defence R&D&I Policy

Military Capabilities

In recent years, the international strategic environment has undergone a substantial evolution, marked by growing multipolarity, rising geopolitical tensions, and the emergence of new hybrid and technological threats. This transformation has had a direct impact on the way military capabilities are conceived and developed, requiring a profound revision of traditional approaches and an adaptation to the security and defence requirements of the 21st century. The intensification of great-power competition, the resurgence of conventional deterrence, the militarisation of space and cyberspace, and the proliferation of disruptive technologies define a scenario in which technological foresight and operational responsiveness have become

Defence Technology and Innovation Strategy – ETID 2026 strategically central as never before[4]. In this new context, the development of military capabilities increasingly revolves around orchestrating a complex, interdependent and dynamic system-of-systems, organised into three fundamental areas: multidomain integration; technological superiority; and operational resilience.

Multidomain integration entails the ability to operate in a coordinated and simultaneous manner across the land, maritime, air, cyberspace, electromagnetic, space and cognitive domains, overcoming the traditional compartmentalisation between them and promoting a more agile, distributed and digitalised command, control and decision architecture that enables real-time integration of sensors, data, decisions and effects. This integration requires interoperable, scalable and reconfigurable capabilities capable of adapting to highly dynamic operational environments in which the electromagnetic spectrum is heavily contested or degraded. The challenge is not only technical but also doctrinal and organisational, as it places the warfighter at the centre of this transformation. It demands a profound shift in the concept of joint force employment and an evolution of planning and training frameworks to address radically new learning needs, such as operating complex systems or managing inter-domain synergies and potential cascading effects[5]. Particularly in emerging domains like space and the cognitive domain, the synergy between effects must take into account the management of personnel's cognitive workload and the importance of human–machine interfaces in building trust in autonomy. Consequently, R&D&I must focus not only on hardware and software but also on how to optimise the performance and resilience of the personnel who use them.

Technological superiority, in turn, has become an indispensable requirement to ensure operational effectiveness in conflicts characterised by asymmetry, accelerated tempo and the fusion of the physical and digital spheres. The incorporation of technologies with disruptive potential, such as artificial intelligence, autonomous systems or new space-based capabilities aligned with the *New Space*[6] paradigm, constitutes a strategic priority for designing and deploying next-generation military capabilities. These technologies not only increase the lethality, precision and speed of response of military systems but also enable new operational concepts, such as collaborative combat, cognitive warfare and distributed swarm operations. The accelerating pace of technological cycles also poses an additional challenge in terms of planning, obsolescence and continuous capability updates, requiring more flexible and adaptive acquisition models, as well as agile R&D&I structures capable of interacting with the civil innovation ecosystem while fully considering the ethical and legal implications of their development and use.

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[4] *NATO Strategic Foresight Analysis* (2023).

[5] *Enhancing EU Military Capabilities beyond 2040*. EDA, 2023.

[6] The *New Space* movement is an emerging industry that promotes the participation of private companies, startups and venture-capital investment in the development of space technologies. Its main objective is to create profitable businesses in activities such as launch services, satellites, space exploration and space-based services, prioritising innovation over exclusive reliance on public funding.

Figure 5. Multidomain integration (AI-generated image)

Operational resilience has increasingly consolidated itself as a critical dimension in a context marked by the proliferation of advanced persistent threats and the intensive use of denial, interference and saturation measures. Resilience entails the ability to maintain operational continuity, adapt to disruption and recover quickly from kinetic, cyber or electromagnetic attacks. This requires secure critical infrastructure, redundant command-and-control systems, and comprehensive preparedness to operate in A2/AD (anti-access/area-denial) scenarios or in environments degraded in terms of telecommunications and navigation capabilities. It is also essential to have agile, robust, flexible and redundant logistical chains capable of sustaining high-intensity operations in contested environments, ensuring autonomous resupply, guaranteeing strategic and operational mobility, and supporting the continuous maintenance of platforms under adverse conditions. Alongside this, active cyber defence, electronic defence and electromagnetic-spectrum protection capabilities must be integrated, combined with dispersion, concealment and deception strategies that hinder adversary action against critical nodes. Likewise, military medical capabilities must be strengthened, both in their preventive and response dimensions, including medical evacuation in combat (MEDEVAC), deployment of field hospitals, telemedicine and crisis-management capacities, as these are essential to sustain prolonged operations, safeguard the physical and psychological health of personnel, and ensure the resilience of the force as a whole.

The war in Ukraine has acted as an accelerator of these trends, offering significant lessons regarding the use of unmanned systems, loitering munitions, layered air defence, resilient communications, electronic warfare and the information domain. It has also highlighted the importance of possessing adaptable, scalable and efficient industrial production capabilities able to respond to high-intensity and long-duration scenarios. In this regard, strengthening the DTIB, both nationally and at European level, becomes a key element in ensuring the availability and sustainability of military capabilities. Strategic autonomy, as the guiding principle of these policies, requires a progressive reduction of critical dependencies in key technological sectors, together with the development of domestic innovation ecosystems that reinforce technological sovereignty[7-8].

This conflict has also underscored the urgency of operating effectively in highly contested and technologically complex environments, expanding the traditional battlespace into domains such as cyberspace, including the electromagnetic environment, space, and the cognitive domain. Beyond the importance of achieving the multidomain integration described above, each of these domains presents specific characteristics that will significantly shape technological development in defence over the coming years, as summarised in Table 2.

Added to this technological and doctrinal transformation is a decisive political-economic factor: the widespread increase in defence investment from 2025 onwards. Driven by the deterioration of European security, the rearmament of global and regional actors, and the need to reinforce credible deterrence against hybrid and conventional threats, most European and NATO countries are substantially increasing their defence budgets. This trend represents an unprecedented opportunity to modernise capabilities, accelerate innovation and reconfigure operational architectures to address the challenges posed by the current environment. At the same time, it demands rigorous and strategic planning to ensure that these investments are directed towards generating effective, interoperable, sustainable capabilities aligned with national and collective interests. The efficiency of this investment will depend largely on the ability to integrate technological innovation with doctrinal transformation, maintain continuity in long-term programmes, and foster an industrial and scientific base capable of supporting the defence effort, with particular attention to civil-military duality and the strategic return for the national economy.

[7] Technological sovereignty in the defence domain is defined as the ability of a State or coalition to develop, provide and protect the critical technologies required for its security without unilateral structural dependencies on third countries. While the European Union incorporates this concept under the framework of Open Strategic Autonomy, focusing on reducing vulnerabilities in supply chains and strengthening the European defence industrial base to enable independent decision making and action, NATO interprets it as the preservation of a competitive technological advantage and operational resilience against adversaries. In practical terms for the force, this sovereignty is expressed through three levels of autonomy: freedom of use (the ability to operate systems without external restrictions); freedom of modification (the capacity to adapt software and hardware to specific needs); and security of supply (guaranteed, uninterrupted access to components and technical support, especially in times of crisis or conflict).

[8] The EID establishes, as one of its guiding principles, the need to increase the level of strategic autonomy in the defence industry so as to reduce dependence on third parties, particularly in relation to the Strategic Defence Industrial Capabilities (CIEDs).

Domain	Key characteristics and lines of technological and operational development
Land	- Increased mobility and distributed lethality. - Light, protected and connected platforms. - Integration of manned and unmanned systems (UGV). - Digitalisation of tactical command and control. - Operational persistence in urban and high-intensity scenarios. - GNSS-denied resilience and counter-drone defence.
Maritime	- Anti-submarine warfare capabilities and advanced surface warfare. - Autonomous underwater and surface vehicles interoperable with manned vessels. - Persistent surveillance and collaborative electronic warfare. - Modular architectures and distributed command for A2/AD environments. - Protection of critical maritime routes and infrastructures. - Countering hypersonic threats and swarms.
Air	- Shared air superiority: manned and unmanned platforms. - Sixth-generation combat systems with embedded AI. - Distributed and spectrum-resilient networks. - SEAD capabilities, airborne electronic warfare and adapted operational refuelling. - Integration with space, naval and land platforms.
Cyberspace	- Autonomous operational environment with passive and active defence. - Cyber intelligence and offensive action within the legal framework. - Protection of command and control, critical infrastructure and digitalised logistics. - Embedded cyber resilience in systems and platforms. - Persistent and secure connectivity in multidomain environments. - Resilience in degraded electromagnetic environments. - Need for realistic training. - Civil-military collaboration. - Dynamic control and management of the electromagnetic spectrum as a central pillar of operational advantage, including integrated offensive and defensive electronic warfare and concealment techniques. - Incorporation of quantum and cognitive technologies.
Space	- Accelerated militarisation with dual-use and domain-specific capabilities. - ASAT threats, GNSS denial and manoeuvring orbital vehicles. - Critical functions: C2, navigation, ISR and communications. - Integration of LEO and VLEO constellations and emerging space doctrines. - Sovereignty in ISR systems to broaden strategic information sources. - Need for international norms for the responsible use of space.
Cognitive	- Confrontation in the realm of narrative and public perception. - Disinformation, media manipulation and social networks as weapons. - Capabilities for detecting hostile campaigns and conducting semantic analysis. - Ethical management of narratives and protection of cognitive capital. - Application of AI, neuroscience, biotechnology and other emerging technologies, as well as behavioural analytics.

Table 2. Key characteristics of each operational domain

Technological Advancement

Technological progress in areas such as artificial intelligence, robotics, the Internet of Things, biotechnology, 3D printing, energy storage, new materials, computing capabilities and telecommunications has brought about a significant transformation across multiple sectors, including defence. This evolution has been largely driven by strong innovation-focused investment within the consumer economy, particularly in electronics and information and communications technologies.

In this constantly evolving landscape, the interest of nations in so-called **disruptive technologies or innovations** has gained particular prominence. These are characterised by their ability to generate drastic changes in established processes and by the difficulty of anticipating both their emergence and their consequences. In NATO's case, this interest is structured around Emerging and Disruptive Technologies (EDTs)[9], focusing on their identification and early-stage support in order to accelerate their maturation, guide their responsible use and preserve the Alliance's technological and strategic advantage. For companies, the emergence of a disruptive innovation can represent either an opportunity for exponential growth or, conversely, the risk of being pushed out of the market. In the military domain, their implementation reshapes how the Armed Forces conduct operations, enabling capabilities that cannot be achieved through incremental improvements and, in some cases, generating unpredictable strategic challenges if measures have not been taken to anticipate them.

Some current examples of these technologies include Unmanned Aircraft Systems (UAS), which have revolutionised both military missions and a wide range of civilian activities; additive manufacturing, which is transforming production and logistics processes; and artificial intelligence, which in the coming years will deliver significant advances in automated sensor-data analysis, equipment maintenance and decision-support systems. Looking ahead, the development of quantum technologies, directed-energy weapons, synthetic biology and hypersonic vehicles has the potential to completely redefine the threat landscape in the fields of security and defence.

Nevertheless, the employment of these new technologies also entails uncertainties and vulnerabilities—both technical (e.g., lack of transparency in the decision-making processes of AI-based systems) and ethical or legal (e.g., restrictions on the use of biotechnology or the development of autonomous systems with offensive capabilities). Added to this is the possibility that adversaries or terrorist groups may exploit these advances, as access to technology and knowledge is increasingly easy, enabling them to employ low-cost tools to generate chaos and destruction. This situation reduces their apparent technological disadvantage and forces the development of new solutions to counter these emerging threats.

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[9] *Emerging and Disruptive Technologies (*https://www.nato.int/en/what-we-do/deterrence-and-defence/emerging-and-disruptive-technologies*)*. NATO identifies the following priority technological areas as EDTs: artificial intelligence (AI), autonomous systems, quantum technologies, biotechnology and human-enhancement technologies, space, hypersonic systems, novel materials and manufacturing, energy and propulsion, and next-generation communication networks.

Figure 6. Representation of EDTs (AI-generated image)

Despite these risks, the potential of these innovations to provide systems with more advanced and intelligent capabilities is undeniable, making it essential to develop expertise in them. For this reason, this Strategy focuses on leveraging these advances to strengthen military capabilities, especially when they can provide disruptive advantages in the operational domain. This involves anticipating the potential uses that adversaries and terrorist organisations may make of these technologies, while ensuring full compliance with the legal framework and upholding the Ministry of Defence's firm ethical commitment to society at all times.

Another dimension of technology that is gaining increasing importance is **technological sovereignty**, mentioned in the previous section. Beyond operational freedom, this sovereignty is based on the ability to control the value chain and life cycle of critical capabilities. In technological terms, it involves managing dependencies that may be highly specific, at the level of components or raw materials, or broader in scope, affecting subsystems or entire systems. The challenges associated with exercising this control are structural: from the need to possess advanced manufacturing infrastructures to the ability to sustain massive investments in highly complex systems. Moreover, technological sovereignty is dynamic, as insufficient support today for the development of emerging technologies may lead to new strategic dependencies in the future.

In this context, exploiting synergies with **dual-use technological advances** is key to maintaining operational superiority and optimising available resources. Many of the innovations that are redefining the military landscape originate in civil and commercial investment, including the space sector[10]. Integrating these developments into the defence sector not only accelerates the adoption of cutting-edge technologies but also reduces costs, enables economies of scale and fosters public-private collaboration. Moreover, the interaction between the civil and military sectors generates a more dynamic innovation ecosystem in which emerging technologies can be rapidly adapted to operational challenges. Areas such as autonomy in unmanned systems, cybersecurity, new space solutions and advanced computing all benefit from this convergence, allowing the Armed Forces to access technological solutions with shorter development cycles and greater resilience. In this way, the synergy between civil investment and defence applications not only strengthens military capability but also boosts industrial competitiveness and technological sovereignty.

However, reliance on technologies originating from the civil market also poses challenges. Integrating solutions designed outside national or allied control may introduce strategic vulnerabilities, whether due to unexpected commercial restrictions, disruptions in global supply chains or security risks associated with components or software not conceived for military environments. The challenge lies in balancing the benefits of agile innovation with the need to guarantee sovereignty, resilience and control over critical elements.

Closely related to the dual-use nature of technology, alternative pathways to the traditional, gradual technology-maturation models of R&D&I have been explored for years, models that often involve decades of technological development. In particular, and linked to the concept of **disruptive, technology-driven innovation**, increasingly agile, collaborative and adaptable approaches are being promoted, enabling rapid responses to new threats through the incorporation of Emerging and Disruptive Technologies (EDTs). Technologies whose development is being clearly driven by civilian initiatives, such as artificial intelligence, robotics, new materials or small satellites, are strong candidates to be included in these innovation approaches.

Other noteworthy aspects of these initiatives include the growing prominence of a broader ecosystem than that of traditional R&D&I, incorporating startups and entrepreneurs, SMEs and the academic sphere. They are also characterised by the use of management approaches that can be considered innovative in themselves, enabling greater participation of end users and faster adaptation to changing needs. Examples of these approaches include challenges, in which technological problems and validation scenarios are defined in conditions close to operational use; hackathons, i.e., programmer gatherings aimed at producing rapid software developments by leveraging existing technology and preparing them for deployment and testing; and the establishment of sandboxes, providing controlled environments, physical or software-based, for testing and developing new technologies and solutions. These constitute more evolved versions of new-technology experimentation that has been carried out in the defence sector for years, not only aimed at testing the performance of existing technological developments to validate their utility for defence, but also at accommodating new technological approaches to address problems previously not considered. Likewise, innovation prizes are becoming increasingly common, designed to encourage new ideas from end users or from entities that are less

[10] Action Plan on Synergies between Civil, Defence and Space Industries. Brussels, 22.2.2021 (COM (2021) 70 final).

traditional in the defence sector, such as startups, often by supporting an initial phase to help them launch their development.

Figure 7. Depiction of the concept of disruptive innovation in the defence sector (AI-generated image)

In this new innovation ecosystem, startups and technology-driven SMEs are taking on a leading role as sources of agile and sometimes "divergent" innovation, capable of offering disruptive solutions that traditional companies might not explore. Their flexibility and speed allow them to respond very efficiently to shifts in the geostrategic environment and to the emergence of new technologies. However, to prevent these innovations from remaining at the prototype stage, it is crucial to ensure their transition into robust, operationally viable products and services. This maturation process requires special attention and can be driven through two complementary pathways: on the one hand, through the involvement of large anchor companies that integrate these solutions into their systems; and on the other, through public support instruments that finance technological development and foster the maturation of both the business model and the product. This set of advantages explains why the most advanced countries and major international organisations engaged in defence-related technological development are launching new initiatives, as will be described later in this document.

Another area of focus, mentioned earlier in relation to future technological dependencies, is that of **emerging technologies**. These innovations, based on highly complex concepts and tools still under development, generate significant uncertainty, but also offer disruptive potential capable of transforming entire sectors. Their advancement requires intensive R&D&I investment, which in some cases only a limited number of countries and large corporations can take on. Moreover, their benefits tend to materialise in the long term, allowing those who spearhead them to maintain a competitive advantage. Even so, accurately predicting when they will reach maturity or what their ultimate impact will be remains a challenge. To foster their development, it is essential to involve R&D&I funding bodies and national research groups, and to promote initiatives that will enable them to acquire the technological level required to participate in international projects. In the defence domain, such initiatives are critical in order to tackle highly complex and costly solutions, ensuring that countries can position themselves at the forefront of technological innovation.

In summary, while recognising the importance of continuing to participate in major programmes for the development of next-generation platforms and systems that incorporate highly sophisticated technological advances, requiring enormous investment and long development timelines, the current pace of technological progress and the growing need for adaptability call for change. In the coming years, it will be crucial to adapt national R&D&I processes and instruments, particularly those of the Ministry of Defence, to promote the full exploitation of dual-use R&D&I efforts, with special emphasis on EDTs and on mitigating technological dependencies.

Actors in the Defence R&D&I Ecosystem

The National Technological and Industrial Base

Accelerated technological progress has given rise to a new industrial revolution driven by digitalisation, automation and artificial intelligence. This transformation is reshaping production models, supply chains and industrial resilience, with direct effects on both the economy and security. For Spain, adapting the national technological fabric to this reality is essential to maintaining competitiveness and remaining a relevant actor in the defence sector, particularly in a context of uncertainty regarding technological evolution, where it is evident that the sector must respond with agility to disruption and to the growing convergence with the civil sphere.

The DTIB plays a fundamental role, not only as a provider of solutions for the Ministry of Defence, but also as a bridge for transferring technological advances from the civil sector into the military domain. In recent years, the defence innovation ecosystem has evolved, strengthening collaboration among universities, research and technology centres, SMEs and large companies. While universities and research centres are essential for generating disruptive knowledge, technology centres act as the necessary bridge to transform this science into practical applications. SMEs contribute technological specialisation and agility in developing niche solutions, while large companies lead the execution of strategic programmes and consolidate advanced industrial capabilities. Finally, associations and clusters act as catalysts of synergies and as key interlocutors with the Government.

In this context, the growing recognition of the importance of R&D&I as a driver of economic, strategic and technological development is spurring higher levels of public and private investment, both nationally and at European level. The strengthening of defence cooperation programmes, strategic autonomy and the digitalisation of industrial processes are shaping the agenda for the coming years, enabling the consolidation of a more robust, resilient innovation ecosystem prepared to address future security challenges.

To maximise the impact of the DTIB on defence R&D&I, it is essential to identify and reduce the barriers that limit its participation, and to promote mechanisms that facilitate the integration of new entities into the defence sector. Table 3 presents the main barriers that affect the entry and consolidation of new companies in the defence sector.

Category	Barrier	Explanation
Funding	Lack of funding in intermediate maturity stages	Difficulty in attracting investment when commercialisation is still distant, creating the need for sustained public support at both national and European level.
	Fragmentation of instruments	Existence of multiple unconnected national and European instruments, making it difficult to leverage them and ensure continuity at higher maturity levels.
	Limited access to patient capital and strategic funds	Although growing, investment vehicles specifically aimed at helping SMEs and startups scale within the defence sector are still limited.
Access to information and data	Restricted access to operational requirements and data	Limitations in anticipating Armed Forces' needs and in accessing key operational requirements and data that shape the design and development of solutions.
Validation and testing	Shortage of physical testing facilities	Difficulty in validating prototypes in real environments, particularly in domains of increasing technological complexity (e.g., AI, autonomy, multidomain operations).
	Insufficient Test, Evaluation, Verification and Validation (TEVV) methods	Need for synthetic environments, digital twins and advanced simulation to conduct more flexible and affordable testing.
Bureaucracy and regulation	Slow and risk-averse procurement	Public procurement processes that are excessively long and seek zero-risk conditions, which contrasts with the nature of innovation. In addition, innovative procurement instruments are used only to a limited extent.
	Uncertainty regarding Intellectual Property	Uncertainty regarding intellectual property and regulatory export restrictions hinders the transfer of civilian technologies into the defence sector.
	Security barriers	Limited awareness of security clearances for company personnel delays the entry of agile actors and the incorporation of innovative solutions.
Culture and talent	Shortage of critical skill profiles	Shortage of personnel trained in key areas, making it difficult to undertake projects involving advanced technologies.
	Cultural differences	Contrasts between the agile, fast-iteration models of innovative entities and the traditional risk-reduction approaches.

Table 3. Barriers to the DTIB's access to the defence sector

Strengthening cooperation between the Government, the industry and the innovation ecosystem is therefore essential to accelerate the development of strategic capabilities and reinforce technological sovereignty. It is critical to enhance public-private cooperation through policies that facilitate the access of defence-sector SMEs and startups to specialised financing ecosystems, including patient capital and strategic-impact investment funds. The creation of transparent and accessible mechanisms must overcome the current barriers that hinder this access, particularly for new companies without prior networks in the defence sector. This will ensure an agile convergence of innovation towards defence needs, fostering a defence technological and industrial base that is more competitive, diverse and resilient.

The Spanish Science, Technology and Innovation System

The Spanish Science, Technology and Innovation System (SECTI) comprises the public and private actors, as well as the policies and management instruments, that promote and coordinate research, development and innovation activities in Spain. It was established by Law 14/2011 of 1 June on Science, Technology and Innovation, with the aim of fostering the generation of knowledge, its application in the productive sphere and its contribution to the social, economic and environmental development of the country.

The timeframe of the ETID coincides with that of the EECTI 2021–2027 and its successor, as well as with the State Plan for Scientific, Technical and Innovation Research (PEICTI) for the period 2024–2027 and beyond, which will translate the objectives of the Strategy into concrete actions and investments. The ETID is aligned with the EECTI, applying its coordination mechanisms and ensuring consistency with the common framework that governs research and innovation in Spain.

In addition, there are other strategic initiatives at national level which, from a more sector-specific perspective, also focus on the development of disruptive technologies and on the guiding and incentivising effect of R&D&I financing tools. The most relevant and synergistic with defence are the 2024 Artificial Intelligence Strategy[11], the Spanish Quantum Technologies Strategy[12], the National Aerospace Security Strategy[13] and the National Deep Tech Strategy (2026–2030).

It should be noted that, within the framework of the EECTI and the other national strategies that have been approved in recent years, there are various R&D&I funding instruments managed by state or regional bodies that increasingly focus on leveraging the cross-cutting nature of technology and its dual-use potential. This enables a significant part of these R&D&I efforts to be transferable to defence applications—an aspect of particular interest for entities within the national technological ecosystem, which see their opportunities for growth and development expanded and may identify new market and export niches within the defence domain.

With this vision in mind, the General Action Protocol between the Ministry of Defence, the Ministry of Science, Innovation and Universities (MCIU), the Centre for the Development of Technology and Innovation (CDTI) and the State Research Agency (AEI) was established and signed on 23 April 2019, with the aim of supporting and promoting the development and integration of technology and innovation in the fields of defence and security. From a comprehensive perspective, this protocol sets ambitious objectives and, since its inception, has provided a significant boost to the defence technological ecosystem, enabling it to develop its capabilities and strengthen its ability to compete at European and international level. Likewise, it has acted as a multiplier of public R&D&I investment by avoiding duplication, optimising management resources and ensuring that such investments are directed towards projects of

[11] https://portal.mineco.gob.es/es-es/digitalizacionIA/Documents/Estrategia_IA_2024.pdf

[12] https://digital.gob.es/content/dam/portal-mtdfp/carruselhome/Estrategia%20Tecnologias%20Cuanticas.pdf

[13] https://www.boe.es/boe/dias/2025/08/05/pdfs/BOE-A-2025-16214.pdf

interest to the end users of the technology—namely, the Armed Forces—increasing the likelihood of market uptake.

As a result of this work, the CDTI has become a key actor in the implementation of the *Industrial and Technological Plan for Security and Defence*[14], assuming responsibility for executing major business-oriented R&D&I investments through its financial instruments, encompassing the entire national innovation ecosystem.

In this context, it is particularly worth highlighting the significant momentum generated for the development of the national technological ecosystem and the dual-use potential of technology by the launch of various Strategic Projects for Economic Recovery and Transformation (PERTEs)[15]. These public-private collaboration instruments, involving different public administrations, companies and R&D&I centres, are designed to promote major initiatives that clearly contribute to the transformation of the Spanish economy. In recent years, taking advantage of funding from the Recovery, Transformation and Resilience Plan (PRTR), several of these major projects have been launched. Among them, those with the greatest potential synergies with the interests and capabilities of the defence sector include the aerospace PERTE, the electric and connected vehicle PERTE, the renewable energies, renewable hydrogen and energy storage PERTE, the naval industry PERTE, and the microelectronics and semiconductors PERTE.

The creation of new public bodies has also been promoted, with mandates that support national technological and industrial development. Some of these organisations are particularly relevant to the defence sector, such as the Spanish Space Agency (AEE)[16], the Spanish Society for Technological Transformation (SETT)[17] and the Spanish Agency for the Supervision of Artificial Intelligence (AESIA)[18].

[14] https://www.lamoncloa.gob.es/consejodeministros/resumenes/Documents/2025/230425-plan-industrial-y-tecnologico-para-la-seguridad-y-la-defensa.pdf

[15] https://planderecuperacion.gob.es/preguntas/que-son-los-perte

[16] The AEE is a public body under the authority of both the Ministry of Science, Innovation and Universities and the Ministry of Defence, which brings together all national space policies and effectively coordinates all services and activities in the sector to ensure the strategic action of the Government of Spain in the space domain.

[17] The SETT is the Public Business Entity responsible for managing and coordinating public investments in the field of technological innovation, guiding their implementation towards the generation of synergies, unified action and a medium-term vision aimed at transforming the Spanish economy in a transversal and structural manner through the incorporation of disruptive digital technologies across multiple sectors.

[18] The AESIA performs five main functions: acting as a think & do tank, supervising high-risk AI systems, coordinating the implementation of the European AI Regulation, promoting AI innovation, and participating in the global debate on AI governance.

Finally, it is important to highlight the efforts undertaken by the regional governments through their respective Smart Specialisation Strategies (S3)[19], which guide technological and industrial development in their regions. The convergence between these strategies and the technological priorities of the defence sector represents another area in which leveraging synergies can generate significant opportunities and benefits.

The effective articulation of defence R&D&I requires close cooperation among the public bodies responsible for driving it. Only coordination that facilitates the alignment of priorities, the exchange of information and the optimisation of resources can generate the necessary synergies to strengthen the national defence innovation system.

The European Union and NATO

In the current international security context, multilateral cooperation in defence has gained renewed importance as a response to the common challenges faced by European democracies. The transnational nature of threats, the growing need for interoperability among allies, and the urgency of reducing strategic dependencies have driven an intensification of collaborative initiatives, both within NATO and, increasingly, within the European Union.

In recent years, the EU has taken significant steps to consolidate its role as a security and defence actor, with the aim of strengthening its strategic autonomy and contributing more effectively to international stability. In this regard, the adoption of the Strategic Compass in 2022 represented a key milestone in the evolution of the Common Security and Defence Policy (CSDP), establishing a shared vision of threats, strategic priorities and concrete lines of action for capability development and security projection[20].

Among the most relevant initiatives in the field of European cooperation, the **European Defence Fund (EDF)** stands out as the European Commission's main instrument for supporting collaborative research and capability development in the field of defence. The EDF is based on two pillars: research (funded at 100%) and capability development (co-funded up to 80%). It has been allocated €7,953 million for the 2021–2027 period[21]. Its annual calls promote transnational cooperation among entities from at least three Member States, prioritising projects that contribute to the coherence of capabilities and to the competitiveness of the European Defence Technological and Industrial Base (EDTIB). The fund finances programmes in areas such as drone swarms, short-range air defence, quantum technologies, manned and unmanned land systems, and next-generation naval platforms. It has also consolidated a diversified portfolio of beneficiaries that includes large companies, SMEs, R&D&I centres and universities, thus fostering the integration of the European defence innovation ecosystem. In addition to its

[19] Smart Specialisation Strategies (S3). These are integrated agendas for territorial economic transformation developed both by the State and by the Autonomous Communities which, among other objectives, seek to make R&D&I a priority for all regions, as well as to concentrate resources in the most promising areas of specialisation in each region.

[20] *A Strategic Compass for Security and Defence.* Council of the European Union (2022).

[21] Regulation establishing the European Defence Fund. European Commission (2021).

technological benefits, the EDF seeks to reduce fragmentation in European defence programmes, increase spending efficiency and generate economies of scale.

This financial effort is complemented by **Permanent Structured Cooperation (PESCO)**, which acts as a political framework of binding commitments among Member States for the joint development of capabilities and the strengthening of interoperability. Launched in 2017, PESCO has driven more than 60 multinational projects in areas such as maritime surveillance, command and control, military mobility, autonomous systems and cyber defence[22]. This initiative makes it possible to establish joint roadmaps, set concrete capability commitments and facilitate the coordination of medium- and long-term investments. The synergy between PESCO projects and those funded under the EDF is steadily increasing, promoting a coherent integration of efforts and outcomes.

However, to elevate this cooperation to a level of systemic readiness in light of the new geopolitical landscape, the publication in March 2025 of the **White Paper on European Defence – Readiness 2030**[23], stands out. In this document, the European Commission sets out a strategic roadmap aimed at strengthening operational readiness, closing critical capability gaps, consolidating the European Defence Technological and Industrial Base (EDTIB), and accelerating innovation and cooperation in defence. The White Paper provides for a set of measures and instruments that could mobilise up to €800,000 million in aggregate investment, with a particular emphasis on air and missile defence, joint industrial production, digitalisation, sustained support to Ukraine, and the development of new technologies.

In this regard, on 27 May 2025, the Council of the EU adopted the Regulation establishing the **Security Action for Europe (SAFE)** instrument, aimed at strengthening the European defence industry. This Regulation forms part of the **ReArm Europe Plan** and seeks to support investments in the European Defence Technological and Industrial Base so that it can respond to the current crisis situation. The plan is based on several pillars, among which the SAFE Instrument is of note. It provides €150,000 million, to be granted as loans with repayment periods of up to 45 years, under highly flexible conditions, to Member States that request support for joint procurement of defence equipment. It also envisages the creation of tax incentives, co-investment schemes and demand-aggregation mechanisms among Member States. This initiative is conceived as the political-financial pillar that complements and amplifies the impact of the EDF and the European Defence Industry Programme (EDIP), reinforcing the strategic coherence of Europe's action in the field of defence.

To operationalise this industrial ambition, the European Commission has deployed a regulatory architecture designed to sustain and expand the investment effort initiated under the EDF. The **European Defence Industry Programme (EDIP)** is configured as the main transition tool and the operational pillar of the European Defence Industrial Strategy (EDIS), with a budget of €1,500 million until 2027. Unlike the EDF, which focuses on research and development, the EDIP expands its scope towards industrial production, joint capability procurement and the

[22] PESCO Projects Overview – European External Action Service (2025).

[23] White Paper for European Defence – Readiness 2030, European Commission (2025).

strengthening of supply-chain resilience, and also includes measures to facilitate the integration of the Ukrainian defence industry into the European ecosystem.

Alongside this industrial instrument, the Commission has launched cross-cutting initiatives such as the **Strategic Technologies for Europe Platform (STEP)**, aimed at fostering investment in critical technologies with both civilian and defence applications. These measures are complemented by proposals to make the European fiscal framework more flexible regarding defence expenditure, as well as by the development of new financial instruments to boost joint industrial investment in this field.

Finally, as a key element for the period beyond 2027, the future **European Competitiveness Fund (ECF)** is emerging as an essential instrument to reinforce support for strategic technologies, including defence, space and dual-use domains, through more integrated and accessible financing. The ECF will simplify access to EU funds through a "one-stop shop", bringing together programmes that are currently dispersed and accelerating the transition from research to industrial scale. It will complement the EDF and the EDIP by providing the critical mass needed to develop key capabilities, strengthen supply chains and enhance the competitive position of European industry, thereby opening up new opportunities for the participation of the Spanish DTIB in large-scale projects.

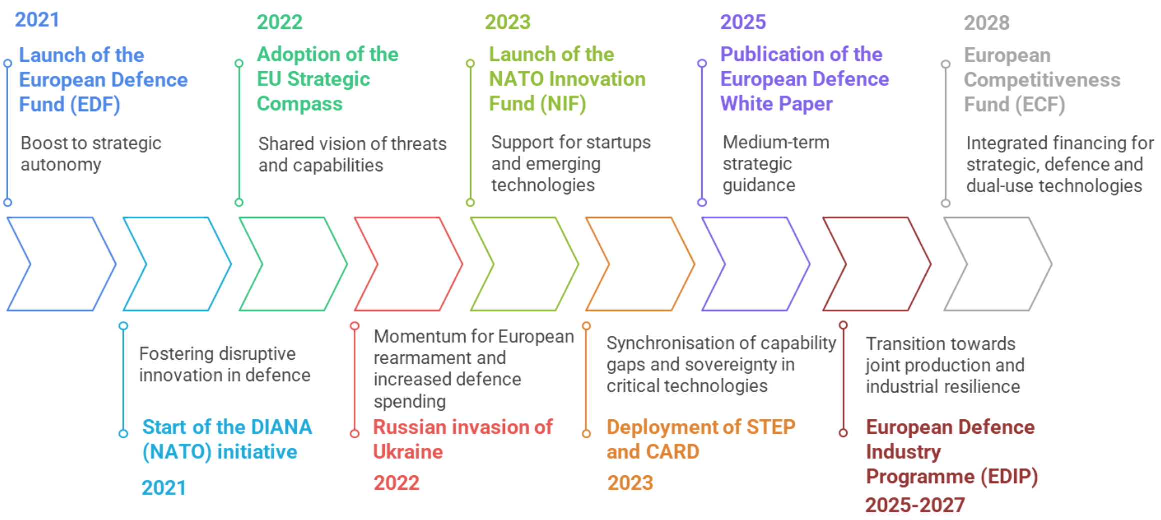

Figure 8. Key milestones in the European and NATO defence strategies

The **European Defence Agency (EDA)** also plays an essential role as a technical, regulatory and strategic catalyst for European defence cooperation. The EDA supports Member States in identifying capability shortfalls, harmonising requirements and assessing emerging technologies. One of its main tools is the CapTechs (Capability Technology Groups), permanent technical-operational structures that bring together national, industrial and academic experts across more than 20 technological and capability domains, including land combat systems, electronic warfare, cyber defence, advanced materials and artificial intelligence[24]. The CapTechs

[24] European Defence Agency (EDA), Capability Technology Groups (CapTechs) – https://eda.europa.eu.

constitute a knowledge community that enables the anticipation of trends, the sharing of developments and the coordination of cooperative R&D programmes.

Complementing this, the EDA leads the Coordinated Annual Review on Defence (CARD), a periodic process that provides a comprehensive overview of the defence capability landscape of the Member States. CARD identifies critical gaps, areas of redundancy and concrete opportunities for cooperation, and is a key instrument for coherently guiding national investments, PESCO cooperation projects and EDF priorities. Its objective is to reduce fragmentation, foster strategic convergence among countries and strengthen the collective efficiency of Europe's defence effort.

In addition, the EDA is responsible for the development of the Capability Development Plan, which constitutes the strategic roadmap for military capability development at European level, identifying priorities and guiding both national and cooperative investments. The Agency also drives the Overarching Strategic Research Agenda (OSRA), which defines medium- and long-term research and technological-development priorities in defence, aligning Member States' efforts and facilitating the coordination of collaborative projects in the field of disruptive innovation.

In the area of disruptive innovation, the EDA works jointly with the European Commission on initiatives such as the **Hub for EU Defence Innovation (HEDI)** and the **European Defence Innovation Scheme (EUDIS)**. HEDI acts as a European platform to foster a culture of defence innovation, connect civilian and military stakeholders, and facilitate the exchange of best practices and emerging technological solutions[25]. Through workshops, innovation catalogues and thematic communities, HEDI seeks to accelerate the transfer of technology into the defence sector. For its part, EUDIS provides dedicated financial support to startups, scale-ups and innovative SMEs, including seed capital, pilot grants and co-investment mechanisms, with the aim of fostering the emergence of disruptive technologies applicable to military scenarios[26-27]. Both initiatives are aligned with the objective of strengthening Europe's technological resilience and ensuring its strategic competitiveness in relation to other global actors.

International cooperation also extends to bilateral and multilateral formats in which Spain participates actively, particularly in European initiatives aimed at the joint development of major platforms and weapon systems, programmes that require high levels of technical complexity, multinational coordination and a long-term strategic vision.

Within NATO, the transformation of the security environment has led to a renewed emphasis on technological innovation as a fundamental pillar of collective defence. In the face of

[25] European Defence Agency (EDA), Hub for EU Defence Innovation (HEDI) – https://eda.europa.eu/what-we-do/activities/activities-search/hedi.

[26] European Commission, European Defence Innovation Scheme (EUDIS) – https://defence-industry-space.ec.europa.eu.

[27] The EDA's OPEX (Operational Experimentation) initiatives are operational experimentation campaigns launched under the umbrella of HEDI, which coordinates real-world testing of emerging technologies—such as unmanned systems—in simulated military environments.

increasingly hybrid, diffuse and technologically sophisticated threats, NATO has underscored the need to integrate Emerging and Disruptive Technologies (EDTs) at all levels of military planning and operations. These technologies are regarded as essential to maintaining the Allies' technological edge and ensuring interoperability among Allied forces[28]. In this context, cooperation in R&D&I within the Atlantic Alliance is structured through several key initiatives.

Among the most prominent initiatives are the **Defence Innovation Accelerator for the North Atlantic (DIANA)** and the **NATO Innovation Fund (NIF)**. DIANA is a transatlantic network of test centres and accelerators that connects civilian innovators with military needs, enabling the validation, adaptation and scaling of dual-use technologies in fields such as autonomy, advanced energy, electronic warfare and the protection of critical infrastructure[29]. The NIF, for its part, is a venture capital fund with €1,000 million committed by 24 Allied nations to invest in strategic technology startups[30]. Its objective is to support solutions that address key security and defence challenges, while also promoting Allied technological sovereignty in sensitive sectors.

Within a broader framework of complementary initiatives aimed at engaging industry in emerging thematic areas with disruptive potential, the **Transatlantic Quantum Community (TQC)** stands out. This platform seeks to foster cooperation among NATO Allies in the field of quantum technologies, facilitating research, development and the exploration of defence applications. The TQC focuses on creating a transatlantic ecosystem that brings together universities, research centres, deep-tech companies and governments to accelerate the maturation and adoption of these critical technologies.

Additionally, Allied Command Transformation (ACT) plays a crucial role in identifying future operational needs and promoting innovation within NATO. Its Innovation Hub[31] initiative acts as a hub connecting NATO with industry, academia and entrepreneurs, facilitating experimentation, prototype development and the adoption of new technologies within the Alliance.

Likewise, the **NATO Science and Technology Organization (STO)** constitutes one of the world's leading networks for scientific and technical cooperation in the military domain. Through its panels and technical groups, the STO promotes forward-looking studies, joint experimentation and the development of innovative operational concepts[32]. Its work is essential for anticipating the evolution of the technological environment and guiding R&D investment towards capabilities that are relevant to the Allies' future operational needs.

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[28] NATO (2021), Emerging and Disruptive Technologies (EDTs) Strategy.

[29] In Spain, there is a DIANA technology accelerator, managed by the National Cybersecurity Institute (INCIBE) and the Technical University of Madrid (UPM), with offices in León and Madrid. It also includes several test centres focused on specific technological domains.

[30] NATO Innovation Fund – https://www.natoinnovationfund.eu.

[31] NATO Innovation Hub – https://www.act.nato.int/activities/innovation-hub.

[32] NATO STO – Science and Technology Organization – https://www.sto.nato.int.

In light of this landscape of complementary initiatives, it is important to highlight that international cooperation in defence not only strengthens deterrence and response capacity but also drives shared innovation, industrial integration and the development of a common technological base, fundamental pillars for building a more secure, autonomous and future-ready Europe. However, this ambition for more integrated and collaborative defence also brings with it a set of cross-cutting challenges for R&D&I.

An initial persistent challenge is achieving interoperability that goes beyond mere technical connectivity. Effectiveness in multinational and multidomain environments, such as those in which the EU and NATO operate, requires R&D&I to address interoperability as a multilevel objective, promoting research into open architectures, common standards and technological solutions that enable agile, almost plug-and-play integration not only between systems, but also among organisations and personnel from different Allied nations.

In parallel, the growing ambition of programmes such as the EDF or PESCO entails the management of highly complex collaborative risks. These projects are exposed to technical, financial, programme-related and geopolitical uncertainties that multiply depending on the number of partners involved. A robust R&D&I strategy must therefore incorporate frameworks for the joint identification, assessment and mitigation of these risks. This implies developing methodologies and tools that enable the various actors—governments, industry, R&D&I centres and universities—to share risk analyses transparently and establish coordinated contingency plans, turning risk management into a collaborative capability in its own right.

This complexity in the cooperation domain extends to the management of the intellectual and industrial property (IP) generated. Flexible, predefined IP models are needed, models that balance the protection of industry's commercial interests with states' needs for access and sovereignty in defence applications. The goal is to create a trust-based environment that protects sensitive innovation, facilitates the technological transfer required to sustain capabilities, and promotes knowledge reuse to strengthen the European Defence Technological and Industrial Base as a whole.

The Ministry of Defence

The Ministry of Defence has several organisations with differentiated roles in the field of defence R&D&I[33]. At the top of this structure, assuming leadership functions, is the State Secretariat for Defence, which is responsible for planning, promoting and managing policies in innovation and technological development in the sector. Within this organisation, the Directorate-General for Strategy and Innovation of the Defence Industry (DIGEID) is the governing body tasked with planning, developing and overseeing the implementation of these policies, which it carries out through the Deputy Directorate-General for Planning, Technology and Innovation (SDG PLATIN).

The DIGEID was created in 2024 in response to the need to strengthen Spain's strategic autonomy in the field of defence by boosting its technological and industrial capabilities. This directorate leads the strategic vision, planning and industrial policy for defence, integrating

[33] Royal Decree 205/2024 of 27 February, which implements the basic organisational structure of the Ministry of Defence.

innovation and technological development to enhance the country's competitiveness and leadership on the international stage.

In addition, the Ministry of Defence has various bodies dedicated to research and to the execution of R&D&I projects. In some cases, this activity constitutes their primary purpose, while in others it is carried out as a function complementary to their core mission. Among these, the National Institute for Aerospace Technology "Esteban Terradas" (INTA) stands out—an autonomous body attached to the State Secretariat for Defence. As a public research organisation, INTA conducts scientific and technical research activities of a dual-use nature and provides technological services. Its main areas of activity include aerospace technology, aeronautics, hydrodynamics, and defence and security technologies.

Of particular note is the recent creation in Jaén of the Technological Centre for Development and Experimentation (CETEDEX), attached to INTA, which is set to become a cutting-edge R&D&I centre specialising in dual-use technologies for development, testing and certification, based on its three pillars: counter-drone; autonomous and connected vehicles; and artificial intelligence. The counter-drone pillar will comprise a complete system with detection and neutralisation capabilities, a controlled radiation zone, and a flight and sensor-installation range. The second pillar will focus on intelligent vehicles, with testing and certification capabilities for advanced driver-assistance systems, covering military, industrial and agricultural vehicles, and will include a high-speed track, an urban area and a dual-lane interurban track equipped with 5G infrastructure. Finally, the artificial-intelligence pillar will conduct automated analysis of large volumes of data, develop technologies for predictive maintenance of defence platforms, perform multi-source information analysis for decision support, and employ biometric-technology applications.

In the field of education and research, the Defence University Centres (CUDs)[34] constitute an important asset. While their primary purpose is to deliver undergraduate degree programmes, they also assume the definition and development of research lines of interest to the Armed Forces. This work is carried out in collaboration with other public education and research entities and organisations, always within the framework of security, peace and defence, thereby contributing to the generation of knowledge and talent in strategic areas.

The cross-cutting nature of R&D&I within the Ministry requires close coordination with other directorate-level bodies responsible for policies that may require or drive R&D&I initiatives. This coordination is led by the DIGEID. For example, with regard to infrastructure, collaboration with the Directorate-General for Infrastructure (DIGENIN) is essential, while in the field of Information and Communications Systems/Information and Communications Technologies (ICS/ICT), coordination is established with the Centre for Information and Communications Systems and Technologies (CESTIC). In both cases, this collaboration is governed by the applicable sectoral policies and by the guidelines of the Ministry's R&D&I Policy, with the aim of focusing efforts on technological challenges relevant to defence and avoiding duplication with R&D&I for civilian purposes. Additionally, the Directorate-General for Armament and Materiel (DGAM) works closely with the DIGEID to integrate, at the design stage of the acquisition process, the engineering, R&D&I pilot projects and prototypes required for armament and

[34] Created by Royal Decree 1723/2008 of 24 October, in accordance with the provisions of the Military Career Law.

materiel programmes. As a strategic actor in the defence R&D&I ecosystem, the DGAM translates operational needs into technological requirements, defines specifications and coordinates developments applied to the acquisition and modernisation of weapon systems and equipment. This work strengthens the operational capabilities of the Armed Forces and enhances the national technological and industrial base.

Finally, the entire structure of the Ministry of Defence, and notably the Armed Forces through the Defence Staff (EMAD), plays a crucial role as the originator of military capability needs and as the end user of R&D&I outcomes. Its ability to define real operational requirements and validate technological solutions brings significant value to projects, ensuring their relevance and facilitating their potential adoption.

The Ministry of Defence plays a key role in driving technology in support of its missions and operational capabilities, which requires optimising the processes for planning, procurement and management of R&D&I projects, as well as the evaluation and exploitation of their results. This will enable more effective use of available funding and maximise the impact of investment in innovation. It is also essential to strengthen and adapt the support instruments for the development of new technological solutions to each stage of maturity and to the accelerated pace of scientific progress. In particular, to respond to the emergence of technologies with disruptive potential, it is necessary to reinforce the mechanisms that support technology-based innovation in defence, understood as a strategic function that enables capability foresight, addresses emerging challenges and consolidates national technological sovereignty. To this end, a **comprehensive innovation framework** is proposed, following three complementary perspectives that guide the design and evolution of the instruments:

- An internal perspective, aimed at fostering innovative initiative within the Ministry of Defence itself, enabling personnel to identify unmet needs and propose technological solutions. The goal is to consolidate effective channels to capture these ideas, validate them in representative environments and encourage experimentation under conditions close to real use.
- A perspective focused on the technological and industrial ecosystem, promoting collaboration with companies—especially SMEs and startups—technology centres and universities, with the aim of adapting innovative solutions to the defence environment. This perspective requires accessible, transparent instruments suited to different levels of technological maturity, capable of attracting new actors and consolidating key capabilities.
- A national and international perspective, designed to integrate and leverage initiatives promoted by other public bodies, national R&D&I programmes, and European and Allied multilateral mechanisms[35]. Active participation in instruments such as the EDF, NATO

[35] The various ongoing initiatives should not be interpreted as independent actions but rather as complementary elements of a European defence-innovation ecosystem. Platforms such as DIANA and EUDIS facilitate the entry of technology-driven startups and SMEs into the defence sector, particularly at lower TRL levels, providing access to accelerators, mentoring networks and early-stage experimentation environments. The Operational Experimentation (OPEX) exercises of the EDA enable technologies to be validated and demonstrated in realistic operational scenarios, supporting the transition of innovative solutions towards concrete defence applications. Finally, the NATO Innovation Fund (NIF) acts as a financial vehicle to drive the scaling and consolidation of the most promising startups, facilitating their access to the investment required to reach the market. This entire pathway is accompanied by the active support of the Ministry of Defence, which participates in and backs these initiatives, ensuring that national talent and

innovation initiatives and national calls will be essential to broaden the scope and strategic return of actions.

In short, the efficient and coordinated management of the Ministry of Defence's resources and capabilities is essential to optimise the budget allocated to R&D&I. This requires aligning actions with the mechanisms available under the state and regional plans derived from the EECTI, fostering national cooperation, and exploring opportunities for European and international collaboration, while always ensuring the protection and development of Spain's strategic technological capabilities. This approach represents an increasingly demanding challenge for those responsible for planning, programming and overseeing the implementation of the Ministry's R&D&I Policy.

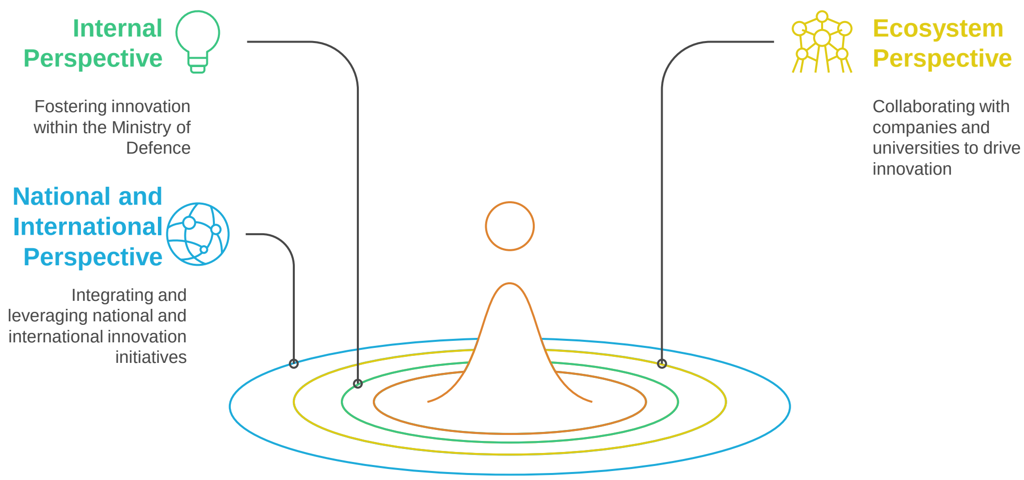

Figure 9. Defence innovation perspectives

Summary

The analysis of the current context and the main trends in defence R&D&I allows us to draw a set of strategic conclusions that should guide the Ministry of Defence's action in the coming years:

- **A geopolitical environment of increasing complexity**, in which the need for a robust and resilient DTIB has been reinforced—one capable of delivering innovative solutions to new challenges and threats. This requires **significant investment commitment** at both national and European level to ensure technological sovereignty and strategic security.
- **Rapid technological progress and the emergence of disruptive technologies**, which have the potential to transform the defence sector. The ability to adapt and anticipate will be essential to maintain operational advantage in constantly evolving scenarios.
- **A national ecosystem of organisations responsible for financing civil R&D&I**, which can act as a key driver to strengthen the national technological and industrial fabric by leveraging dual-use technologies and fostering synergies between the civil and defence sectors.

innovation have real opportunities to mature and deploy their capabilities in the defence sector—from the earliest stages to full operational integration.

- **A European and transatlantic context offering extensive opportunities for development and internationalisation**, enabling entities from the national DTIB to take part in international cooperation initiatives and access new markets and technological-development programmes.
- **The Ministry of Defence is a key actor in technological management**, which must adapt its processes and instruments to respond with greater agility and leadership to the demands of the new context. Its central role in promoting and developing defence-related technology requires a dynamic and efficient strategy that maximises the impact of investment in R&D&I.

This characterisation of the environment forms the starting point for structuring the ETID: a strategy that must anticipate future challenges, reduce critical technological dependencies and ensure that the Armed Forces have the capabilities required to carry out their missions.

3. Guidelines and Actions

The present Strategy incorporates the challenges and opportunities described in the previous chapter and sets out a series of technological and managerial actions to achieve the objectives of the R&D&I Policy, in accordance with the following guidelines, which give rise to the three pillars of the ETID:

- **TECHNOLOGICAL OBJECTIVES PILLAR: The R&D&I activities promoted by the Ministry shall be guided by technological objectives**, ensuring that efforts are focused on technological areas with high impact on the improvement of current and future military capabilities, while optimising the use of available funding.
- **COOPERATION PILLAR: Technological cooperation at both national and international level will be an essential component of defence R&D&I activities**, enabling the exploitation of advances in dual-use R&D&I and generating multiplier effects, as well as addressing high-cost and high-complexity technological challenges, thereby contributing to the development and internationalisation of the DTIB.
- **CONTINUOUS IMPROVEMENT PILLAR: The pursuit of excellence within the Ministry, through the continuous improvement of processes associated with defence R&D&I**, so that they act as catalysts for technological progress in the Armed Forces and for the technological development of the defence sector.

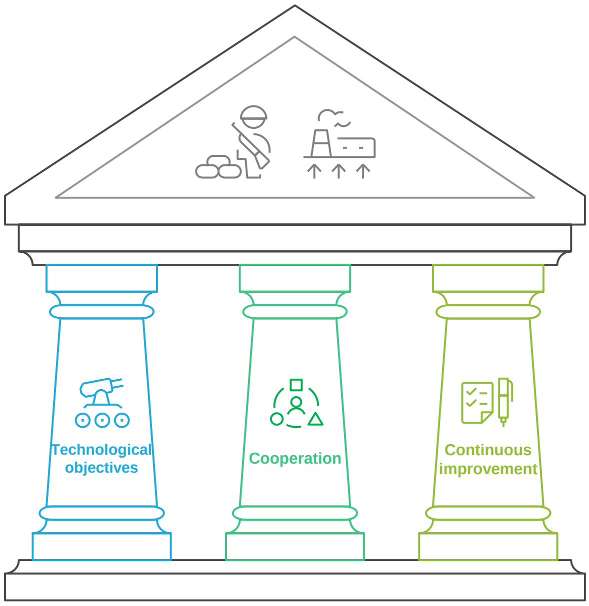

Figure 10. Pillars for the development of the Defence R&D&I Policy

The actions within each pillar have been defined based on the combined analysis of **four key dimensions** for the development of the defence sector: military capabilities; technology; the technological capabilities of the DTIB; and the strategic constraints affecting defence R&D&I.

The **military capabilities dimension** is grounded in the documents approved in the defence planning process, prepared by the Defence Staff, as well as in the specific visions developed by the Army, the Navy and the Air and Space Force. These documents provide a solid foundation for identifying the operational needs that should guide technological and innovation efforts.

The **technological dimension** is based on analysing the expected evolution of both established and emerging technologies, and on assessing their potential application to the processes, systems and functions that shape military capabilities. This approach enables the anticipation of trends and helps direct efforts towards the technologies with the greatest strategic impact.

The analysis of the **technological capabilities of the DTIB**, which significantly influences how each priority is approached, has relied on information derived from technology-watch activities and other internal knowledge sources within the Ministry. Notably, this dimension draws on the **EID**, which guides both the Government and companies in relation to CIEDs.

Finally, a set of **strategic constraints** relevant to defence R&D&I has been considered. These include the need to reduce technological dependencies in order to advance towards technological sovereignty that guarantees strategic autonomy; the dual-use potential of technology, which facilitates synergies with the civil sector, optimises resources and accelerates innovation processes; and the technical complexity and high economic cost associated with the development of certain technologies and infrastructures, factors that make national and international cooperation essential for sharing efforts and ensuring access to critical capabilities.

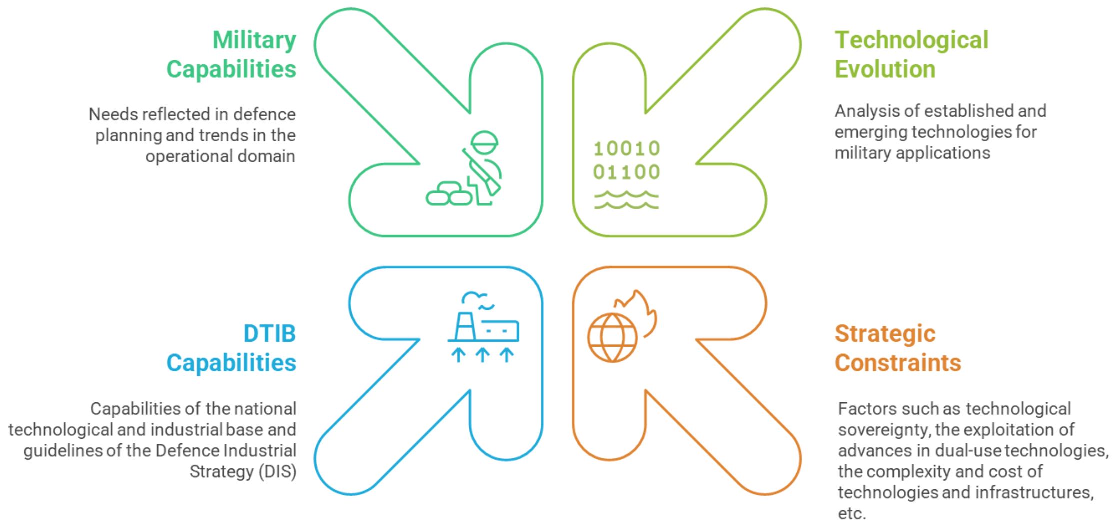

Figure 11. Dimensions for the strategic analysis

A five-year implementation horizon for the Strategy has been established, running until 2030. This timeframe is considered appropriate for launching and consolidating the main planned actions, as well as for assessing the progress achieved. It is recognised, however, that longer time horizons may require a thorough review of the Strategy, given the pace of change in both the technological landscape and the broader security and defence context.

Technological Objectives Pillar

The Ministry of Defence plans to promote or support the development of technological actions focused on the technological priorities of this Strategy, which are expressed through two complementary levels.

At a first level, the Strategy provides a comprehensive vision of the main technological interests of defence through a set of **R&D&I lines of interest to defence**. These lines are directed towards applying the latest technological advances to systems and subsystems designed for defence use, so as to enhance their functionalities or create new possibilities for their operational employment. The definition of this concept is consistent with the applied and mission-oriented nature of defence R&D&I, in the sense that technology is not considered an end in itself but rather a means to improve military capabilities.

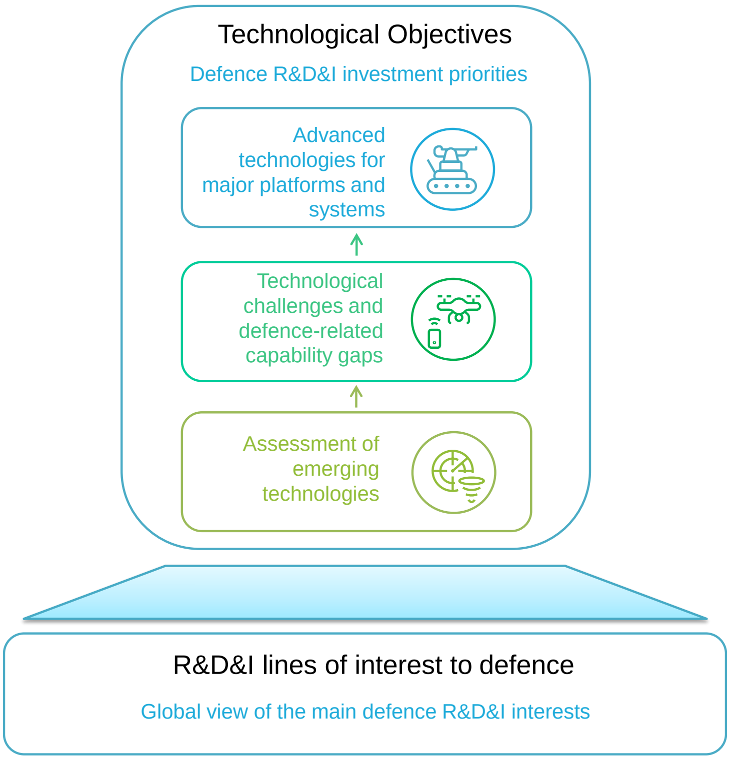

Figure 12. R&D&I lines and technological objectives

At a second level, these R&D&I lines are prioritised and grouped together, as they are considered to be **technological objectives** upon which the Ministry's R&D&I activities should be focused. This prioritisation concentrates efforts in those areas with the greatest impact on military capabilities, whilst also ensuring consistency with the Ministry's funding and management possibilities and the technological development of the DTIB.

The technological objectives of this Strategy are structured on three levels, depending on the scale and characteristics of the systems and technologies involved and on the type of actions foreseen to achieve them. The scope and purpose of these three levels, as well as the objectives they include, which are described in greater detail in Annex B, are outlined below:

A. **Development of advanced technologies for future major platforms and weapon systems**.

This level comprises a single objective that brings together a set of programmes aimed at enabling the development and integration of advanced technologies into the Armed Forces' future major platforms and weapon systems across the land, naval, and air and space domains. These technologies are aligned with needs defined in the Military Capability Objective (OCM) and the Long-Term Force Objective (OFLP), and act as a driving force for the technological development of the DTIB, as well as a catalyst for the creation of highly skilled employment in strategic sectors.

Given the increasing complexity of the operational environment and the evolution of threats to which the Armed Forces must respond, it is essential to field major weapon systems equipped with advanced technologies. Their development requires a high degree of technical complexity and a sustained investment effort, making it imperative to anticipate critical capabilities through specific technology programmes. These programmes make it possible to address, in good time, the maturation of key technologies through demonstrators that validate their feasibility, level of development and potential for integration into end systems, thereby reducing the associated technical and programme risks.

At European level, collaborative projects are being promoted under the EDF and other multinational initiatives to develop next-generation platforms and weapon systems across all domains. Notable among these are air system-of-systems architectures, which integrate manned and unmanned aircraft within collaborative combat concepts; new designs for modular land platforms, with demanding requirements for protection, systems integration and mobility; and next-generation naval platforms oriented towards network-centred warfare, interoperability and the integration of unmanned systems for operations in coastal and oceanic environments. Additionally, the programme addresses European secure communications systems, which are essential for ensuring resilient connectivity in multidomain scenarios, as well as defence capabilities against hypersonic threats, including advanced sensors, interceptors and early warning architectures.

At national level, several technology programmes have been launched in recent years to reduce the technological risks associated with future platforms and major systems in all operational domains. This is also the case for various projects linked to the Special Modernisation Programmes (PEM), which are being rolled out under the *Industrial and Technological Plan for Security and Defence*.

These flagship programmes, both national and international, represent a strategic opportunity to develop and consolidate key technological capabilities. In this context, the Ministry of Defence will promote the preparation of Industrial Participation Schemes[36] associated with each programme. These plans will set out the national industrial organisation based on existing capabilities and will define the technologies that must be developed to ensure relevant and sustainable national participation across the full life cycle of these systems.

[36] As set out in the EID 2023.

B. **Development of technologies for the main defence-related challenges and technological gaps.**

At this intermediate level, a set of technological objectives of very diverse nature is established, aimed at addressing the main challenges present in the most complex operational scenarios faced by the Armed Forces. In addition, the intention is to leverage current technological advances to develop innovative solutions in the defence domain.

These objectives are oriented towards a wide variety of systems and subsystems, with a broader and more diverse focus than in the previous level. In general, these are technological developments of a smaller scale than those included in major programmes, although in many cases they lay the groundwork for the DTIB to participate in larger-scale national and international initiatives. Such participation is aligned with the technological level that Spain is expected to achieve at national scale.

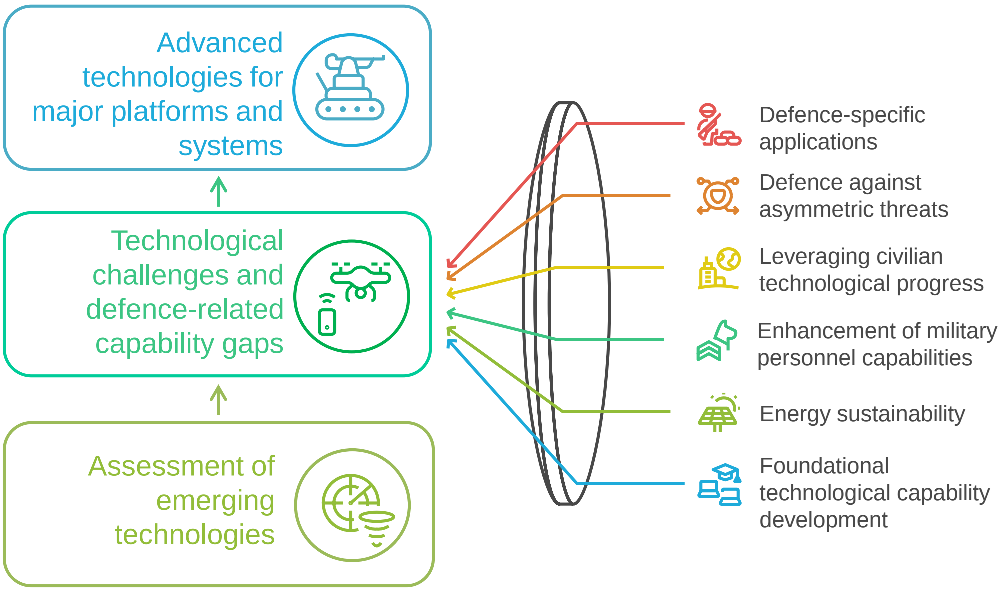

Figure 13. Technological objectives

The selection of these objectives responds to various strategic motivations, organised into the following categories:

1. **Defence applications with high technological requirements.**

   Focused on strengthening military applications that require technologies with more stringent requirements than those used in the civil sphere. As the latter does not require this type of technology, investment by the Ministry of Defence is necessary. Nonetheless, these innovations may, in the future, generate benefits for the civil sector as well.

2. **Defence against asymmetric threats.**

   Development of technological solutions aimed at protecting military personnel in operations and the population against non-conventional threats.

3. **Leveraging advances in civilian technology.**

   Incorporation of technologies developed in the civil sphere that may have disruptive applications in defence, generating new opportunities and transforming operational concepts.

4. **Enhancement of military personnel capabilities.**

   Development of technologies aimed at optimising training, performance and the effectiveness of personnel in missions, thereby increasing their operational capabilities.

5. **Energy sustainability.**

   Implementation of technologies that reduce the environmental impact of military operations and contribute to the UN Sustainable Development Goals (SDGs) and the fight against climate change.

6. **Foundational national technological capability development.**

   Support for the DTIB in developing capabilities in high-potential defence technologies, particularly those that are costly and have limited national presence. The objective is to strengthen the ability of national entities to respond to future sector demands and facilitate their participation in international cooperation projects.

Each of these categories encompasses a set of specific technological objectives, a detailed description of which can be found in Annex B. It is important to note that the financial investment associated with each objective will vary according to factors such as technological maturity and the potential for dual-use (civilian and military) applications.

It should also be highlighted that each of these technological objectives is accompanied by specific development plans that set achievable levels of ambition for the duration of the Strategy. These plans will define a set of R&D&I actions that will often combine the development of prototypes close to operational use with the development of technological demonstrators that strengthen the DTIB, together with other enabling actions for defence R&D&I. These actions may make use of instruments promoted by the Ministry of Defence or be carried out through national or international cooperation.

Specific action domain	Technological Objectives
Defence applications with high technological requirements	Advanced guidance and control technologies for munitions
	High-performance electronic technologies
	Electronic warfare solutions adapted to current and future electromagnetic environments
	Military communications in complex environments
	Tactical combat cloud for defence
	Technologies for robust PNT
	Technological solutions for cyber operations
Defence against asymmetric threats	Enhanced systems for remote detection of land-based IEDs
	Technologies for protection against unmanned maritime vehicle threats
	Technological solutions against low-altitude aerial threats
	CBRN threat control
Leveraging civilian technological progress	Application of artificial intelligence to defence
	Technologies to support the life-cycle management of military systems
	Improvement of defence industry production processes
	Unmanned ground platforms for defence missions
	Unmanned underwater and surface vehicles for defence missions
	UAS for defence missions
	Materials for application in platforms and for the dismounted soldier
	Innovative solutions for defence in the space domain
Enhancement of military personnel capabilities	Technologies for the dismounted soldier
	Advanced training and decision support through simulation
Energy sustainability	Energy generation, storage and efficiency in isolated bases and infrastructures
	New propulsion technologies for manned platforms and unmanned systems
Foundational national technological capability development	Technologies for the development of directed-energy and electromagnetic weapons
	Technologies for hypersonic vehicles
	Quantum technologies applied to defence

Table 4. Technological objectives focused on the main defence-related challenges and technological gaps

C. Monitoring of emerging technologies with future defence application.

This level focuses on the technology watch and analysis of emerging technologies with low technological maturity, whose future development could open new opportunities for defence R&D&I or generate disruptive changes that impact the sector.

Since these technologies are still in the early stages of research, mostly at the level of basic research, no specific investments are planned, except in cases where opportunities arise. Nevertheless, the Ministry of Defence will play a key role as a facilitator, acting as a link between the national research community and the opportunities that may emerge within the international defence organisations in which Spain participates. Likewise, the Ministry will seek to provide guidance to support the evolution of these technologies towards potential defence applications.

Actions under the Technological Objectives Pillar

In order to ensure consistency between investment in R&D&I and the technological priorities of the Ministry of Defence, the Strategy envisages, on the one hand, the active promotion of projects aimed at achieving the defined technological objectives, and, on the other, the periodic review of these objectives so they can be adapted to evolving operational needs, emerging technological developments and the capabilities of the DTIB, should significant changes arise in any of these areas. This dual line of action ensures a dynamic, focused and up-to-date framework to guide technological innovation activities in the defence sector.

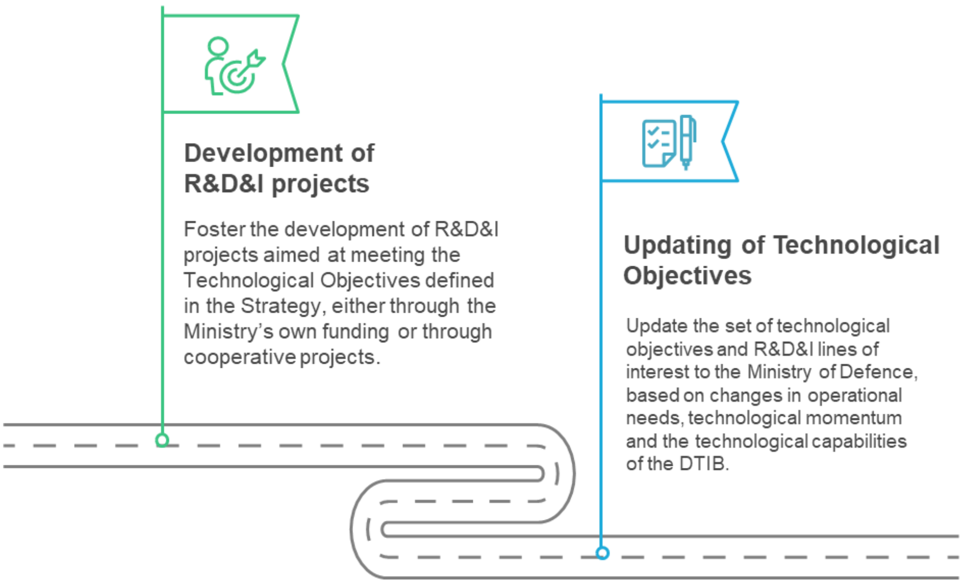

Figure 14. Actions under the Technological Objectives Pillar

Cooperation Pillar

This pillar aims to promote increasing levels of technological cooperation, both nationally and internationally, so that R&D&I efforts can be combined with those of other funding bodies for defence and dual-use R&D&I, with a view to achieving objectives of common interest

National Cooperation

The Ministry of Defence will promote greater R&D&I cooperation with the various organisations that make up the Spanish Science, Technology and Innovation System (SECTI), with the aim of strengthening the technological development of the country's industrial and scientific fabric in the field of dual-use technologies. This will allow these entities, in the future, to become providers of innovative solutions for the Armed Forces. The fact that the ETID constitutes the sectoral defence strategy within the EECTI facilitates the alignment of efforts with different state and regional bodies, to the benefit of the development of the national DTIB.

The development of this cooperation will be shaped by initiatives designed to increase support for the defence sector, in particular through the *Industrial and Technological Plan for Security and Defence*, which envisages investments by different bodies and entities using existing instruments, coordinated under a National Committee for Security and Technological Sovereignty. This Committee brings together the main sectoral ministries with responsibilities in defence, industry, digitalisation and technology, as well as those public agencies that operate or fund technological projects.

In addition, cooperation will be underpinned by general action protocols, whether existing or newly created, extended to collaboration with regions whose Smart Specialisation Strategies (S3) converge in terms of technological interests.

The Ministry's vision of this technological cooperation is summarised in Figure 15. It establishes that the funding of technologies at low TRLs, where civilian and military applications are not yet defined, will fall to the instruments of the PEICTI, with a more scientific focus. At this stage, the Ministry of Defence will act as an observer, analysing the potential impact of these developments in the defence domain.

As technologies evolve towards higher readiness levels and acquire more concrete applications, the model envisages that PEICTI instruments may continue to fund developments with a strong dual-use character. In parallel, the Ministry of Defence will focus its investments on leveraging and raising the maturity of those dual technological advances, adapting them to the specific requirements of the military domain through programmes such as COINCIDENTE, while also driving progress in niche areas of exclusively military application.

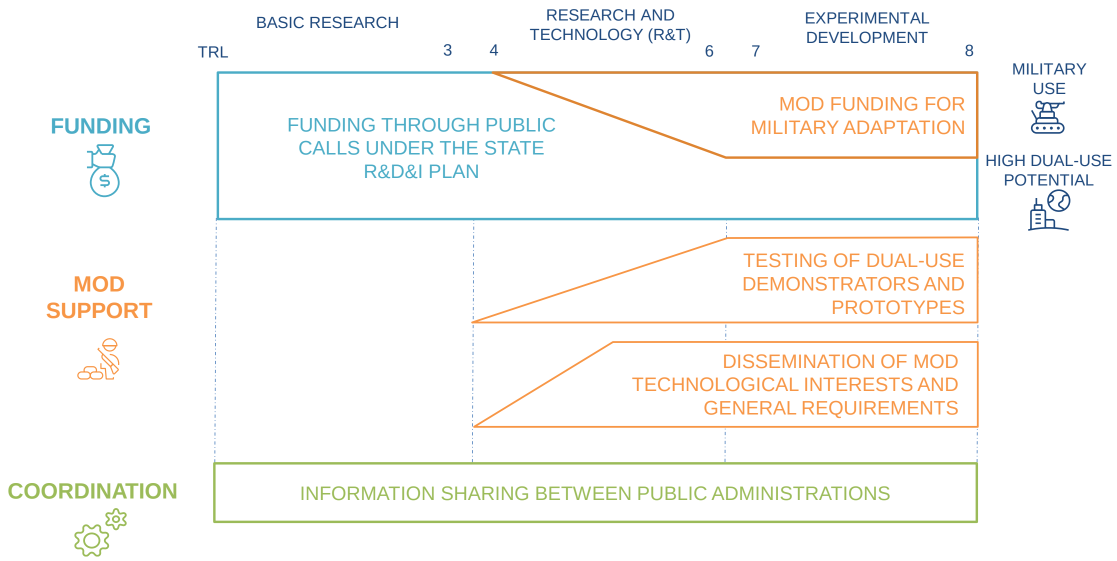

Figure 15. Ministry of Defence vision for national cooperation in R&D&I

Beyond funding, the Ministry of Defence has strategic resources that can facilitate the progression of these projects towards higher technology readiness levels and their eventual transition to the market. Among these resources, the Ministry's knowledge as the end user of the systems employed by the Armed Forces, its ability to identify long-term technological needs, and its capacity to conduct testing and experimentation in facilities and test ranges under conditions close to real operational use are particularly noteworthy. These factors provide significant added value to developments financed through external funds, which is why the Ministry remains committed to fostering these forms of support, generating benefits for all parties involved.

In this context, emphasis will be placed on the following actions:

- Supporting initiatives promoted by other ministries and funding agencies that manage instruments for the **development of dual-use R&D projects aligned with defence needs**, including Public Procurement of Innovative Solutions (PPI)[37] and other grant programmes, in order to ensure maximum usefulness and exploitation of results.
- Strengthening **regional cooperation in dual-use technologies**, to achieve greater alignment of regional R&D&I efforts with defence needs and expand the participation of regional entities in the defence sector and in European cooperation.
- **Enhancing coordination with existing national technology-based innovation ecosystems**, to ensure that their efforts translate into increased support for innovative entities working towards defence objectives.
- **Facilitating greater involvement of the national research community** in national and international defence initiatives focused on emerging technologies with disruptive potential.

[37] PPI is a strategic instrument for driving technological maturation in defence, thereby enabling innovation to progress from the laboratory to the operational market with a guaranteed customer base. Strengthening its use will encourage the DTIB to orient its R&D towards solutions aligned with the needs of the Armed Forces and will reinforce the national technological base and sovereignty.

International Cooperation

The Ministry of Defence will promote a more active and strategic participation of the national technological ecosystem in international defence R&D&I cooperation initiatives, with the aim of positioning Spain as a reference partner in the development of European and Allied capabilities. To this end, support tools for the internationalisation of companies, R&D&I centres and universities will be strengthened, facilitating their integration into collaborative projects within the European Union, NATO and other multilateral frameworks. This effort will help seize the potential of cooperation to access emerging technologies, share risks in the development of complex capabilities and strengthen both national and European strategic autonomy.

To achieve this, the following lines of action are envisaged:

- **Continue fostering active and coordinated participation in European programmes linked to the EDF, as well as in new European initiatives that build on it**, through active participation in the preparation of work programmes and by encouraging the submission of proposals led or co-led by national entities, with the involvement of SMEs, R&D&I centres and universities within international consortia.
- **Promote greater participation of national entities in the EDA's technological research activities**, supporting the direct involvement of national experts in CapTechs, the alignment of national R&D agendas with EDA strategic agendas, and the execution of new projects complementary to those addressed nationally and under the EDF.
- **Strengthen technological, disruptive innovation through international cooperation**, supporting national startups, scale-ups and SMEs with potential to contribute to HEDI, EUDIS, DIANA and NIF projects, which facilitate access to environments for experimentation, investment and technological scaling within the Allied context.
- **Promote greater engagement with European and NATO knowledge networks**, particularly through the STO or initiatives such as the Transatlantic Quantum Community (TQC), as a means of positioning the national scientific and technological community within high-level cooperation networks.
- **Consolidate strategic multilateral cooperation frameworks built upon major future platform and systems development programmes**, prioritising those that guarantee industrial returns and increase the degree of shared technological sovereignty.

These actions will enable Spain to fully leverage the opportunities offered by international cooperation, accelerate the technological maturation of the national ecosystem and contribute to the development of a more resilient, integrated and competitive DTIB.

Actions under the Cooperation Pillar

The Cooperation Pillar promotes coordinated action at both national and international level in order to maximise the impact of the defence technological ecosystem. At national level, collaboration will be strengthened with funding bodies responsible for dual-use R&D&I, particularly at regional level and within innovation ecosystems, facilitating the involvement of the research community in initiatives linked to defence needs.

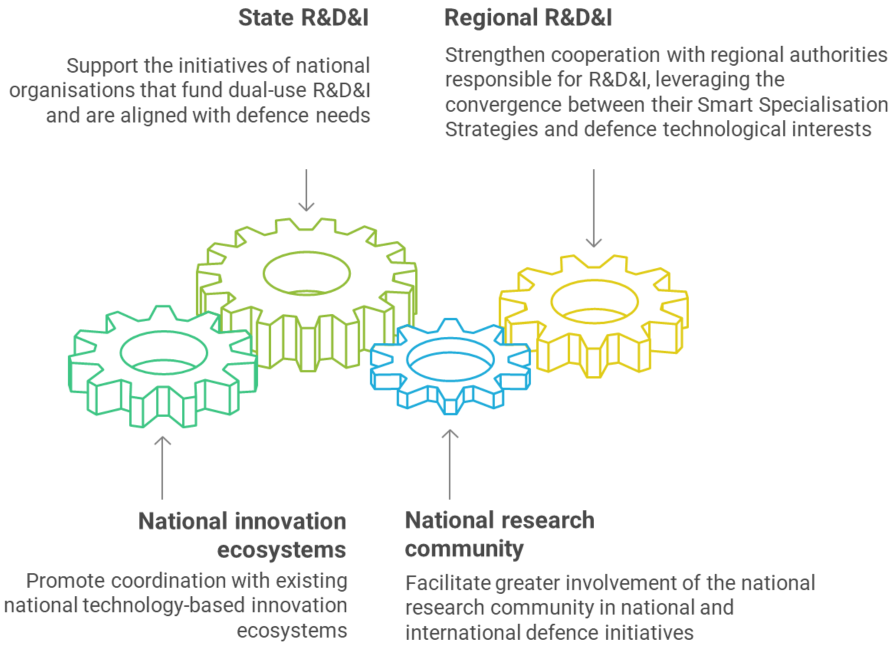

Figure 16. National-level initiatives under the Cooperation Pillar

At international level, a more active and strategic participation will be promoted in European programmes, especially in the EDF and other emerging initiatives. The involvement of national entities in the EDA's technological activities, in disruptive innovation within the NATO and European frameworks, and in the consolidation of multilateral frameworks for flagship capability and major-platform programmes will also be encouraged.

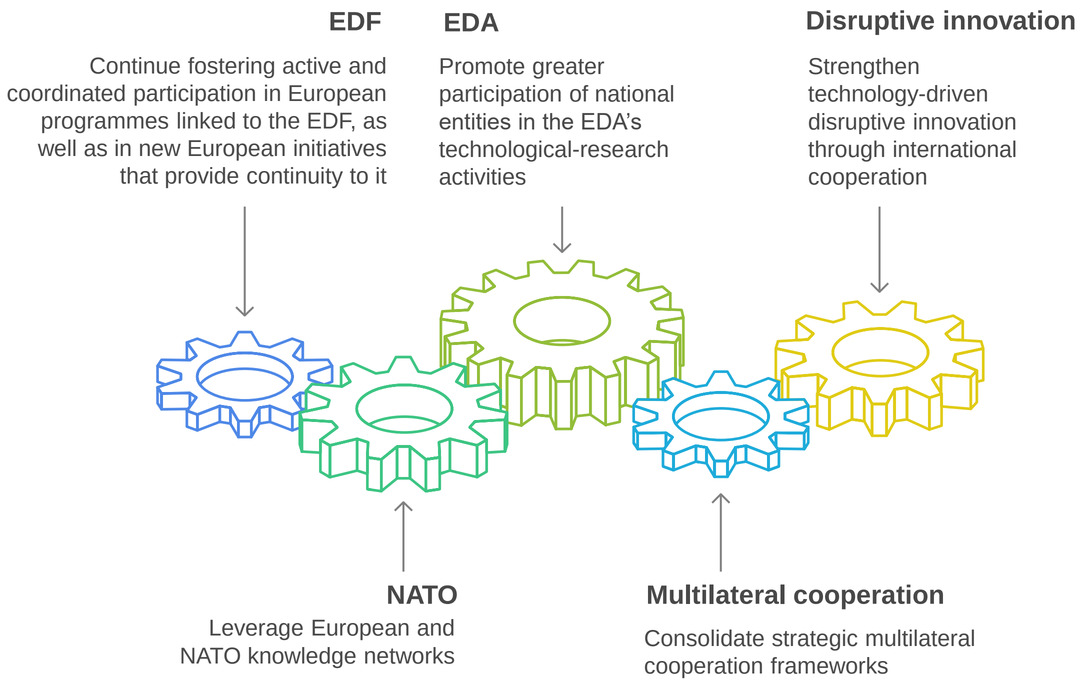

Figure 17. International-level initiatives under the Cooperation Pillar

Continuous Improvement Pillar

The Ministry of Defence plays a central role in driving R&D&I in the defence domain through the various functions performed by its organisational bodies. To maximise its impact, constant evolution is required, both in its internal organisation and in the processes and instruments through which innovation is promoted, all supported by adequate funding and specialised human resources. Continuous improvement must not only ensure greater internal efficiency but also reinforce the Ministry's role as a catalyst for technological innovation, in close collaboration with other actors within the national and international ecosystem.

Processes and Instruments

Over the next five years, the Strategy will focus its efforts on comprehensively transforming the R&D&I management processes that enable innovation, with the objective of better supporting the entire life cycle of technological solutions, from the identification of needs to their validation and operational adoption.

Additionally, emphasis will be placed on enhancing and expanding the available instruments, which act as operational levers for translating strategic priorities into concrete actions. These instruments, grouped into three major categories according to their purpose (development of technological solutions; support for R&D&I cooperation; and management of technological knowledge), each fulfil specific functions but must be structured in a more integrated and adaptive manner to respond to the challenges of the current technological and operational environment.

Finally, technological cooperation with other national and international actors and organisations, as well as strengthened links with the DTIB, will be central aspects on which this pillar will place particular emphasis.

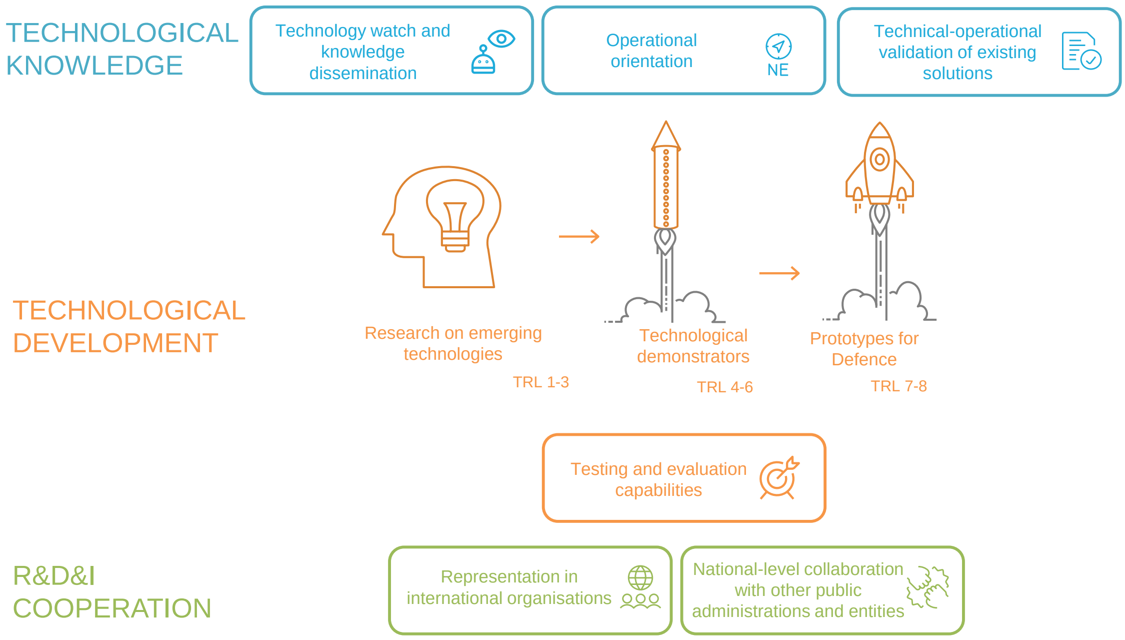

Figure 18. Instruments in support of R&D&I

To this end, action will be organised into four priority areas:

1. Review of R&D&I project life-cycle processes

A **systematic review of the processes** related to the planning and programming, procurement, monitoring and evaluation of R&D&I initiatives will be promoted, incorporating more agile methodologies and tools aimed at reducing administrative timelines and increasing adaptability and rapid response capacity in the face of changing operational and technological environments, as well as evolving funding scenarios.

At the same time, **internal coordination mechanisms** among the different Directorates-General, technical bodies and end users within the Ministry of Defence will be strengthened. This effort seeks to achieve closer alignment of R&D&I activities with the Armed Forces' priority operational needs and other challenges faced by the Ministry of Defence, facilitating greater involvement of personnel in key project phases, while ensuring more effective use of the knowledge generated and the results obtained.

2. Strengthening instruments to stimulate defence innovation and technology maturation

The dynamic nature of the technological environment and the accelerated emergence of disruptive capabilities require more adaptive instruments, capable of addressing both the full range of technological readiness levels, from low TRLs to pre-commercial stages, and the diversity of actors that make up the national DTIB.

Within this framework, instruments targeting the **early stages of the innovation cycle** will be reinforced, with the aim of identifying, exploring and guiding emerging and disruptive technologies with potential defence applications. The COINCIDENTE Programme will be leveraged as an agile vehicle for technology exploration, through open thematic calls designed to facilitate the participation of a broad spectrum of innovative entities, including SMEs, universities and R&D&I centres. In parallel, new support mechanisms will be promoted to surface innovative ideas originating within the Ministry itself, as well as to facilitate the entry of new actors into the defence innovation ecosystem.

To ensure continuity for technologies with the greatest potential, **technology maturation mechanisms** will also be strengthened through schemes that allow developments to be supported beyond their initial phases and to overcome the well-known "valleys of death".

These efforts will be complemented by the consolidation of **technical-operational experimentation campaigns**, enabling the validation of solutions in environments representative of military use and facilitating their transition from the civil to the military domain.

The technology maturation process will also be underpinned by the systematisation of **technical validation** procedures and the reinforcement of national testing and demonstration infrastructures, leveraging advanced capabilities such as those of INTA and developing new facilities focused on key technological niches relevant to future defence challenges.

All these initiatives will be implemented bearing in mind that the instruments promoted by the Ministry of Defence operate within a broader ecosystem, in which programmes and mechanisms driven by other bodies, at both national and international level, also play a key role. Coordination and integration with these instruments will be essential to extend the reach and effectiveness of support measures for technological development and the strengthening of the defence industrial ecosystem.

3. Mechanisms to expand and consolidate technological cooperation

In support of the full set of actions under the cooperation pillar, the establishment and enhancement of **framework agreements and general cooperation protocols** will be encouraged with R&D&I funding entities at national and regional level, as well as with existing innovation ecosystems. These arrangements will seek to ensure strategic coordination, complementarity of investment efforts and optimisation of the overall collective effort.

In addition, **national governance mechanisms** dedicated to promoting and coordinating international defence cooperation will be reinforced, ensuring coherent, ambitious participation aligned with the country's strategic interests.

In parallel, further avenues will be explored to increase the uptake and exploitation by the Armed Forces of the results of cooperative projects carried out at European level, in particular through the EDF, thereby enhancing their potential operational impact.

4. Strengthening links with the national DTIB

Given the central role of the DTIB in the development of defence technologies, it is necessary to strengthen links between industry, end users and the bodies responsible for R&D&I management. This will be achieved by intensifying information exchange and **interaction with DTIB entities**, fostering deeper technological dialogue and more effective collaboration within national and European programmes.

In this context, **technology dissemination activities** will be reinforced, including the Technology and Innovation Portal, technology bulletins and thematic events such as the National Congress on R&D in Defence and Security (DESEi+d), as well as collaboration in the organisation of information days for companies on European defence funding opportunities (EDF Info Days). These initiatives will facilitate awareness of and access to available national and European opportunities, promoting the participation of new actors and broadening the national defence innovation base.

Likewise, information exchange with the industrial and scientific community will be intensified through **systematic technology watch activities, early consultations and sectoral meetings**, enabling the identification of emerging capabilities and the alignment of national supply with the priorities of the Ministry of Defence priorities through the latter's Technology Watch and Foresight System.

Funding

The financial framework underpinning this Strategy is shaped by the commitments undertaken by Spain in the European and transatlantic forums in which it participates. These commitments point to a general increase in defence investment over the coming years, which will have a significant impact on the funding available for defence R&D&I.

At present, defence R&D&I funding is primarily channelled through Expenditure Policy Area 46 (R&D) within the defence sector (464), which includes expenditure programme 464A (Research and Studies of the Armed Forces), managed by the Ministry of Defence, as well as programme 464B[38] (Support for Technological Innovation in the Defence Sector), managed by the Ministry of Industry and Tourism. However, the portion of funding allocated to programme 464B varies depending on the major programmes being pre-financed at any given time by the Ministry of Industry and Tourism, and is therefore contingent upon the large-scale developments currently underway.

In addition to these resources, account must be taken of the growing volume of investment managed by other civil R&D&I funding bodies, which are increasingly allocating funding to dual-use projects, as reflected in the aforementioned *Industrial and Technological Plan for Security and Defence*. This is complemented by funding provided by the European Commission through multinational cooperation mechanisms.

The ambition of this Strategy is to allocate approximately 80% of R&D&I financial resources to the development of technological objectives, while reserving the remaining 20% for other R&D&I lines of interest to defence.

Monitoring

During the period of validity of this Strategy, progress in the implementation of the planned actions will be monitored using the set of indicators defined in Table 5, with a view to adjusting efforts and the level of ambition as implementation evolves.

These indicators will be grouped into two parallel blocks. The first will relate to investments and R&D&I activities deployed over the lifetime of the Strategy, while the second will focus on initiatives aimed at reviewing cooperation processes and fostering continuous improvement to reinforce the Strategy's implementation, as set out in Table 5 and Figure 19.

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[38] Under expenditure programme 464B (Support for Technological Innovation in the Defence Sector), repayable loans are granted to companies within the defence industry. The immediate objective of this programme is to support the participation of Spanish companies in the development of industrial technological projects related to defence that are strategic or international in nature, typically associated with the Special Modernisation Programmes (PEM).

These industrial technological projects ultimately have an impact on the Ministry of Defence's budget through expenditure programme 122B (Special Modernisation Programmes). From that point onwards, the defence industry begins the repayment of the loans to the Ministry of Industry and Tourism. Consequently, for the purposes of financing defence R&D&I, it may be considered that the Ministry of Defence ultimately assumes the cost of these technological projects through expenditure programme 122B.

Area	Purpose	Description
Defence and dual-use R&D&I investments and activities	R&D&I investments	- Public investment allocated to R&D&I for defence purposes. - Dual-use R&D&I investments financed by national and regional authorities. - Investments in international R&D&I cooperation initiatives related to defence. - Investment leveraged through nationally and internationally co-funded R&D&I activities relative to the public contribution made.
	R&D&I project calls	- National and international R&D&I project calls targeting defence or dual-use technologies, assessed according to: ○ Number of activities involving Spanish entities. ○ Participation rates of SMEs, start-ups, universities and R&D&I centres. ○ Type of activity (research; development; technology-based innovation; information exchange; etc.).
	R&D&I projects	- Contribution of new R&D&I projects to the achievement of the Strategy's objectives, assessed in terms of: ○ Alignment with technological objectives and R&D&I lines. ○ Technological maturity: R&T, development, technical-operational testing or other defence R&D&I enabling activities. ○ National or international implementation. ○ Type of lead entity (large companies; SMEs; start-ups; R&D&I centres; universities).
Cooperation and continuous improvement	Cooperation actions	- Initiatives aimed at promoting increasing levels of national cooperation with an impact on defence R&D&I. - Initiatives aimed at promoting increasing levels of international cooperation with an impact on defence R&D&I.
	Ministry of Defence continuous improvement processes	- Initiatives aimed at improving the MoD's internal processes related to defence R&D&I. - Technology dissemination initiatives related to defence R&D&I.

Table 5. Strategy Indicators

In addition, based on the information gathered through the technology monitoring and foresight function, progress and changes occurring across the four dimensions underpinning the Strategy—military capabilities, technology, technological capabilities of the DTIB, and strategic enablers for defence R&D&I—will be assessed, with a view to introducing more in-depth revisions to relevant parts of the Strategy where necessary.

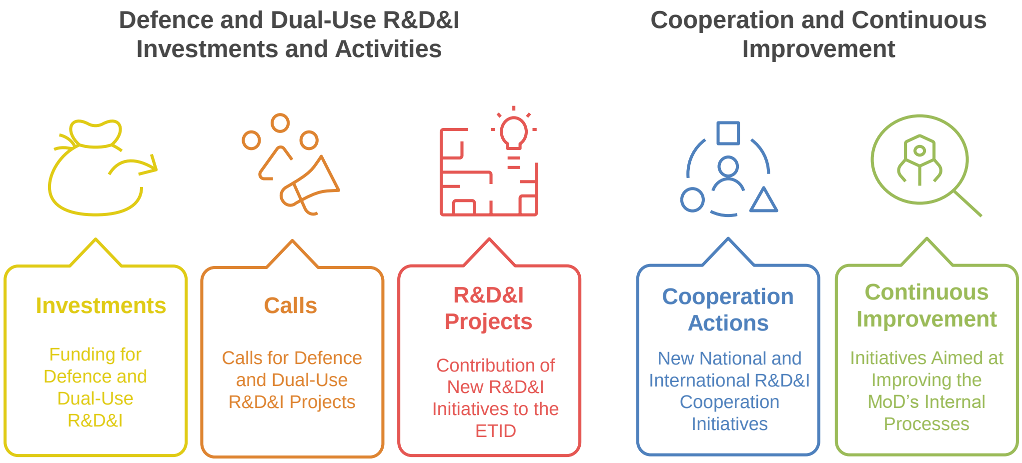

Figure 19. Strategy Indicators Framework

Actions under the Continuous Improvement Pillar

Under this integrated approach, the Strategy seeks to coherently transform innovation processes and instruments, accompanying technologies from their early stages through to operational application, while maximising collaboration, efficiency and the overall impact of the defence technology ecosystem.

To this end, planning, procurement, management and internal coordination processes will be enhanced, ensuring effective use of resources and closer alignment with operational needs. At the same time, instruments to foster early-stage innovation and technology maturation will be strengthened, links with the national DTIB will be reinforced, and national and international technological cooperation frameworks will be consolidated. Finally, systematic mechanisms will be established to measure investments and progress, facilitating performance assessment and data-driven decision-making.

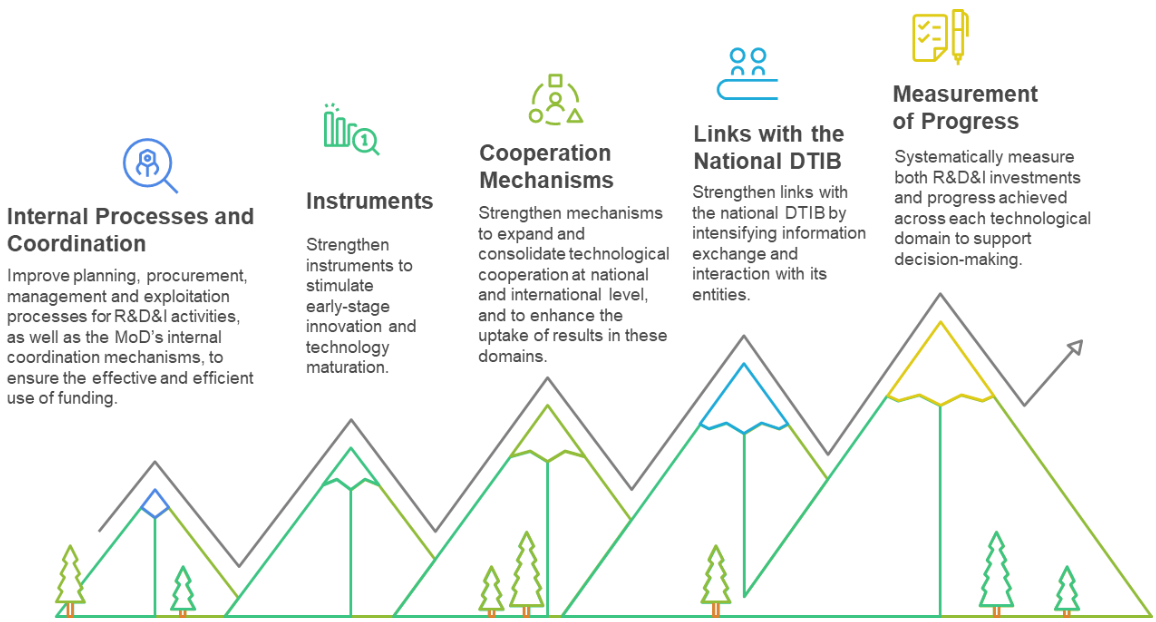

Figure 20. Actions under the Continuous Improvement Pillar

Summary of Planned Actions

Technological Objectives Pillar	
[OTEC - 1]	Promote the development of R&D&I activities and projects aimed at achieving the technological objectives defined in the Strategy.
[OTEC - 2]	Update the set of technological objectives and R&D&I lines of interest to the Ministry of Defence, based on changes in operational needs, technological advances and the technological capabilities of the national DTIB.
Cooperation Pillar	
[COOP - 1]	Support initiatives promoted by other national bodies funding dual-use R&D&I that are aligned with defence needs.
[COOP - 2]	Deepen cooperation with regional authorities responsible for R&D&I, leveraging synergies between their smart specialisation strategies and defence interests.
[COOP - 3]	Foster coordination with existing national technology-based innovation ecosystems.
[COOP - 4]	Facilitate greater involvement of the national research community in national and international defence initiatives.
[COOP - 5]	Continue to promote active and coordinated participation in European programmes linked to the EDF and in new European initiatives supporting the European defence industry.
[COOP - 6]	Promote greater participation of national entities in the European Defence Agency's technological research activities.
[COOP - 7]	Foster disruptive technology-based innovation through international cooperation.
[COOP - 8]	Promote the effective use of European and NATO knowledge networks.
[COOP - 9]	Consolidate strategic multilateral cooperation frameworks around programmes for the development of major platforms and future systems.
Continuous Improvement Pillar	
[MCON - 1]	Improve planning, procurement, management and exploitation processes for R&D&I activities, as well as the Ministry of Defence's internal coordination mechanisms, to ensure the effective and efficient use of funding.
[MCON - 2]	Strengthen instruments to stimulate early-stage innovation and technology maturation.
[MCON - 3]	Reinforce mechanisms to expand and consolidate technological cooperation at national and international level, and to enhance the uptake of results in these domains.
[MCON - 4]	Strengthen links with the national DTIB by intensifying information exchange and interaction with its entities.
[MCON - 5]	Systematically measure both R&D&I investments and progress achieved in each technological domain to support decision-making.

Table 6. Actions under the ETID Pillars


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Annex A. R&D&I Lines of Interest to Defence

The set of R&D&I Lines of interest to defence included in the Strategy is organised into the following eleven **Areas**[39]:

1. Weapons and munitions
2. Sensors and electronic systems
3. Technologies common to defence systems
4. Bases and facilities
5. Land platforms
6. Naval platforms
7. Air platforms
8. Space systems
9. Soldier
10. CBRNe
11. Information, communications and simulation technologies

An initial group of Areas **represents fields for the development technologies and systems typically used in defence**, which may have their own entity within defence needs or be integrated into larger platforms and weapon systems. Thus, Areas 1 (Weapons and munitions) and 2 (Sensors and electronic systems) represent fields in which the nature of the systems developed or the demanding performance required give rise to a significant number of R&D&I Lines. This is also the case for Area 11 (Information technologies, communications and simulation), with a strong cross-cutting nature, grouping R&D&I Lines related to C4I systems, cyber defence and simulators.

Conversely, Areas 4 to 9 (Bases and facilities; Land platforms; Naval platforms; Air platforms; Space systems; and Soldier) represent the main **areas of application** of the technologies developed in the Strategy, often developing major platforms and weapon systems used in defence, integrating technological developments addressed in other Areas. These Areas are complemented by Area 3 (Technologies common to defence systems), which compiles R&D&I Lines equally applicable to most of the previous Areas. Area 9 (Soldier) can be considered a particular case of the previous ones, as it groups together developments and innovations focused on people, which are transferred through their equipment or through their cognitive abilities and health status.

Finally, Area 10 (CBRNe), focused on the development of defence technologies against asymmetric threats, represents a particular case within this set of Areas due to its stronger orientation toward specific defence threats. Each of these Areas, in turn, is structured into a set of **Sub-Areas** that group together the R&D&I Lines that address related **defence technological challenges** (see Figure 21).

[39] This corresponds to the same set of Areas included in the ETID 2020.

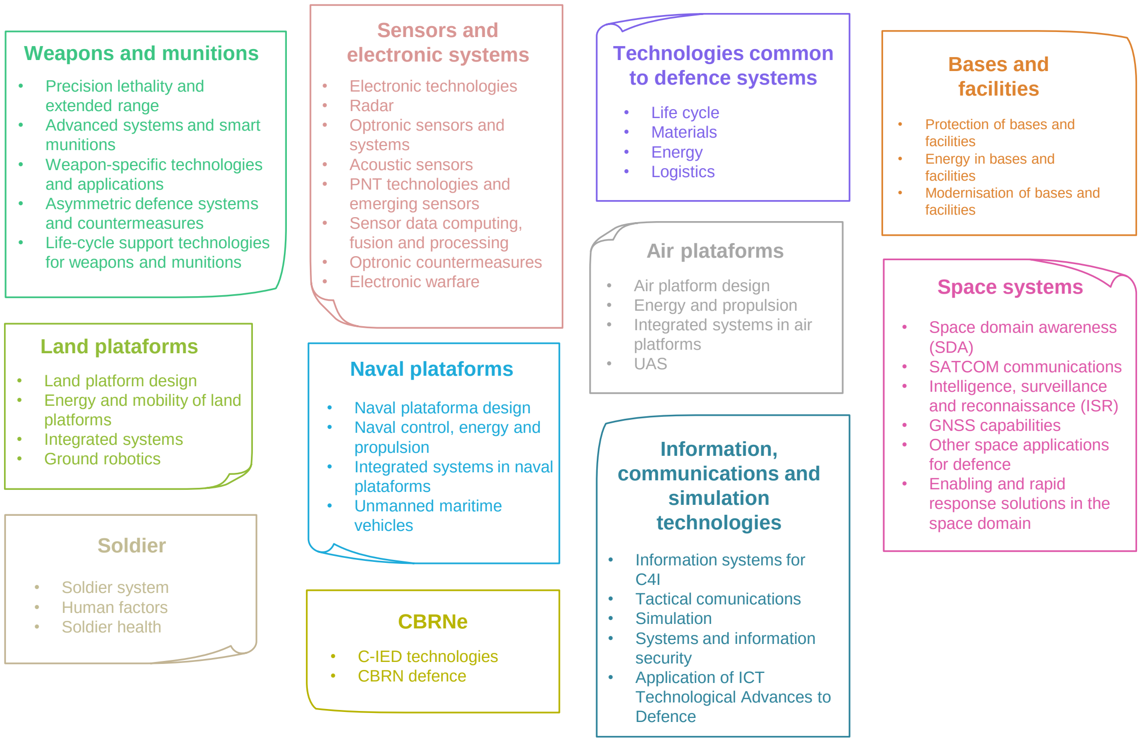


Figure 21. ETID areas and sub-areas

Although this is a hierarchical organisation of information, there are multiple horizontal relationships between these Sub-Areas and their R&D&I Lines, as a consequence of the complexity inherent in the use of technology across the many types of defence systems and applications.

The following sections detail each of the R&D&I Lines of interest for defence, highlighting those that contribute most significantly to achieving the technological objectives of the ETID. The full list of this set of R&D&I Lines is included in Table 6.

Finally, Table 8 shows the relationship between each of the ETID Areas and the Essential Defence Capabilities defined in the 2023 EID.

1. WEAPONS AND MUNITIONS	
1.1. PRECISION LETHALITY AND EXTENDED RANGE	
1.1.1. Low-cost terminal guidance and programmable fuzes	Research and development of affordable terminal-guidance kits with high resistance to electronic countermeasures, and multifunction programmable fuzes (proximity, impact, delay). Technological challenges include sensor miniaturisation and algorithms for terminal-phase correction, ensuring sub-metric accuracy in contested environments, and the use of interoperability standards. Planned actions involve demonstrators to validate cost-per-shot reduction and test campaigns on instrumented ranges. This enables proportional responses in urban or asymmetric scenarios. Part of the "Advanced munition guidance and control technologies" objective.
1.1.2. Advanced propulsion for indirect fire (extended range and MLRS)	Development of propulsion technologies to extend the range of artillery and rockets, including advanced propellants, rocket-assisted projectiles (RAP) and base bleed for artillery, as well as high-energy solid propellants for MLRS (Multiple Launch Rocket System). Challenges include optimising energy efficiency to double ranges (exceeding 100 km), managing thermal loads at high velocities, and ensuring compatibility with existing launchers. Planned activities include CFD (Computational Fluid Dynamics) simulations, wind tunnel testing and prototypes to validate stand-off projection.
1.1.3. Robust navigation for munitions	Design and development of alternative navigation solutions (APNT) for munitions operating in GNSS-denied environments, integrating high-accuracy inertial sensors with anti-jamming GNSS receivers and vision-based or terrain-based navigation. Technological challenges include multisensor data fusion to improve accuracy, resistance to spoofing, and miniaturisation for small calibres. Planned activities encompass the development of adaptive algorithms, validation in simulated electronic warfare scenarios and demonstrators to achieve fully autonomous flight. Part of the "Advanced munition guidance and control technologies" and "Technologies for robust PNT" objectives.
1.1.4. Scalable and selective effects munitions	Design and development of variable warheads providing controlled effects, with scalability from non-lethal to focused destruction. Challenges include the development of insensitive energetic materials to enhance safety, algorithms for dynamic effect selection, and ballistic testing to minimise collateral damage. Planned activities involve R&D&I in advanced composites, integration with programmable fuzes and prototypes for validation in real environments.

1. WEAPONS AND MUNITIONS	
1.2. ADVANCED SYSTEMS AND SMART MUNITIONS	
1.2.1. Multimodal seekers and AI for ATR	Design and development of multispectral seekers (EO/IR, radar) with AI for autonomous target recognition (ATR), enabling “fire-and-forget” employment in systems and smart munitions such as guided missiles, torpedoes or loitering munitions. Challenges include data fusion in degraded environments, learning algorithms for friend–foe discrimination, and certification of trustworthy AI. Planned activities cover the development of embedded neural networks, testing in multidomain simulators and demonstrators to achieve high accuracy. This enables selective strikes in saturated scenarios. Part of the “Advanced munition guidance and control technologies” objective.
1.2.2. Autonomy, swarm collaboration and data links	Development of new AI-based solutions for collaborative navigation, target reallocation and LPI/LPD data links resilient to electronic warfare. Technological challenges include swarm protocols, low-latency secure communications and autonomous fault management. Planned activities include swarm simulations, integration with C2 systems and prototypes for distributed operations. This strengthens multidomain lethality. Part of the “Advanced munition guidance and control technologies” objective.
1.2.3. Non-hypersonic propulsion for tactical missiles and loitering munitions	Design and development of solutions based on ramjet and turbofan engines for guided missiles and loitering munitions, optimising efficiency for subsonic/supersonic speeds (up to Mach 4) and extended cruise/loiter missions. Challenges include thermal management, chemical kinetics under variable environments and integration with guidance systems for dynamic trajectories. Planned activities include combustion test benches, demonstrators for ranges exceeding 300 km and collaboration with other aerial platform programmes. This reduces response times and ensures A2/AD penetration in tactical applications.

1. WEAPONS AND MUNITIONS	
1.3. WEAPON-SPECIFIC TECHNOLOGIES AND APPLICATIONS	
1.3.1. Directed energy weapons using high-power lasers	Design, development and integration of directed energy weapon systems using high-power lasers (Laser-based Directed Energy Weapons, LDEW) for military and security applications, enabling enhanced self-defence and response capabilities. These weapons offer immediate, precise responses, with low cost per shot and no conventional ammunition, allowing reduced logistical footprint and collateral damage. Part of the "Technologies for the development of directed energy and electromagnetic weapons" objective.
1.3.2. RF directed energy weapons	Development of radiofrequency (RF) directed energy weapon technologies, with the aim of enabling future systems for electronic attack, capable of generating RF power levels high enough to temporarily disable or even destroy the electronic systems of the threat. Part of the "Technologies for the development of directed energy and electromagnetic weapons" objective.
1.3.3. Technologies for kinetic electromagnetic weapons (railguns)	Research and development of railgun systems for high-velocity kinetic effects, with compact power sources, SWaP reduction and platform integration to neutralise asymmetric threats (UAS, swarms, hypersonic threats, etc.), enabling proportional responses in A2/AD environments, with low cost per shot and reduced logistics. Challenges include improving barrel durability against electromagnetic friction wear, energy management for sustained rate of fire, and the design of adjustable projectiles for scalable effects. Part of the "Technologies for the development of directed energy and electromagnetic weapons" objective.
1.3.4. Smart mines	Design and development of mines with acoustic/magnetic sensors and AI for selective target discrimination (friend/enemy/neutral), in compliance with international conventions. Challenges include the development of embedded AI algorithms for selectivity in complex environments, integration of multimodal sensors for robust detection, and minimisation of environmental impact during deployment and deactivation. Planned activities include prototype development for validation in land and naval scenarios, test campaigns to assess discrimination under variable conditions, and collaboration with international initiatives on selectivity standards. This enables controlled area effects and proportional responses in access denial operations, aligned with proportionality requirements in hybrid conflicts.

1. WEAPONS AND MUNITIONS	
1.4. ASYMMETRIC DEFENCE SYSTEMS AND COUNTERMEASURES	
1.4.1. Low-cost effectors for C-UAS / C-RAM	Development of low-cost effectors to neutralise UAS or RAM (Rocket, Artillery and Mortar) swarms, enabling proportional responses to low-cost threats, aligned with volume warfare requirements and logistical reduction. Challenges include balancing cost-effectiveness with sub-metre accuracy, optimisation of controlled fragmentation to minimise collateral damage, and resilience to electronic countermeasures in saturated environments. Planned activities include the development of expendable munitions using insensitive energetic materials, test campaigns in simulated saturation scenarios and industrial scalability. Part of the "Technological solutions against low-altitude aerial threats" objective.
1.4.2. Effectors for robotic and asymmetric mine countermeasures	Development of specialised effectors (e.g., focused explosive charges, EMP pulses) for robotic neutralisation of land and naval mines in both standard and asymmetric scenarios (including saturation, low-cost and hybrid threats). Challenges include the development of certifiable AI algorithms for discrimination and secure remote operations, miniaturisation of effectors for integration into UGVs/UUVs, and compliance with environmental regulations (REACH, Ottawa Convention). Planned activities include the development of multimodal sensors, testing in simulated scenarios (simple and complex), and demonstrators to validate remote neutralisation, with the aim of enabling proportional responses to massive minefields or IEDs in saturated environments. Part of the "Enhanced systems for remote detection of land IEDs" objective.

1. WEAPONS AND MUNITIONS	
1.5. TECHNOLOGIES SUPPORTING THE WEAPON AND MUNITION LIFE CYCLE	
1.5.1. Munition life cycle	Development of technologies aimed at improving the tracking, control and comprehensive management of munitions throughout their entire life cycle (covering manufacture, storage, transport, use and demilitarisation), in order to optimise service life, ensure operational availability and reduce logistical risks and costs. Priority is given to solutions enabling real-time monitoring of climatic and physicochemical conditions to which munitions are exposed, including the integration of embedded sensors, traceability systems, predictive ageing modelling and decision-support tools for stock management. These technologies will contribute to increasing safety, sustainability and efficiency in munition maintenance and storage across diverse environments.
1.5.2. Impact reduction in weapon and munition processes	Research and development of technologies contributing to the reduction of negative impacts on human health and the environment throughout the life cycle of weapons and munitions, from manufacture to demilitarisation. Priority will be given to solutions that improve energy and material efficiency in industrial processes, the use of less toxic and safer materials, and the adoption of clean production techniques, rapid material classification and recycling, with particular emphasis on the recovery of critical and high strategic value elements. New methods for munition demilitarisation and neutralisation will also be promoted to minimise hazardous waste and pollutant emissions, as well as more sustainable and safer transport and storage technologies. This line reinforces the sustainability of industrial and logistical defence capabilities, in line with the principles of security, operational efficiency and the circular economy.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.1. ELECTRONIC TECHNOLOGIES	
2.1.1. High-performance RF antennas, devices and modules	Enhancement of the performance of antennas, devices and components that form part of military radiofrequency (RF) systems through the application of technologies and developments applicable to these elements, in order to achieve advanced functionalities in radar, electronic warfare and communications systems. Part of the "High-performance electronic technologies" objective.
2.1.2. Application of photonic technology to RF systems	Application of photonic technologies to improve the performance of military radiofrequency (RF) systems through developments at component, subsystem and full system level, providing significant benefits in terms of size, weight and power reduction (SWaP – Size, Weight and Power) for the platforms in which these systems are integrated. Part of the "High-performance electronic technologies" objective.
2.1.3. SMRF architecture	Development of an SMRF (Scalable Multifunction RF Systems) architecture for the implementation of military systems that are modular (based on the interconnection of hardware and software blocks) and multifunctional (using common hardware to provide all the functionalities required by the platform). The use of this architecture is expected to deliver advantages in the development and maintenance costs of military systems, while also facilitating the rapid insertion of new technologies and functionalities into such systems.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.2. RADAR	
2.2.1. New radar architectures and signal processing algorithms	Research and development of new radar architectures capable of providing significant advantages over existing systems or delivering additional capabilities, together with advanced radar signal processing algorithms for the detection and tracking of elusive/difficult targets in complex environments (e.g., high clutter and interference levels and adverse weather conditions). These systems should be software-based in order to allow rapid reprogramming or adaptation to changes in potential threats.
2.2.2. Air defence radar systems	Development of state-of-the-art air defence radar systems for both land and naval units, in order to enhance the national technological capability already acquired and advance towards the development of new next-generation systems.
2.2.3. SAR/MTI systems	Development of hardware and software technologies for SAR/MTI (Synthetic Aperture Radar / Moving Target Indicator) radar systems onboard airborne platforms. SAR imaging technology enables “change detection” on terrain through the application of interferometric SAR (InSAR) techniques, while MTI techniques enable the discrimination of moving targets. In addition, all-weather SAR imagery can reveal information hidden in other regions of the spectrum (visible, infrared, etc.), complementing the information obtained by these sensors and increasing the probability of target detection.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.3. OPTRONIC SENSORS AND SYSTEMS	
2.3.1. Systems based on EO/IR detectors	Research and development of new optronic systems based on detectors in the visible (EO) and infrared (IR), aimed at enhancing performance for military ISTAR missions. Particular focus is placed on systems based on miniaturised detectors, including the development of new types of microbolometers or nanobolometers, advanced tracking capabilities to increase automation in combat, and hybrid imaging sensors combining different infrared bands with the visible range.
2.3.2. Night vision systems	Research and development aimed at improving night vision systems (NVS) based on image intensifier tubes or high-sensitivity detectors. Particular interest is focused on lens systems with extended field of view (FOV), as well as new panoramic systems integrating multiple intensifier tubes, and improvements in SWaP.
2.3.3. Laser-based technologies for ranging, LIDAR, guidance and target designation	Research and development aimed at improving technological solutions based on laser technologies for defence applications, as well as the development of new systems. Activities include, among others, ranging systems, target designators, imaging systems and navigation aids using LIDAR (Light Detection and Ranging), laser guidance systems and other innovative applications such as lasers for underwater environments.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.4. ACOUSTIC SENSORS	
2.4.1. Underwater acoustic sensors	Research and development of advanced acoustic sensor technologies for military underwater applications, aimed at improving detection, classification, tracking and surveillance capabilities in naval environments. This includes the development of new active and passive sonar systems, including high- and medium-frequency sonars optimised for unmanned platforms (UUV and USV), compact high-frequency sensors suitable for integration into swarms or autonomous systems, and technologies for operations in acoustically complex or shallow-water environments. It also includes the development of next-generation sonobuoys with onboard processing capability, cooperative transmission and networked operation, aimed at expanding acoustic coverage and improving early detection of underwater threats. In addition, multimodal sensors combining acoustics with optical or electromagnetic technologies are considered, together with improvements in sensitivity, target discrimination and noise robustness. AI-based acoustic processing will enable early classification of acoustic patterns (propulsion, acoustic signature, etc.), reducing false positives. Part of the "Technologies for protection against threats based on unmanned maritime vehicles" objective.
2.4.2. Atmospheric acoustic sensors	Research, development and integration of terrestrial acoustic systems for military applications, such as the detection of detonations and localisation of firing points, as well as the estimation of trajectories of mobile aerial and terrestrial targets. Integration with other sensors, such as optical and electromagnetic systems, is also included, providing a more comprehensive view of the environment and improving target detection and tracking capabilities.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.5. PNT TECHNOLOGIES AND EMERGING SENSORS	
2.5.1. Technologies for robust PNT in the absence of GNSS	Research and development of advanced positioning, navigation and timing (PNT) solutions to ensure the operability of mobile military platforms (land, naval, air, space and unmanned), as well as command and control nodes or systems in environments where the GNSS signal is degraded or denied. This line includes technologies such as high precision inertial navigation, visual navigation or terrain correlation, alternative sensors (magnetic, barometric or signals of opportunity), high stability clocks and distributed network synchronisation mechanisms. The integration of these capabilities into modular onboard or fixed architectures will be promoted, ensuring interoperability with tactical communications and C4I systems, as well as operation under criteria of energy efficiency, compactness and cyber resilience. Part of the “Technologies for robust PNT” objective.
2.5.2. Quantum sensors for defence applications	Development of quantum sensors and quantum metrology devices for the precise measurement of physical parameters with high resolution and extreme sensitivity. Notable examples include gravimeters, magnetometers, accelerometers, gyroscopes, compact optical atomic clocks, RF sensors and CBRN sensors. Their design prioritises precision and operational stability, even in complex and adverse environments. These capabilities enable strategic applications such as high-precision inertial navigation and gravimetry; autonomous navigation and enhancement of PNT systems, even in GNSS-degraded environments; time synchronisation in multidomain operations, essential for C4ISR interoperability; RF signal detection and advanced electronic warfare capabilities; detection of underground or underwater structures; weapon guidance; operation of unmanned vehicles; real-time detection of CBRN threats; or autonomous satellite navigation, among others. They are underpinned by emerging technologies such as cold-atom interferometry, ion traps, Rydberg atoms, advanced quantum optics, hybrid quantum-classical systems or nitrogen-vacancy (NV) centres in diamond, which operate at room temperature and allow miniaturisation and integration into portable platforms. Future heterogeneous sensor networks, integrating AI and quantum cybersecurity, will enable dynamic scenario analysis and, more disruptively, quantum radars will detect low-observable aerial targets without compromising operational stealth. Part of the “Quantum technologies applied to defence” objective.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.6. COMPUTING, SENSOR FUSION AND DATA PROCESSING	
2.6.1. Sensor fusion	Development of improved algorithms and techniques for fusing data from different sources (EO/IR imagery, multispectral and hyperspectral imagery, LIDAR, SAR, ISAR, full-motion video, acoustic signatures, LINK-16/22 tracks and GMTI data, etc.), including data from navigation systems, GNSS signals and alternative PNT sources. Particular attention will be given to uncertainty management, temporal and geospatial integration of information, and efficient exploitation of these capabilities in onboard or networked architectures, in order to enhance tactical and strategic situational awareness.
2.6.2. Onboard hardware for intensive AI processing	Research and development of hardware architectures optimised for the execution of artificial intelligence (AI) algorithms directly on board defence platforms (air, space, land and naval). This line focuses on high-performance, low-power edge computing solutions (SWaP), including graphics processing units (GPU), FPGA and specialised system-on-chip (SoC) solutions, as well as the exploration of emerging technologies such as neuromorphic computing. The objective is to provide platforms capable of processing large volumes of sensor data in real time, enabling advanced autonomous functionalities without reliance on communication links to ground stations. This increases resilience, reaction speed and system autonomy in operationally demanding environments with limited or denied connectivity. Part of the “Application of artificial intelligence to defence” objective.
2.6.3. Automatic and intelligent analysis of sensor data	Development of algorithms capable of analysing data obtained from different sensors used in defence, with the aim of automatically detecting, recognising or identifying the presence within the scene of entities of significance and interest to the Armed Forces, thereby reducing the analytical burden on human operators. Particular interest is placed on the application of the latest advances in artificial intelligence to analyse data provided by sensors used in highly complex scenes, where until now no robust alternatives existed to automate such analyses. Part of the “Application of artificial intelligence to defence” objective.

2. SENSORS AND ELECTRONIC SYSTEMS	
2.7. OPTRONIC COUNTERMEASURES	
2.7.1. DIRCM-based protection for airborne platforms	Research and development of laser-based DIRCM (Directed Infrared Counter Measures) systems for integration into military aircraft to counter infrared-guided missile launches present in multiple theatres of operation. Particular emphasis is placed on the integration of DIRCM systems into networked architectures, enabling coordinated and collaborative threat detection and countermeasure operations across multiple airborne platforms.
2.7.2. Pyrotechnic decoys, flares and smoke grenades	Research and development of pyrotechnic systems required for the protection of air, naval and land platforms. Particular interest is placed on multispectral decoys with maximum spectral coverage, including ultraviolet, visible and infrared bands. Innovations in deployment techniques are also considered of special interest, such as decoys launched from drones or submarines, and networked decoy systems coordinated from different platforms simultaneously.

2. SENSORS AND ELECTRONIC SYSTEMS

2.8. ELECTRONIC WARFARE

2.8.1. Non-communications electronic warfare systems	Development of state-of-the-art non-communications Electronic Warfare systems, including electronic support measures (ESM), electronic intelligence (ELINT) and electronic countermeasures (ECM), incorporating technological advances in RF antennas, components and modules, as well as advanced dedicated algorithms. Part of the “Electronic warfare solutions adapted to the current and future electromagnetic environment” objective.
2.8.2. Communications electronic warfare systems	Development of state-of-the-art communications Electronic Warfare systems (ESM/COMINT and ECM), incorporating technological advances in RF antennas, components and modules, together with the most advanced warning and signal intelligence techniques, adapted to the new communications present in the electromagnetic (EM) environment. Particular importance is placed on systems for the detection and neutralisation of different types of satellites. Part of the “Electronic warfare solutions adapted to the current and future electromagnetic environment” objective.
2.8.3. Multi-platform and cooperative electronic warfare	Development of technologies enabling the implementation of multi-platform and cooperative electronic warfare systems. The coordinated and cooperative use of electronic warfare equipment onboard different platforms to obtain an Electronic Order of Battle (EOB) will additionally improve the precision of detection, localisation and identification of the opponent’s RF emissions, as well as increase the effectiveness of electromagnetic countermeasures applied against enemy systems. Part of the “Electronic warfare solutions adapted to the current and future electromagnetic environment” objective.
2.8.4. RC-IED jammers	Development of state-of-the-art frequency jamming systems to counter radio-controlled improvised explosive devices (RC-IED). These systems include personal portable solutions, vehicle-mounted systems and fixed facilities, providing versatility and multi-purpose functionality, implementing different modes of operation (active, reactive and hybrid) and incorporating time synchronisation means to ensure interoperability and compatibility with allied jamming systems, as well as with own communications and systems.

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.1. LIFE CYCLE	
3.1.1. Platform maintenance	Development of advanced technologies to optimise the maintenance of military platforms across the different domains (land, maritime, air and space). These technologies aim to improve platform availability, extend operational life and ensure efficient operation, both from a structural perspective and in terms of the performance of onboard equipment and systems, while also reducing maintenance time and costs. Technologies applicable to reactive, preventive and predictive maintenance are considered, together with more effective inspection methods. Part of the “Technologies supporting the life cycle of military systems” objective.
3.1.2. Data intelligence applied to predictive maintenance of platforms	Development of artificial intelligence-based algorithms for the automatic analysis of large volumes of data obtained from platform sensorisation and maintenance activities, enabling accurate and reliable prediction of the remaining useful life of each component or system. Part of the “Technologies supporting the life cycle of military systems” objective.
3.1.3. Open modular architectures, digital engineering and simulation for the life cycle	Research and development of Modular Open Systems Approach (MOSA) and Model-Based Systems Engineering (MBSE), together with the use of digital twins and LVC simulation environments, to facilitate agile design, modular integration and interoperability of complex defence systems across all domains. The scope includes the development of standardised interfaces (mechanical, electrical, electronic and software), the application of MBSE to optimise design, verification and validation (V&V), predictive maintenance, and the certification of operational digital models. Part of the “Technologies supporting the life cycle of military systems” objective.
3.1.4. Protection against corrosion and degradation processes	Development and implementation of innovative technologies to prevent and protect platforms against corrosion and degradation processes in all types of aggressive environments and hostile conditions, including ambient temperature exposure, high-temperature oxidation processes, high mechanical loads, hydrogen embrittlement, saline environments, and the fouling of ship hulls by bacteria and marine organisms, among others. The objective is to minimise the deterioration of platforms and their subsystems, thereby extending their service life. Part of the “Technologies supporting the life cycle of military systems” objective.

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.1. LIFE CYCLE	
3.1.5. Incorporation of circular economy processes	Development of technologies to optimise the management of materials used by the defence industry under a circular economy model. This approach includes strategies for the recovery, reuse and upgrading of military equipment in order to extend its service life. In addition, management processes for the recovery of critical materials will be addressed, promoting their reuse and reducing dependence on critical resources. Part of the "Technologies supporting the life cycle of military systems" objective.
3.1.6. Development of technological solutions to reduce the use of critical materials in defence	Development of advanced solutions aimed at reducing dependence on critical materials in strategic defence applications, including energy systems, communications, sensors, armament and platforms. The solutions will focus on substituting critical materials or incorporating materials recovered from other processes with technically viable functional alternatives, without loss of operational performance. This approach will contribute to strengthening strategic autonomy, sustainability and the resilience of defence technological capabilities in the face of restrictions in the global supply chain. Part of the "Technologies supporting the life cycle of military systems" objective.
3.1.7. Industrial resilience and scaling of military system production	Research, development and demonstration of solutions to provide more robust and adaptable manufacturing plants, enabling the improvement, maintenance and increase of production of critical systems and subsystems in high-demand scenarios, while ensuring quality, safety and supply chain resilience. Capabilities such as reconfigurable and flexible manufacturing, the use of process and factory digital twins for rapid planning, advanced automation and inline quality assurance using vision systems and artificial intelligence will be promoted. Intelligent planning methods will also be applied to manage bottlenecks and agile reconfiguration. Measures for secure supply chain management (SCRM), cybersecurity in production lines and rapid certification in response to changes in materials or suppliers will be included, especially in critical areas (e.g., munitions and effectors, sensors, batteries and power electronics, UAS, etc.). Core of the "Improvement of defence industry production processes" objective.

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.2. MATERIALS	
3.2.1. Weight reduction in platforms	Development of lightweight materials and structures that, without compromising the performance or safety of the platforms in which they are integrated, optimise their operational capability and transportability. These advances will also improve key aspects such as energy consumption, autonomy and mobility.
3.2.2. Passive platform protection systems	Development of advanced passive protection systems capable of replacing traditional armour used on land, naval and air platforms against both current and emerging threats (high-power lasers, microwaves, etc.). These new systems will seek not only a significant reduction in platform weight, but also to ensure equal or superior protection against ballistic impacts and explosions, providing more effective protection adapted to current threats. Part of the “Materials for application in platforms and the soldier” objective.
3.2.3. Platform signature reduction through materials	Development of advanced coatings, materials and structures to optimise the reduction of radar, infrared, acoustic, visible and other signatures of land, naval and air platforms. The objective is to enhance concealment and stealth capability without compromising essential operational capabilities, ensuring no interference with overall platform performance. Part of the “Materials for application in platforms and the soldier” objective.
3.2.4. Materials for high-temperature applications	Development of materials and coatings for high-temperature applications, such as propulsion systems, structures operating in high-temperature environments, fire-resistant components or hypersonic structures, among others. These materials will be designed for integration into military systems, enabling continuous control of their performance and behaviour throughout their entire life cycle, ensuring reliability and performance under extreme temperature conditions. Part of the “Technologies for hypersonic vehicles” objective.

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.3. ENERGY	
3.3.1. High-power energy systems	Research and development on onboard energy systems capable of supplying the power required for new systems demanding high electrical current pulses, whether short-duration or sustained, such as directed energy weapons, electromagnetic guns or active protection systems. These developments include both energy storage systems enabling rapid charge and discharge cycles and the associated power control electronics. Core of the “Technologies for the development of directed energy weapons” objective.
3.3.2. Environmental energy harvesting systems	Adaptation and validation of energy harvesting technologies for micro-generation of electrical energy from environmental sources (vibration, thermal, solar, wind, electromagnetic), through compact, low-maintenance systems. These solutions will be oriented towards military applications such as unattended sensor networks, soldier systems and grid-isolated systems in facilities or camps, with the objective of increasing energy autonomy and reducing dependence on the logistics chain. Priority will be given to robust, low-consumption solutions capable of discreet integration into diverse operational environments.
3.3.3. Micro-generation electrical power systems	Development of small-scale electrical power generation systems, distinct from energy harvesting technologies and fuel cells, to provide autonomous and flexible power in military operations. Technologies such as microturbines, advanced portable generator sets and other compact systems capable of integration into platforms, use as energy support for the soldier, or deployment in temporary infrastructures such as camps or command posts will be considered. These systems will prioritise energy efficiency, reduction of weight and volume, reliability under adverse conditions and compatibility with different fuels and logistical requirements.
3.3.4. Fuel cell systems for military use	Development of electrical generation systems based on fuel cells, adapted to the requirements of operation in military environments. These solutions must be compatible with hydrogen and other alternative fuels, and intended for integration into platforms, soldier equipment, mobile infrastructures, camps or deployed bases (FOB). Priority will be given to energy efficiency, reduction of logistic and thermal footprint, silent operation and robustness against adverse environmental conditions. Part of the “New propulsion solutions for manned platforms and unmanned systems” objective.

Defence Technology and Innovation Strategy – ETID 2026

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.3. ENERGY	
3.3.5. Electrical energy storage systems for military use	Development of electrical energy or power storage systems with increased storage capacity, charging capacity, flexibility in power delivery, and reduced weight and volume, for use across different military systems. These systems include, among others, next-generation batteries, including structural batteries, supercapacitors and integrated systems. Part of the "Energy generation, storage and efficiency in isolated bases and infrastructures" and "New propulsion solutions for manned platforms and unmanned systems" objectives.
3.3.6. Wireless power transmission systems	Development of wireless energy or electrical power transmission technologies, at different scales and ranges (including above or below the atmospheric ionisation threshold), for military applications in platforms, bases, camps or soldier equipment. These solutions must be assessed for use both in national territory and in operational deployments, prioritising transmission efficiency, electromagnetic safety and reliable operation in hostile environments.

3. TECHNOLOGIES COMMON TO DEFENCE SYSTEMS	
3.4. LOGISTICS	
3.4.1. Water management systems	Research and development of fixed and portable systems for comprehensive water management in military operations, including generation, purification, desalination, treatment and decontamination, adapted to the needs of naval platforms, deployed bases and units in operational areas. These technologies must improve water autonomy, reduce the logistical burden associated with water supply and ensure availability in degraded environments, minimising the risk of contamination from natural causes or hostile actions. Priority will be given to efficient, compact solutions resistant to extreme environmental conditions.
3.4.2. Waste management processes	Development of processes and technologies for comprehensive waste management in bases, facilities and naval platforms, both in national territory and in operational areas. Logistical, operational and environmental aspects will be addressed, including solutions for waste collection, sorting, treatment and safe disposal. Circular economy-based approaches, such as recycling, material reuse and energy recovery, will be promoted in order to reduce logistical footprint, improve operational sustainability and increase deployment autonomy.
3.4.3. Alternative non-fossil fuels	Development of alternative fuels to petroleum-derived fossil fuels, aimed at reducing the EU's external dependence on fuels and increasing the resilience and energy independence of the supply chain, including those that can be used under the NATO Single Fuel Concept (SFC). Both the development of alternative fuels and the technological solutions for their management by the Armed Forces, as well as their application in military platforms, are considered.

4. BASES AND FACILITIES	
4.1. PROTECTION OF BASES AND FACILITIES	
4.1.1. Sensor networks for the protection of facilities and land deployments	Research and development of technologies enabling the protection of bases and critical facilities in the land domain, as well as troop deployments in urban areas, ports and extensive areas with complex terrain and lack of infrastructure. These solutions will be based on distributed, autonomous, cooperative and remote multisensor ground networks, aimed at determining firing direction, detecting and identifying vehicles, firing direction, individuals, objects and activities.
4.1.2. Sensor networks for the protection of maritime areas	Research and development of architectures and technologies for acoustic and multisensor networks for the surveillance and protection of maritime areas against underwater and surface threats, with particular focus on littoral environments, port infrastructures and restricted access areas. This line will address the design of distributed networks of fixed or mobile sensors, operating autonomously and cooperatively, with networked data fusion capabilities, as well as their integration with unmanned systems (USV, UUV) and command and control systems. The line includes the use of secure optical infrastructures based on dark fibre, both as a high-capacity, low-latency communication channel between sensor nodes and in its emerging application as a distributed linear acoustic sensor through optical detection and vibration sensing technologies (DAS/DVS). Aspects such as network resilience, energy efficiency, multistatic detection capability, real-time operation and interoperability with naval or joint C4ISR systems are also considered. These capabilities will enable extended underwater surveillance coverage, increased system resilience and early detection of anomalous activities in critical areas.
4.1.3. Protection against explosive threats in facilities	Development of new passive protection elements, both fixed and portable, intended for deployment in operational areas or for the protection of facilities exposed to threats involving ballistic attacks or explosions. Of particular interest is also the development of tools and the acquisition of knowledge required for model creation, simulation, experimentation and analysis against explosive-based threats.

4. BASES AND FACILITIES

4.2. ENERGY IN BASES AND FACILITIES

4.2.1. Energy system in bases and facilities	Development of energy generation and storage systems capable of supplying sufficient power for the activities of bases, camps in operational areas and isolated facilities, enabling a reduction in logistical requirements and supply chain dependencies, while increasing resilience, efficiency and energy independence. Complementary aspects (e.g., standardisation, renewable resource planning and simulation tools, etc.) are also considered to ensure that these technologies can be effectively deployed in operational environments. Part of the "Energy generation, storage and efficiency in isolated bases and infrastructures" objective.
4.2.2. Smart electrical energy networks for defence	Development of smart electrical microgrids applicable to defence facilities, both in national territory and in operational areas, aimed at improving the quality, management and security (both physical and cyber) of electrical supply. These networks must increase energy flexibility and resilience, as well as facilitate the integration of renewable energy sources and storage systems. Part of the "Energy generation, storage and efficiency in isolated bases and infrastructures" objective.
4.2.3. Fuel self-production	Development of systems for decentralised and in situ production of fuels and useful chemical products, intended to reduce dependence on logistical supply during overseas operations. These solutions must be capable of generating liquid or gaseous fuels and other strategic compounds from locally available raw materials (water, biomass, waste, CO_2, etc.), adaptable to different platform types and applications. Priority will be given to compatibility with existing engines, ease of deployment, process energy efficiency and reduction of the logistical footprint in prolonged or hard-to-access operational scenarios.
4.2.4. Integrated and efficient climate control and DHW	Adaptation and validation of climate control and domestic hot water (DHW) systems for deployable bases and facilities, aimed at achieving high energy efficiency through the integration of multiple thermal sources. These systems must optimise the combined use of solar energy, waste heat, biofuels or other locally available sources, reducing overall energy consumption of the installation and increasing operational autonomy in environments with logistical constraints.

4. BASES AND FACILITIES	
4.3. MODERNISATION OF BASES AND FACILITIES	
4.3.1. Incorporation of Industry 4.0 technologies within bases, facilities and Department processes	Application of Industry 4.0 technologies (e.g., IoT, automation, advanced analytics, artificial intelligence, etc.) to modernise bases and logistics facilities and to optimise their processes. Their integration will be promoted through technological innovation projects that contribute to improving operational efficiency, sustainability and the digital transformation of the Department. Part of the "Technologies supporting the life cycle of military systems" objective.
4.3.2. Intelligent and efficient buildings	Development of technologies for the design, construction, operation and deployment of buildings and temporary infrastructures in bases and camps, adapted to defence operational requirements and capable of integration in multinational environments. Priority will be given to solutions that improve energy efficiency through new materials, advanced construction techniques and intelligent resource management systems.
4.3.3. Test facilities for defence against emerging threats	Development of advanced test facilities enabling the Armed Forces and the defence R&D&I ecosystem to develop, validate and certify technologies against particularly demanding emerging threats. These facilities must be prepared to reproduce realistic and highly demanding conditions, whether physical, electromagnetic or cyber, facilitating the evaluation of weapon systems, sensors, protection solutions, platforms and C4ISR systems against current and future scenarios. Priority will be given to flexibility and compatibility with international standards and cooperation frameworks.

5. LAND PLATFORMS

5.1. LAND PLATFORM DESIGN

5.1.1. Design of next-generation manned land platforms	Research and development across the different domains contributing to the development of next-generation manned land platforms. Cross-cutting actions are envisaged in areas that allow progress in improving the structural design of land platforms, taking into account their motion dynamics and inherent characteristics, including mobility, survivability (shape studies and simulation of behaviour against explosions and ballistic impacts), habitability and payload capacity, with the aim of achieving designs that optimise these parameters.
5.1.2. Architecture and integration in land platforms	Development of open, modular and scalable architectures that facilitate the physical and logical integration of new systems or payloads in order to adapt platforms to multiple missions, expand platform health monitoring and improve information management and energy consumption of onboard systems, thereby enhancing fleet efficiency and simplifying maintenance.

5. LAND PLATFORMS	
5.2. ENERGY AND MOBILITY OF LAND PLATFORMS	
5.2.1. Hybrid and electric propulsion and electrification of land platforms	Research and development focused on the integration of new technologies in the field of hybrid propulsion. The development of fully electric propulsion systems is also envisaged, including the development of axial-flux, radial-flux or other electric motor concepts, as well as the electrification of platforms and their subsystems. In addition, the integration and validation of electrical energy storage systems enabling platform and subsystem operation in fully electric mode are considered. Part of the "New propulsion solutions for manned platforms and unmanned systems" objective.
5.2.2. Conventional propulsion and transmission systems	Development of propulsion and transmission technologies that enhance vehicle mobility performance in terms of propulsion or power transmitted to the running gear, enabling increased payload capacity and improved ability to operate across different terrains. Among other aspects, enhancements are envisaged in propulsion systems, including the use of alternative fuels (SAF, hydrogen, ammonia, among others), as well as more efficient and lightweight transmission mechanisms.
5.2.3. Advanced mobility systems	Research and development of auxiliary technologies supporting the propulsion system, aimed at improving platform mobility and its ability to operate effectively across diverse terrain conditions. This includes systems complementary to propulsion and transmission aimed at improving land platform mobility, such as innovative traction technologies (wheels and tracks) or advanced suspension systems. Technologies that increase the reliability and robustness of the running gear (such as anti-puncture systems) are also considered.

5. LAND PLATFORMS	
5.3. INTEGRATED SYSTEMS	
5.3.1. Platform crew situational awareness	Research and development to optimise information management within the platform in order to maximise operator situational awareness and facilitate both vehicle control and mission execution. This includes advances related to the integration of sensors and C4I systems on the platform, the fusion and intelligent presentation of information to the crew, and the use of advanced and immersive control interfaces and driver assistance systems (automation of certain functions, shared human-machine control, etc.), all supported by artificial intelligence.
5.3.2. Integration and interoperability of weapons with land platforms	Research and development of new weapon stations that optimise weight and dimensions as well as the functionality and handling of the integrated weapons, seeking more compact designs with increasing levels of automation, enabling shorter weapon engagement times and potentially reducing the number of required operators. In addition to the reloading process and ammunition management, specific functions such as detection, tracking and acquisition of potential targets and threats are to be automated, while critical decisions regarding weapon selection and firing command remain under operator control. Designs of remote weapon stations that anticipate the integration of next-generation armaments, such as laser weapons or electromagnetic guns, are also sought.
5.3.3. Active and reactive protection systems	Research and development of active and reactive protection technologies to complement traditional passive armour in order to increase the overall level of platform protection. On the one hand, both explosive and non-explosive reactive armour solutions are pursued, capable of reacting to projectile impact in order to neutralise or mitigate the damage inflicted on the platform. On the other hand, active protection technologies are envisaged to enable the detection, identification, tracking, and neutralisation of threats prior to their impact on the platform, with priority given to sensor hybridisation for the detection and tracking of RAM threats (rockets, artillery and mortar projectiles), UAS, loitering munitions and anti-tank missiles. This also includes the integration or installation of these systems within the platform self-protection suite. Part of the "Technological solutions against low-altitude aerial threats" objective.

5. LAND PLATFORMS	
5.4. GROUND ROBOTICS	
5.4.1. Conversion of platforms or groups of platforms into unmanned systems	Research and development aimed at converting one or more existing military vehicles into unmanned platforms, enabling remote control either individually or as part of a convoy. Vehicles may operate under teleoperation or with higher levels of autonomy, allowing military missions to be executed without human presence on board. The goal is to obtain standardised automation kits comprising sensors, actuators, communications equipment, control electronics and human-machine interfaces, easily adaptable to different platform types and enabling remote system control. In convoy scenarios, unmanned platforms may be combined with manned platforms, including configurations in which manned vehicles do not lead the convoy, enabling flexible adaptation of the role and number of vehicles within the system. Part of the "Unmanned land platforms for defence missions" objective.
5.4.2. Advanced UGV functionalities based on robotic autonomy	Research and development of technological solutions to enhance autonomous functionalities of robotic systems used in defence, supported by artificial intelligence. In particular, interest focuses on achieving increasing degrees of autonomy in unstructured environments (e.g., navigation and positioning in GNSS-denied environments, automatic path generation, obstacle detection and avoidance, complex manoeuvres, among others), cooperative operation between platforms (e.g., autonomous following, swarm formation, automatic task allocation, coordinated manoeuvres, etc.), as well as aspects of communications interoperability and the use of robotic architecture standards adapted to defence requirements. Part of the "Unmanned land platforms for defence missions" objective.

5. LAND PLATFORMS	
5.4. GROUND ROBOTICS	
5.4.3. Robotics for specific defence missions	Research and development aimed at obtaining robotic systems adapted to different military missions, tailoring platform characteristics (e.g., vehicle architecture, dimensions, mobility, payload capacity, level of autonomy, beyond-line-of-sight range, etc.) to the specific requirements of each mission. To this end, the development of generic robotic platforms across different weight segments (heavy, large, medium, small and mini) is pursued, from which mission-specific variants can be derived through the integration of dedicated payloads. Particular interest lies in C-IED/CBRN applications (detection/identification, marking and sampling), surveillance and reconnaissance, logistic support to the soldier, medical evacuation (including infectious casualties), engineering/combat engineering, urban operations, electronic warfare, communications relay, C-UAS, emergency response and combat operations, ensuring in the latter case that a human operator always retains control over the robot's armament. There is also interest in UGVs acting as mothership platforms, capable of hosting, transporting and deploying different types of UxV. Part of the "Unmanned land platforms for defence missions" objective.
5.4.4. Biomimetic robotics	Design and development of innovative robotic architectures differing from conventional UGV vehicular designs, inspired by the geometries and locomotion mechanisms of living beings to give rise to robots with new mobility and operational capabilities. These systems include humanoid robots with bipedal locomotion and the ability to manipulate human-oriented objects, as well as robots inspired by vertebrate and invertebrate animals, such as quadrupeds, reptiles, and others. Designs should prioritise ergonomics, natural interaction with the environment and energy efficiency, achieving realistic balance and mobility and integrating language models for environment interpretation and contextual dialogue.

6. NAVAL PLATFORMS

6.1. NAVAL PLATFORM DESIGN

6.1.1. Design of surface naval platforms	Research and development of next generation surface naval platforms, addressing not only hydrodynamic, aerodynamic, structural, habitability, armour and signature reduction aspects, but with a particular focus on a modular architecture enabling the integration of interchangeable sensors, equipment and systems according to operational requirements. Furthermore, advanced configurations such as partially supported vessels (hydrofoils) or air-cushion vehicles (hovercrafts) will also be explored, aimed at enhancing mobility and amphibious capability. Work will also be required to improve interoperability between own manned and unmanned systems and platforms, as well as with allied forces' units, facilitating flexible and efficient joint operations.
6.1.2. Design of submarine naval platforms	Research and development of new submarine platform designs aimed at improving hydrodynamic performance, optimising interaction between the hull and the propulsion system, and reducing detectability. The use of advanced materials that increase structural strength and contribute to acoustic and electromagnetic stealth will be promoted. Priority will be given to a modular architecture enabling the submarine to be adapted to a wide range of missions, from asymmetric warfare operations to advanced surveillance. Future submarines shall be designed to integrate unmanned underwater vehicles (UUV), including their associated launch and recovery systems.

6. NAVAL PLATFORMS	
6.2. NAVAL CONTROL, ENERGY AND PROPULSION	
6.2.1. Propulsion systems for naval platforms	Research and development supporting the design of new propulsion systems with improved performance in terms of power, efficiency and reduction of pollutant emissions (COx, NOx, etc.), enabling increased manoeuvrability and operational responsiveness of platforms. Aspects include improvements in conventional propulsion (diesel engines, petrol engines, gas turbines, etc.), adoption of alternative propulsion technologies (biofuels, liquefied natural gas, ammonia, green hydrogen, etc.), diesel-electric hybrid systems, exploitation of renewable sources, as well as the evolution of propulsion systems (conventional propellers, CLT, waterjets, Voith-Schneider propellers, azimuth thrusters, etc.). In parallel, work will be conducted on non-conventional propulsion systems (biomimetic propulsors-flexible, rigid-flexible-toroidal systems, etc.), as well as emerging propulsion concepts based on supercavitation, magnetohydrodynamics (MHD), compact engines, distributed electric propulsion or other solutions capable of overcoming the speed and stealth limitations of conventional propulsion, providing greater operational efficiency and a decisive tactical advantage in the maritime domain. Part of the "New propulsion solutions for manned platforms and unmanned systems" objective.
6.2.2. Propulsion systems in submarines	Research and development focused on enhanced hybrid configurations integrating Air Independent Propulsion (AIP) technologies with high-capacity batteries. The objective is to increase submerged endurance, thereby minimising detection opportunities (thermal and acoustic signatures) and expanding the operational area. Progress will be required in technologies such as next-generation fuel cells, with cleaner reformers and higher energy efficiency, as well as new batteries, particularly lithium-ion batteries, to improve energy density (greater endurance and speed), reduce charging times, extend service life and reduce maintenance requirements. Likewise, research into new materials and advanced thermal management systems is essential to ensure safety in lithium use and mitigate overheating or explosion risks under extreme operational conditions. This is complemented by the integration of hybrid systems with intelligent energy management, capable of optimising consumption between AIP and batteries according to mission profile, ensuring more efficient and flexible use of available resources. Solid-state batteries, optimised diesel-electric systems and hydrogen-based propulsion will also be of interest. Part of the "New propulsion solutions for manned platforms and unmanned systems" objective.

6. NAVAL PLATFORMS

6.2. NAVAL CONTROL, ENERGY AND PROPULSION

6.2.3. Power generation systems for naval platforms	Research and development of new onboard electrical power generation and storage sources in response to the growing emergence of new energy demands in military vessels, such as electromagnetic railguns, directed energy weapons (DEW), electromagnetic launch systems on aircraft carriers, etc., which require very high power over short time intervals. Progress will be needed in temporary energy storage systems such as batteries, supercapacitors or flywheels, enabling efficient accumulation and release of the required energy. To enhance ship electrification, particular emphasis will be placed on integrated electric propulsion (IEP) based on an advanced naval propulsion architecture, where all distributed onboard power generators feed a common electrical grid supplying power both to propulsion engines and to the rest of onboard systems. Part of the “New propulsion solutions for manned platforms and unmanned systems” objective.
6.2.4. Manoeuvrability of naval platforms	Research and development of control technologies and systems aimed at improving manoeuvrability and dynamic positioning of both manned and unmanned naval platforms. This includes the design and integration of bow thrusters, rudders, servomotors, active stabilisers and other steering systems enabling precise and safe navigation in complex operational environments, constrained manoeuvres or adverse environmental conditions. These capabilities are essential to increase tactical effectiveness and facilitate docking, anchoring and other operations that require precise platform control.

6. NAVAL PLATFORMS	
6.3. INTEGRATED SYSTEMS IN NAVAL PLATFORMS	
6.3.1. Evolution of combat systems in naval platforms	Research and development of new architectures and functionalities for naval platform combat systems, aimed at facilitating adaptation to the growing variety and sophistication of threats, the emergence of new weapon systems (directed energy weapons, laser weapons, munitions deployed from unmanned platforms), the increasing volume of data to be processed, and the need to reduce decision and response cycles in real time. The system-of-systems approach will be maintained, ensuring scalability, seamless integration of new sensors and weapons, interoperability among national systems as well as with allied countries' systems, and compliance with security and cyber-protection requirements.
6.3.2. Digital ship	Research and development of solutions for the automation, advanced sensorisation and full digitalisation of naval platforms, based on a shared, joint and standardised digital architecture at European level. This includes deployment of digital twins, standardisation of onboard-generated data and integration of artificial intelligence for interpretation of operational information and real-time decision-support. In addition, technologies for autonomous navigation and robust positioning in the absence of GNSS will also be investigated as a key element in strengthening operational resilience and functional continuity of the digital ship system. The evolution towards highly digitalised ships will require prioritisation of cybersecurity through the development of secure communication protocols, intrusion detection systems and active protection mechanisms. Digitalisation will also encompass the human factor, through personnel tracking systems and physiological monitoring to anticipate situations of fatigue, stress or operational risk.
6.3.3. Integration of unmanned vehicles in surface platforms	Research and development of solutions for the physical and functional integration of unmanned vehicles in mothership vessels, including onboard accommodation (storage, launch and recovery) as well as their control and operational interoperability. The design of spaces, handling systems and support logistics will be addressed, along with the integration of UxV into the platform's command and control systems, ensuring their incorporation into the Navy's Combat System. This integration will enable centralised mission management, secure and efficient exchange of tactical information, and seamless coordination with other manned and unmanned platforms. Part of the "Unmanned surface and underwater vehicles for defence missions" objective.

6. NAVAL PLATFORMS	
6.4. UNMANNED MARITIME VEHICLES	
6.4.1. Unmanned underwater vehicles	Research and development of unmanned underwater vehicles (ROV, AUV, gliders and UL-UUV) designed to operate in complex environments, deep sea and without persistent communications, in long-duration and high-risk missions. These systems shall be adapted to different operational profiles, such as acoustic intelligence operations (ACINT), anti-submarine warfare (ASW), seabed surveillance, rapid environmental assessment (REA) or support to special operations, including intervention and covert deployment functions. Key technologies to be researched include high-pressure-resistant materials, efficient and precise propulsion system, combined inertial-acoustic navigation, intervention robotic arms and functional modularity. The use of onboard artificial intelligence will be enhanced to enable autonomous decision-making, dynamic mission replanning and automatic recognition of underwater targets. Improvements in energy density and underwater communications will also be pursued to enable persistent operations without direct intervention. Part of the “Unmanned surface and underwater vehicles for defence missions” objective.
6.4.2. Unmanned surface vehicles	Development of unmanned surface vehicles (USVs) designed to operate autonomously in complex maritime environments, both littoral and open sea, for missions including surveillance, reconnaissance, mine warfare, amphibious support and protection of critical infrastructure. These systems shall provide high levels of autonomy, resilience and integration within C4ISR networks, even in scenarios with degraded communications or GNSS denial. Priority technologies include autonomous navigation compliant with COLREG, obstacle avoidance, multisensor fusion (radar, EO/IR, LIDAR, sonar, inertial sensors), real-time decision-support and explainable AI for mission management and cooperative operations between platforms. In addition, secure and resilient communications, low-signature hybrid or electric propulsion and advanced energy management for prolonged operations will also be promoted. Modular payload architectures and standardised interfaces will be encouraged to adapt different mission profiles. Work will be carried out on the integration of modular weapon systems, C2 systems, AI and advanced sensors for target identification and tracking, as well as interoperability between national and allied platforms. Part of the “Unmanned surface and underwater vehicles for defence missions” objective.

6. NAVAL PLATFORMS	
6.4. UNMANNED MARITIME VEHICLES	
6.4.3. Swarms of unmanned naval vehicles and motherships	Research and development of robust control and coordination technologies for operating swarms of networked unmanned surface and underwater vehicles (USV and UUV), capable of acting cooperatively and autonomously in the execution of naval missions. The use of onboard artificial intelligence will be promoted to provide swarms with adaptive capabilities to the environment, dynamic task allocation, decentralised decision-making and real-time mission replanning. Collaborative operation will be envisaged both among themselves and with systems from other domains (land, maritime or air), fostering multidomain integration in distributed operations. Communications shall ensure secure, continuous and resilient data exchange between platforms, even in GNSS-denied environments or under electronic threat conditions. In addition, the development and incorporation of unmanned naval mothership platforms will be promoted, acting as command, launch, recovery and logistical support centres for unmanned vehicles, enabling extension of operational range, sustainment at sea and interoperability with the rest of naval forces. These platforms shall feature open architectures, reconfigurable mission modules and advanced management and communications systems, facilitating efficient integration of heterogeneous swarms in complex operational scenarios. Part of the "Unmanned surface and underwater vehicles for defence missions" objective.

7. AIR PLATFORMS

7.1. AIR PLATFORM DESIGN

7.1.1. Development of manned fixed-wing air platforms	Research and development in the design of next-generation manned platforms, both transport and combat aircraft. Actions are envisaged to mature and define new concepts of operation (collaborative combat, precision delivery, transport of over and outsized cargo, etc.); actions to define and develop designs that reduce the platform footprint, particularly the electromagnetic footprint; designs incorporating lighter and more efficient aerostructures and armour; and more flexible architectures enabling the integration of interchangeable equipment to achieve multi-mission configurations. Actions are also envisaged to define and design architectures that facilitate the integration of digitalisation technologies, information management, autonomy and artificial intelligence, in order to provide new aircraft with the capabilities required to address future needs of the Armed Forces (integration into the combat cloud, enhanced situational awareness, automatic take-off and landing, etc.). Actions aimed at improving the life cycle of platforms through development and innovation in aircraft health monitoring systems are also contemplated.
7.1.2. Development of manned rotary-wing air platforms	Research and development across all areas contributing to the evolution of next-generation manned rotary-wing platforms. Actions are envisaged to mature and define innovative designs that retain helicopter VTOL (vertical take-off and landing) capability while improving characteristics to achieve high-speed, long-range and high-altitude solutions, without neglecting actions aimed at improving the performance and capabilities of current platforms. Development of multipurpose solutions with more efficient aerostructures and modular architectures will be promoted, along with improvements in connectivity, self-protection, survivability and attack capability, autonomy, availability and sustainability, ensuring that next-generation rotary-wing platforms maintain their pre-eminence in multidomain operations (armed reconnaissance, attack, air assault, close air support, combat SAR, etc.).

7. AIR PLATFORMS

7.1. AIR PLATFORM DESIGN

7.1.3. Development of vehicles for hypersonic flight	Research and advancement in the knowledge of hypersonic flight (speeds exceeding Mach 5), from the definition of operational concepts for both offensive and defensive vehicles, to the identification of the technologies required to enable their design. This includes the study of aeroelastic conditions and the propagation and impact of shock waves at hypersonic speeds during flight, as well as thermodynamic characterisation under plasma formation and air ionisation conditions around the vehicle. Actions are also envisaged to identify mechanical, thermodynamic, electromagnetic, strength, vibration and fatigue requirements for structural elements as well as coatings, control surfaces and actuators, take-off and landing systems, and electrical and electronic subsystems. Identification of testing and manufacturing requirements for these elements, as well as analysis of habitability requirements, are also contemplated. Part of the "Technologies for hypersonic vehicles" objective.

7. AIR PLATFORMS	
7.2. ENERGY AND PROPULSION	
7.2.1. Energy and propulsion systems for air platforms	Actions supporting the design of new propulsion systems and improvement of existing ones, for both manned and unmanned platforms. These propulsion systems will be appropriately sized in terms of scale, complexity and performance according to the type of aircraft for which they are developed, ensuring in all cases that the platform achieves the performance required for the corresponding defence mission. Particular attention will be paid to propulsion systems for smaller unmanned platforms (Class I), in order to enable them to perform the multiple missions required, encompassing actions across all types of engines (combustion, electric, hybrid, etc.). Actions are envisaged to design propulsion plant architectures and subsystems, reduce thermal and acoustic signatures, develop technologies enabling the use of alternative fuels, and optimise performance and energy efficiency of air platforms, whether through development of energy generation and storage technologies or by advancing energy management systems. Part of the "New propulsion solutions for manned platforms and unmanned systems" objective.
7.2.2. Propulsion for hypersonic regimes	Research and development of propulsion systems capable of sustained operation in hypersonic regimes (Mach 5+), including scramjet-type concepts, combined systems (turbojet + ramjet/scramjet) and others. Aspects such as high-speed ignition, supersonic combustion, adaptive geometries and the use of advanced energetic fuels will be addressed. Development of facilities capable of operating under hypersonic conditions is also envisaged. Part of the "Technologies for hypersonic vehicles" objective.

7. AIR PLATFORMS	
7.3. INTEGRATED SYSTEMS IN AIR PLATFORMS	
7.3.1. Air avionics systems	Development of technologies relevant to avionics for both onboard-manned and remotely piloted air platforms, enabling greater autonomous functionality while optimising human workload. Actions include the design and development of all aircraft subsystems following the integrated modular avionics concept (communications, guidance and control, navigation, passive and active sensors, etc.). The objective is to achieve a higher degree of digitalisation and onboard processing, optimising the information available to the pilot and to achieve human-machine interfaces that enable more efficient control, enhance situational awareness and support decision-making. Particular emphasis is placed on defining and maturing system architectures for remotely piloted platforms in order to achieve higher levels of autonomy. Part of the "UAS for defence missions" objective.
7.3.2. Mission systems	Development of onboard technologies to improve mission execution capabilities in both manned and remotely piloted air systems. Actions are envisaged to evolve current mission systems towards solutions integrating equipment that is currently independent, reducing avionics weight and optimising onboard processes. Robust positioning and navigation solutions enabling mission execution with a high degree of autonomy from external aids (GNSS signals or other navigation aids) are considered, along with improvements in payload management to achieve enhanced situational awareness in support of decision-making, ensuring more efficient mission execution and improving defence mission capabilities of remotely piloted systems (intelligence, surveillance, reconnaissance and target acquisition). Actions to define and develop the MUM-T (manned-unmanned teaming) concept are also envisaged, enabling both UAS and manned aircraft to conduct collaborative missions such as combat, air support or logistic support, among others. Part of the "UAS for defence missions" objective.

7. AIR PLATFORMS	
7.3. INTEGRATED SYSTEMS IN AIR PLATFORMS	
7.3.3. Weapon systems on air platform	Research and development of technologies aimed at improving integration of weapon systems and increasing the degree of interoperability of armament across different types of air platforms. Actions are envisaged to enhance both physical and logical integration of the sensors and effectors required to respond to the growing variety of threats, including next-generation weapons. Increased automation across the entire process (detection, tracking and target acquisition) is pursued in order to facilitate integration of weapon systems into the aircraft mission system and reduce response time. Particular emphasis is placed on actions to define and mature weapon system architectures and functionalities for remotely piloted air platforms, in order to enhance the capabilities of this type of aircraft. Part of the "UAS for defence missions" objective.
7.3.4. Air-to-air refuelling solutions for military aircraft	Actions aimed at optimising air-to-air refuelling operations in terms of efficiency and autonomy, as this is a fundamental mechanism enabling long-duration or long-range air operations for both fixed-wing and rotary-wing platforms, manned or unmanned, while maintaining mission capability. Actions are envisaged to improve and innovate refuelling deployment equipment, both for boom operations and probe-and-drogue systems. Development of control and monitoring subsystems for refuelling operations is also envisaged, with the objective of increasing the level of automation. Progressive achievement of fully autonomous air-to-air refuelling operations is pursued, potentially including the approach manoeuvre between tanker aircraft and receiver aircraft.
7.3.5. Integration of UAS into airspace	Actions aimed at enabling full integration of unmanned air systems into airspace, complying with military regulatory requirements (EMAR or PERAM), EASA airworthiness requirements, and applicable SES (Single European Sky) requirements, including interoperability and Flexible Use of Airspace (FUA). Developments of technological solutions contributing to UAS certification will be considered, enabling them to operate in both operational scenarios and in civil airspace.

7. AIR PLATFORMS	
7.4. UAS	
7.4.1. Unmanned air systems	Continuation of research and development across all domains contributing to improved Class I unmanned air systems, as well as contributions at national level and in cooperation with other countries to the development of Class II/III systems. Actions are envisaged to define and develop new UAS designs supporting successful execution of current ISR/ISTAR missions, as well as achieving the required performance (speed, ceiling, endurance, connectivity, autonomous perception/navigation, etc.) to support potential new missions. These actions encompass designs enhancing VTOL capability, more efficient aerostructures, more flexible architectures and adaptation to new propulsion systems, among others. Part of the "UAS for defence missions" objective.
7.4.2. Multipurpose unmanned air systems	Actions aimed at research and development of multipurpose unmanned systems to achieve platforms with multiple capabilities (surveillance, reconnaissance, warfare payloads, etc.), enabling employment in diverse missions such as decision support, pre- and post-strike intelligence, signals intelligence, target acquisition, and even kinetic attack by the system itself. Actions range from defining concepts of operation, system architecture and modular platform design (including movable parts), to mission and communications systems and integration of interchangeable payloads. Actions to improve subsystems providing manoeuvrability, high speed, long range and other key performance aspects will be promoted, along with studies on feasibility, compatibility, constraints and interference among subsystems and payloads, and interoperability requirements, contributing to the definition of use cases for multipurpose UAS. Part of the "UAS for defence missions" objective.

7. AIR PLATFORMS	
7.4. UAS	
7.4.3. Logistic unmanned air systems	Actions aimed at research and development of unmanned air systems for cargo transport, achieving solutions with the performance and capabilities required for various logistic support missions such as resupply in operational areas or distribution of materiel in bases and barracks. Actions include defining and maturing concepts of operation, system sizing and architecture, platform design, mission and communications systems, propulsion and energy needs, degree of automation/autonomy, as well as development of UAS equipment and subsystems related to storage, transport, collection and delivery according to system size. Part of the "UAS for defence missions" objective.
7.4.4. Swarms of unmanned air systems	Development of mission solutions enabling control of multiple unmanned air platforms simultaneously as a single system. Actions are envisaged to define and mature concepts of operation for swarm systems and to design system architectures. Solutions must be modular and platform-agnostic, enabling either distributed intelligence networks or centralised networks, maintaining human mission command while relieving the operator of individual vehicle control, allowing autonomous, dynamic, coordinated and collaborative movement of platforms. Actions are also envisaged to research and develop swarm deployment systems capable of integration into land, air and maritime systems, covering all aspects required for deployment from safe storage and transport to launch and recovery, communications infrastructure and integration into the command and control system of the mothership system, etc. Part of the "UAS for defence missions" objective.

8. SPACE SYSTEMS

8.1. SPACE DOMAIN AWARENESS (SDA)

8.1.1. Technological solutions supporting Space Domain Awareness (SDA)	Development and enhancement of technological capabilities oriented towards surveillance and tracking of the space environment, covering both the ground segment (radars, telescopes, optical sensors and other systems dedicated to the observation of satellites, objects and space phenomena) and the space segment (onboard payloads). These capabilities will enable detection, identification and characterisation of objects in space, including space debris, natural celestial bodies (such as meteoroids and asteroids), own or third-party satellites and adverse space weather phenomena, through the analysis of parameters such as size, shape, orbital behaviour, manoeuvres and activity patterns. The objective is to strengthen space situational awareness, improve anomaly detection, anticipate potential collisions and mitigate risks associated with hostile or unusual actions in the space domain. Part of the "Innovative solutions for defence in the space domain" objective.
8.1.2. Space traffic management (STM) systems	Development and evolution of advanced space traffic management (STM) systems, aimed at exercising command and control functions over an increasingly congested orbital environment resulting from the growing number of satellites in orbit and operators. These capabilities must enable safe, efficient and coordinated management of space traffic, facilitating collision prediction and prevention, orbital trajectory planning and real-time conflict resolution. Interoperability with air traffic management (ATM) systems will also be promoted, with a view to future integration of both environments under common regulatory and operational frameworks. The development of these systems will contribute to strengthening space security, ensuring the sustainability of the orbital environment and protecting national and European interests in the space domain.

8. SPACE SYSTEMS	
8.2. SATCOM COMMUNICATIONS	
8.2.1. Satellite technologies for satellite communications (SATCOM)	Development of payloads for voice and data transmission, optimised for integration into small platforms in medium Earth orbit (MEO), low Earth orbit (LEO) and even very low Earth orbit (VLEO), in order to complement and interoperate with current geostationary orbit (GEO) systems, such as SPAINSAT NG, or future European multi-orbit capabilities (e.g., IRIS²). These capabilities must ensure secure, high-speed communications that are resilient to interference, jamming or spoofing, contributing to the reinforcement of sovereignty and strategic autonomy in the SATCOM domain. Development of satellite platforms and payloads enabling the tactical communications bubble concept will also be promoted, integrating emerging technologies such as 5G for distributed operational environments, as well as quantum and/or post-quantum technologies. The development of the ground segment is also envisaged, enabling its adaptation for efficient and flexible operation of MEO/LEO/VLEO constellations, as well as dynamic management of voice and data traffic switching between systems in different orbits, ensuring continuity and robustness of military communications in complex scenarios. Part of the "Innovative solutions for defence in the space domain" objective.
8.2.2. SATCOM user terminals	Development and optimisation of user terminals for satellite communications (SATCOM), adapted to the capabilities and operational requirements of new constellations of small satellites in MEO, LEO and VLEO, with the ability to efficiently manage real-time voice and data transmission. These terminals must be fully interoperable with existing geostationary orbit (GEO) systems, such as SPAINSAT NG, enabling seamless transition between orbital segments and guaranteeing continuous, secure and interference-resilient communications across the operational spectrum. Development of a wide range of terminals is envisaged, including those onboard mobile defence platforms (land, air and naval), as well as semi-static, portable and manpack versions, adaptable to different tactical scenarios and deployment levels. The objective is to provide deployed forces with a robust, flexible SATCOM capability that can be easily integrated into multi-environment command and control networks.

8. SPACE SYSTEMS	
8.3. INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (ISR)	
8.3.1. ISR payloads	Development and enhancement of technologies onboard Earth observation satellites, aimed at providing advanced intelligence, surveillance and reconnaissance (ISR) capabilities from both low Earth orbit (LEO) and geostationary orbit (GEO). Priority will be given to the development of high-resolution optical and radar payloads, including multispectral reconnaissance imaging sensors, mid-wave infrared (MWIR), long-wave infrared (LWIR) and synthetic aperture radars (SAR), within the framework of the space segment of the Spanish Earth Observation Satellite System (SEOT). Integration of onboard SIGINT (signals intelligence) capabilities enabling interception, localisation and analysis of electromagnetic emissions in the operational environment will also be promoted. Part of the "Innovative solutions for defence in the space domain" objective.
8.3.2. Data exploitation for ISR	Development and enhancement of the ground segment of Earth observation systems, oriented towards reception, processing, fusion and advanced interpretation of data from optical sensors, including multispectral reconnaissance imagery, mid-wave infrared (MWIR), long-wave infrared (LWIR), and synthetic aperture radars (SAR), onboard satellites in LEO, MEO and VLEO. Integration of multisensor data will be promoted to enrich information content, improve temporal continuity of observations and expand detection, identification and monitoring capabilities. Evolution of the ground segment is also envisaged to enable advanced control and tracking of satellites in non-geostationary orbits, including command and mission planning capabilities in near-real time, as a key element of a robust, flexible ISR architecture oriented towards operational decision-making in dynamic scenarios.

8. SPACE SYSTEMS	
8.4. GNSS CAPABILITIES	
8.4.1. GNSS capabilities in LEO/VLEO orbits	Development of global navigation satellite capabilities integrated into small satellites in low Earth orbit (LEO) and very low Earth orbit (VLEO), with the aim of leveraging the operational advantages offered by these platforms in terms of latency, enhanced regional coverage and resilience to interference. These capabilities will complement and coordinate with traditional GNSS systems in medium Earth orbit (MEO), strengthening robustness, availability and accuracy of positioning, navigation and timing (PNT) services, which are essential for military operations in demanding and contested environments. Priority will be given to interoperability between the European GNSS system (Galileo) and those of allied countries, as well as to integration into distributed secure navigation architectures, contributing to strategic autonomy and protection of critical capabilities in the space domain. Part of the "Innovative solutions for defence in the space domain" objective.
8.4.2. High-performance GNSS receivers	Development of advanced global navigation satellite system (GNSS) receivers designed to provide highly reliable, accurate and robust geolocation and radionavigation capabilities in demanding tactical environments with satellite coverage. Their integration is envisaged across a wide range of platforms, manned and unmanned, land, naval and air, as well as in smart weapons and portable equipment for the soldier. Receivers must be multi-constellation, incorporate signal augmentation systems (SBAS, such as EGNOS) and be prepared to operate with the Galileo Public Regulated Service (PRS) for governmental and defence applications. Advanced resilience features against interference will be prioritised, including anti-jamming, anti-spoofing and anti-meaconing capabilities, as well as robust authentication mechanisms, ensuring continuity and reliability of positioning even in highly contested environments. Part of the "Technologies for robust PNT" objective.

8. SPACE SYSTEMS	
8.5. OTHER SPACE APPLICATIONS FOR DEFENCE	
8.5.1. Space-based early warning capabilities	Development of technological solutions for satellite payloads and sensors integrated into the ground segment, aimed at detecting and tracking thermal signatures associated with the launch of ballistic missiles, hypersonic missiles and other space vectors. These capabilities will enable early event localisation, precise trajectory tracking and near-real-time threat characterisation. The objective is to provide an autonomous and reliable space-based early warning capability, strengthening space domain situational awareness and enabling timely response through activation of missile defence systems and strategic decision-making at national or multinational level. Part of the "Innovative solutions for defence in the space domain" objective.
8.5.2. METOC capabilities in LEO orbits	Development and implementation of onboard meteorological and oceanographic (METOC) payload capabilities for small satellites in low Earth orbit (LEO) and very low Earth orbit (VLEO), aimed at providing environmental data in direct support of Armed Forces operations. These capabilities will align with the Rapid Environmental Assessment (REA) concept, facilitating rapid and updated assessments of atmospheric, maritime and land conditions in areas of operational interest. The objective is to strengthen tactical and strategic decision-making through continuous and reliable environmental awareness. The information obtained will complement that provided by civil bodies and will be integrated into information management processes to improve the efficiency of the environmental intelligence cycle. Part of the "Innovative solutions for defence in the space domain" objective.
8.5.3. On-orbit satellite servicing	Development of autonomous orbital servicing platforms equipped with robotic, vision and recognition subsystems, designed to perform in-situ refuelling, modular reconfiguration and repair of critical failures in satellites not originally designed for servicing. Use of standardised interfaces and artificial intelligence algorithms for predictive anomaly diagnosis and manoeuvre planning in non-cooperative environments is envisaged. Reconfigurable architectures enabling assembly of larger orbital structures, such as antennas and solar panels, through modular component kits are also foreseen. This capability will drive the creation of a self-maintained orbital infrastructure, reducing the need for replacement satellite launches and mitigating collision risks through active deorbiting of non-operational satellites and space debris.

8. SPACE SYSTEMS	
8.6. ENABLING AND RAPID RESPONSE SOLUTIONS IN THE SPACE DOMAIN	
8.6.1. Devices and systems forming the structure of a satellite	Development and optimisation of reference architectures and subsystems integrating a satellite, regardless of payload type, adapted to the specific requirements of defence operations. This includes improvements to solar panels, component miniaturisation, use of materials designed to withstand the space environment, and optimisation of power systems. Advances in onboard processing algorithms and edge computing capabilities will be prioritised, reducing the bandwidth required for communications with the ground segment and enabling efficient preprocessing of information. Payload reconfigurability capabilities will also be integrated, enabling dynamic adaptation to different missions according to operational needs.
8.6.2. Defensive protection against ASAT threats	Development of technological solutions for defensive protection against Anti-Satellite Activities (ASAT) aimed at ensuring security and freedom of operation in the space domain. These solutions include early detection and tracking systems for hostile activities, as well as electronic countermeasures capable of disrupting or deceiving satellite control and communication systems. Passive protection measures are also envisaged to harden systems against threats without resorting to active countermeasures, including radiation shielding and redundant designs with duplicated components, ensuring satellite operability in the event of critical system failures. Cybersecurity measures ensuring confidentiality and security of communications are also included, together with strategies for operational evasiveness and the use of radar-absorbing materials to minimise electromagnetic signature.

8. SPACE SYSTEMS	
8.6. ENABLING AND RAPID RESPONSE SOLUTIONS IN THE SPACE DOMAIN	
8.6.3. Small satellites	Development of small satellites specifically designed for defence missions, either individually or integrated into constellations, distributed architectures or cooperative swarms, optimised to operate over specific geographical areas. These platforms reduce costs and development and deployment timelines, including industrialisation capabilities, while offering higher revisit rates that increase surveillance, monitoring and response capabilities over areas of interest. They also provide operational flexibility and redundancy in hostile or degraded environments. Small satellites are conceived as a complementary capability to large satellite systems, integrated into a resilient and scalable space ecosystem serving the Armed Forces' needs. Part of the "Innovative solutions for defence in the space domain" objective.
8.6.4. High-altitude pseudo-satellites	Development of high-altitude stratospheric platforms (HAPS – High Altitude Pseudo-Satellites) oriented towards defence missions, capable of operating in the stratosphere for prolonged periods over specific areas, providing persistent communications, observation and surveillance capabilities in areas of interest. These platforms complement low- and medium-orbit satellites by offering rapid response, localised coverage and greater operational flexibility, particularly in environments lacking satellite coverage or where it has been degraded. Their integration into operations will strengthen C4ISR capabilities, serve as tactical communications nodes, or support guidance of unmanned systems and precision weapons. Part of the "Innovative solutions for defence in the space domain" objective.
8.6.5. Small satellite launchers	Development of technological solutions for agile launch of small satellites for defence missions, aimed at accelerating deployment timelines and reducing operational costs compared with traditional systems. Versatile launch platforms are envisaged, including solid- or liquid-fuel rockets, air launch from aircraft, airborne systems such as stratospheric balloons, and sea launch from mobile platforms. Multilaunch configurations will also be explored, leveraging the reduced size and mass of platforms to optimise payload and maximise logistical and economic efficiency of orbital deployment. Part of the "Innovative solutions for defence in the space domain" objective.

9. SOLDIER	
9.1. SOLDIER SYSTEM	
9.1.1. Soldier passive protection systems	Development of innovative, competitive, modular and ergonomic technologies aimed at increasing soldier protection against projectiles, fragments, bladed weapon cuts and other threats, as well as minimising the trauma caused by these risks. These innovations will form the basis for the design and manufacture of passive protection systems and elements for the soldier, such as ballistic vests, helmets and limb protection, facilitating their subsequent integration into the soldier system. Part of the "Materials for application in platforms and the soldier" objective.
9.1.2. Soldier signature reduction systems through materials	Development of technologies aimed at reducing the radar, infrared, visible and other signatures of the soldier, enhancing camouflage with the surrounding environment and hindering detection by potential adversaries. These advances will also ensure that optimal levels of mobility and comfort for the user are maintained. Part of the "Materials for application in platforms and the soldier" objective.
9.1.3. Soldier energy systems	Development of a common architecture, with its corresponding interfaces and intelligent management system, enabling increased energy efficiency of dismounted soldier subsystems. Integration and validation of new energy storage and generation systems adapted to soldier mission requirements are also envisaged, including next-generation batteries as well as alternative energy sources. Part of the "Technologies for the dismounted soldier" objective.
9.1.4. Improvement of soldier comfort	Development of innovative solutions to improve the soldier's thermal comfort under all types of environmental conditions. These technologies aim at regulating body temperature in scenarios of extreme heat and humidity, as well as in severe cold conditions, in order to prevent risks such as heatstroke or hypothermia. These advances will not result in any significant reduction of operational capabilities, mobility or soldier performance during mission execution. Part of the "Technologies for the dismounted soldier" objective.

9. SOLDIER	
9.1. SOLDIER SYSTEM	
9.1.5. Reduction of soldier load	Development of innovative solutions such as lightweight materials, miniaturised systems and integrated wearable devices, aimed at reducing the load carried by the soldier (weapons, ammunition and equipment). These technologies seek to improve mobility and physical endurance, reducing fatigue and exhaustion that may lead to injuries and operational casualties. The development of active and passive exoskeletons is also envisaged to assist in marching, load handling, equipment transport, explosive ordnance disposal and weapon handling, optimising soldier performance. Part of the "Technologies for the dismounted soldier" objective.
9.1.6. Integrated and connected soldier system	Development of modular, scalable and secure architectures for the soldier system, conceived as a system of systems integrating communications, sensors, weapons, augmented visualisation and autonomous navigation. Interoperability through open architectures and standards will be prioritised, enabling integration into heterogeneous tactical networks and operation as a distributed node in collaborative missions. Tactical mesh connectivity between soldiers will be addressed through adaptive, cybersecure and interference- and spoofing-resilient solutions, as well as efficient real-time data and video sharing. Technologies to ensure situational awareness will also be included: wearable sensors, data fusion, AR/VR visualisation, interaction with unmanned platforms and embedded analysis and filtering algorithms, together with autonomous navigation capabilities in GNSS-denied environments integrated into the personal mission system. Part of the "Technologies for the dismounted soldier" objective.
9.1.7. Integration and interoperability of individual weapons with the soldier	Research and development of technologies to integrate individual weapons (rifles, pistols, grenade launchers) with the soldier, enhancing effectiveness through electromechanical devices that optimise functionality, situational awareness and interoperability with C2 architectures. The scope includes advanced aiming systems (digital optics, AR sights with data fusion), intuitive human–machine interfaces, sensors for threat detection and LPI/LPD communication modules for integration into tactical networks. Challenges include miniaturisation, new materials to reduce size, weight and power consumption (SWaP), certification of AI algorithms for target prioritisation, and resilience against electronic countermeasures in GNSS-denied environments. Part of the "Technologies for the dismounted soldier" objective.

9. SOLDIER	
9.2. HUMAN FACTORS	
9.2.1. Control and improvement of soldier performance	Development of tools for monitoring and optimising the soldier's physical, psychological and cognitive capabilities: personalised physical training, psychological assessment and preparation, cognitive training, operational training through simulation, learning of sociocultural aspects of the theatre of operations, etc. Development of systems based on low-power wearable sensors capable of measuring physiological parameters and transmitting data in real time for soldier monitoring during training and real operations, enabling continuous assessment of physical, psychological and cognitive states. Development of non-invasive neurotechnologies is also included, aimed both at improving user neural functions (attention, memory, stress management, etc.) through self-regulation training of brain activity, and at monitoring cognitive load to detect mental fatigue situations and prevent errors. Part of the "Technologies for the dismounted soldier" objective.
9.2.2. Advanced human–machine interfaces	Development of human–machine interfaces that enhance soldier situational awareness and interaction with equipment and platforms, ensuring they are intuitive, easy to use and oriented towards mitigating information overload. The objective is to achieve interfaces enabling simplified and efficient control, as well as learning through use, exploring new technologies that facilitate human-machine communication.
9.2.3. Human–unmanned system interaction in missions	Research and development of technological solutions facilitating collaborative work between humans and autonomous platforms (or swarms) as team members (human–machine teaming). Progress is required in the integration of explainable and trustworthy artificial intelligence tools enabling effective adaptation between unmanned systems and operators. Robots must also be equipped with capabilities such as situational awareness and decision-making, allowing them to understand and execute complex instructions. The objective is to achieve the most efficient possible human–unmanned system interaction, enabling broader introduction and deployment of these systems in military missions.
9.2.4. Integration of personnel into platforms	Research and development of solutions improving physical, physiological and psychological aspects related to the integration of personnel into different military platforms. This includes aspects such as ergonomics, resistance to motion sickness or disorientation, among others.

9. SOLDIER	
9.3. SOLDIER HEALTH	
9.3.1. Early medical response	Tools and solutions for tactical combat casualty care (TCCC) enabling mitigation or reduction of the impact of severe injuries sustained in operational areas, such as shrapnel penetration, burns or blast-related trauma, avoiding complications associated with prolonged delays (wound infection, haemorrhage, necrosis, neurological damage, etc.) before evacuation to advanced medical care facilities. Development of training tools enabling non-specialised (non-medical) personnel to perform effective tactical medical interventions is envisaged, including both digital tools based on virtual and augmented reality and physical training aids. Research and development of solutions enabling availability of blood, blood products or oxygen carriers at point of injury or advanced medical posts (Role 2), such as lightweight transport and refrigerated storage systems, products extending shelf life or synthetic blood and oxygen substitutes, as well as solutions for oxygen production and storage at Role 2. Development of regenerative therapy products, haemostatic agents and related solutions is also included.
9.3.2. Technologies supporting healthcare in operations	Development of medical triage support systems for mass-casualty scenarios combining physiological sensing technologies and/or unmanned platforms with artificial intelligence algorithms to improve informed decision-making and accelerate triage and evacuation processes. Development of telemedicine equipment integrating secure and robust communications, as well as medical reach-back teams bringing specialised medical knowledge closer to forward medical facilities. Development of AI-based clinical decision support tools capable of analysing patient clinical information for diagnosis and treatment recommendations. Technological solutions aimed at reducing both the medical logistical burden and dependence of medical units on the supply chain (e.g., additive manufacturing of medical tools, pharmaceutical production in deployed areas, biofabrication, etc.) are also envisaged.

10. CBRNe	
10.1. C-IED TECHNOLOGIES	
10.1.1. Intelligent remote detection of explosive devices in land environments	Development of advanced systems for the remote or standoff detection of improvised explosive devices (IEDs) through multisensor technologies onboard unmanned aerial and ground platforms (UAV and UGV), with local processing capabilities and data analysis using artificial intelligence (AI) and deep learning techniques to identify patterns, anomalies or relevant indicators. Technologies are envisaged for the direct detection of IED components (main charge, initiator, container, etc.), as well as indirect detection based on observation of environmental alterations (soil disturbances, density variations, non-natural changes in vegetation), including the fusion of multispectral and hyperspectral data, ground-penetrating radar (GPR) and electro-optical and infrared (EO/IR) sensors. Part of the "Enhanced systems for remote detection of land-based IED" objective.
10.1.2. Remote detection of explosive atmospheres with early warning systems	Development of very high-sensitivity remote sensors for the detection of vapours emitted by explosive substances, integrated into early warning system (EWS) architectures, with capabilities for data fusion from different sensors and automated analysis using artificial intelligence (AI) techniques, including predictive models. The combination of technologies such as nanomaterial-based sensors, ion mobility spectrometry (IMS), differential mobility analysis (DMA), laser-induced breakdown spectroscopy (LIBS), surface-enhanced Raman spectroscopy (SERS), terahertz (THz) technologies, gamma radiation detection and chemiresistive sensors is envisaged, together with network connectivity capabilities, integration into unmanned platforms and distributed data analysis, in order to minimise operational risk and improve the effectiveness of surveillance and protection missions against concealed explosive threats. Part of the "Enhanced systems for remote detection of land-based IED" objective.
10.1.3. Advanced forensic analysis techniques	Development of technological solutions to improve the acquisition, analysis and exploitation of all information associated with explosive device incidents, including evidence selection and collection in post-blast scenarios while minimising risks, so that this information can be used to enhance all stages of the counter-IED and counter-UAS process (e.g., damage mitigation measures for platforms and personnel; dismantling of networks responsible for device placement; tactics, techniques and procedures, etc.).

10. CBRNe	
10.1. C-IED TECHNOLOGIES	
10.1.4. Detection and neutralisation of explosive threats in the naval environment	Research and development of technological solutions aimed at the detection, tracking and neutralisation of explosive and asymmetric threats, including water-borne improvised explosive devices (WBIED), naval mines, explosive-carrying divers, as well as hostile unmanned vehicles (UxV) operating on the surface, underwater or in the air, with kamikaze or directed-attack capability. These solutions must provide comprehensive protection for naval platforms (surface and subsurface), maritime infrastructures, access points and port facilities, ensuring effectiveness under all weather and sea conditions and enabling autonomous, coordinated and real-time response to emerging threats. Part of the “Technologies for protection against threats based on unmanned maritime vehicles” objective.
10.1.5. Integrated technological solutions for defence against aerial threats (C-UAS / C-RAM)	Research and development of technological solutions aimed at the detection, identification, tracking and neutralisation of aerial threats such as small unmanned aerial systems (UAS), loitering munitions and high-velocity projectiles (rockets, artillery and mortars) that may compromise the security of bases, platforms and deployed troops. These technologies should be applied both in active protection systems for land and naval platforms and in area and point defence systems, including C-UAS (Counter-Unmanned Aerial Systems) and C-RAM (Counter-Rocket, Artillery and Mortar) capabilities for fixed or deployable environments. Priority is given to the development of data processing and fusion algorithms from multiple sensors, capable of providing accurate responses within extremely short timeframes, enabling effective intervention prior to impact. These solutions must also be integrated into robust and scalable air defence architectures prepared to operate in complex environments and against simultaneous or saturating threats. Core of the “Technological solutions against low-altitude aerial threats” objective.

10. CBRNe	
10.2. CBRN DEFENCE	
10.2.1. Remote or standoff CBRN detection	Research, development and fusion of technologies with potential application in remote or standoff detection of CBRN agents, as well as low-cost and low-power CBRN sensor networks capable of detecting, identifying and monitoring toxic clouds and transmitting information to command in real time for continuous surveillance of operational areas or critical spaces. Development of highly autonomous, long-endurance unmanned aerial sensor platforms capable of transmitting real-time chemical or radiological isointensity maps for control of large contaminated areas. Development of standoff chemical detection systems in liquid and solid matrices, as well as their integration on ground vehicles to avoid transit over contaminated terrain. Research and development of technologies for remote detection and localisation of alpha particles to prevent exposure of operational personnel during reconnaissance interventions. Research and development of technologies and systems for automated remote detection of biological contamination clouds. Part of the “Control of the CBRN threat” objective.
10.2.2. Point detection and identification of CBRN agents	Research and development of technologies for portable or man-portable CBRN detection and identification equipment to improve performance of existing systems: higher precision and lower energy requirements for radiological agents; greater sensitivity, improved identification capability, reduced size and lower energy requirements for chemical agents. In the case of biological detection/identification, in addition to the above, rapid and automated technologies requiring little or no sample manipulation are required. The design and development of benchtop analytical equipment for deployable CBRN analysis laboratories are also envisaged, together with systems for CBRN sample collection and management for forensic analysis.

10. CBRNe	
10.2. CBRN DEFENCE	
10.2.3. CBRN decontamination	Research and development of new systems for CBRN decontamination of areas, vehicles, equipment and personnel that are safe for both personnel and the environment and enable rapid and secure recovery of the affected environment. Technologies with universal and effective application against the wide range of CBRN agents, which do not require or minimise the use of liquids, in order to alleviate the logistical burden associated with dependence on large volumes of water or organic liquids. Technologies compatible with sensitive equipment (electronics, platforms, etc.) enabling effective use after decontamination. This concept also includes solutions capable of suppressing or neutralising CBRN atmospheres to prevent dispersion. Integration of technologies or systems enabling automation and acceleration of decontamination processes, as well as monitoring of their effectiveness, to respond to crises involving large numbers of casualties or contaminated assets while minimising exposure times and required operational personnel. Development of robotic systems for search and removal of radiologically contaminated debris is also envisaged, avoiding exposure of human operators. Part of the “Control of the CBRN threat” objective.
10.2.4. Intelligent CBRN personal protective equipment	Research and development of new materials, designs and mechanisms to obtain more ergonomic and lightweight personal protective equipment providing enhanced CBRN protection without compromising soldier comfort. Integration of advanced functions such as self-decontaminating capability, increasing soldier protection and preventing the suit itself from becoming a source of secondary contamination, as well as sensing capability not only of CBRN agents or industrial toxins but also of ambient oxygen percentage and carbon monoxide levels to inform the need for self-contained breathing apparatus during CBRN interventions. The design and capability for rapid and mass production of personal protective equipment are also envisaged to respond to crises affecting not only the military force but also the civilian population, considering aspects such as child sizing and enhanced comfort, particularly of the mask. Part of the “Control of the CBRN threat” objective.

10. CBRNe	
10.2. CBRN DEFENCE	
10.2.5. Collective CBRN protection	Research and development of filtration or threat removal systems protecting the interior of platforms and infrastructures against CBRN agents and industrial toxins, allowing relaxation of personal protective equipment usage. Modular system designs with low energy demand and universal, interchangeable filters or threat removal devices are sought. To enhance protection capability, systems are intended to incorporate CBRN sensing functions triggering activation, as well as self-decontamination functions. Optimisation of system usage will also be pursued through integration of indicators monitoring and alerting filter depletion or saturation to determine remaining service life or system performance levels. Part of the "Control of the CBRN threat" objective.
10.2.6. Medical countermeasures against CBRN agents	Research and development of technologies for new therapeutic and prophylactic medical treatments (antidotes, vaccines, decorporation agents, etc.) and for rapid and early diagnosis of intoxications and exposure to ionising radiation, as well as infectious disease conditions, mainly those caused by contagious diseases. Technologies improving medical countermeasure effectiveness through increased bioavailability, targeted delivery (nanoencapsulation, targeting ligands, etc.), optimisation of protein or mRNA sequences, among others. Development of processes and systems for urgent and mass production of medical countermeasures, including paediatric administration formulations, to respond effectively to CBRN crises is also included. Part of the "Control of the CBRN threat" objective.
10.2.7. CBRN situational awareness	Research and development of data fusion and integration algorithms within CBRN incident management software. Development of information systems supporting command and control of such incidents, modelling and simulation tools enabling prediction of contamination cloud evolution and localisation of threat origin, integrating data from civilian sources such as the State Meteorological Agency (AEMET), the Radiological Surveillance Network (REVIRA) or 112 Emergency Coordination Centres. This line also includes health, syndromic and epidemiological surveillance systems managing information in an integrated and global manner.

11.INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.1. INFORMATION SYSTEMS FOR C4I	
11.1.1. Advanced C2 functionalities for operational planning and conduct	Research and development of new functionalities for command and control (C2) systems at the strategic, operational and tactical levels. The objective is to provide the Force with intelligent tools that automate and accelerate the planning, conduct and synchronisation of operations across all domains, shortening the decision cycle (OODA loop), enhancing shared situational awareness, achieving information superiority and supporting agile decision-making.
11.1.2. Interoperability of C4I systems	Implementation of new interoperability standards and tools to enable the integration of JISR data and information, as well as the interconnection between national C4I systems with international and allied systems. It also includes the development of tools that allow interoperability to be maintained between simulators and C2 systems, increasing training opportunities for forces employing these C2 systems.
11.1.3. Intelligent exploitation of multiple information sources	Development of technological solutions enabling cognitive-level information fusion from multiple heterogeneous sources, including OSINT, and the generation of military intelligence to support decision-making across different defence-relevant domains. The aim is to computationally reproduce a level of cognitive reasoning close to that of the human mind, enabling responses to complex, partially abstract or ambiguous questions by correlating multiple variables or establishing relationships between them. Part of the “Application of artificial intelligence to defence” objective.

11.INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.1. INFORMATION SYSTEMS FOR C4I	
11.1.4. Architectures and technologies for the tactical combat cloud	Research and development of the digital architecture, data services and enabling technologies that constitute the tactical combat cloud. This includes the design of a decentralised, resilient and secure infrastructure for information capture, processing and distribution in contested operational environments. It encompasses the development of edge computing solutions onboard platforms or deployed in distributed nodes, mechanisms for distributed data synchronisation and fusion, and orchestration of services at the tactical edge to accelerate the decision cycle. Priority will be given to flexible, modular and scalable architectures (SDN), modularity, interoperability with allied systems and the use of open standards to ensure integration of sensors and effectors within a multidomain ecosystem. This infrastructure underpins capabilities such as real-time distributed command and control. Part of the "Tactical combat cloud for defence" objective.
11.1.5. Real-time command and control architectures for interconnected defence systems	Design and development of functional and technological architectures for distributed command and control (C2), adapted to environments with extremely demanding and near-immediate temporal requirements, such as air defence against hypersonic and ballistic threats. These architectures must enable operation of interconnected systems of systems (sensors, decision centres and effectors) with real-time decision-making capabilities, multi-level interoperability and resilience against disruptions. Development will address functional reference models for C2 systems with reduced cycle times, integration of adaptive multisensor fusion capabilities, AI-based predictive algorithms and resource allocation using explainable AI, and fault-tolerant distributed control. Their deployment over infrastructures such as the tactical combat cloud will be studied, with specific requirements for latency, synchronisation, availability and security. These capabilities are considered key to improving effectiveness and survivability in complex air threat scenarios, multidomain operations and point or area defence against mass attacks, saturation or evasive manoeuvres. Part of the "Tactical combat cloud for defence" objective.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.2. TACTICAL COMMUNICATIONS	
11.2.1. Software-defined radio and cognitive radio	Research and development of new waveforms adapted to specific operational environments, enhancing performance, interoperability and security of tactical radio communications. Development of SDR radio equipment with national sovereignty for all form factors and adapted to Armed Forces communications systems will be encouraged. Cognitive radio-based solutions will also be promoted to improve dynamic management of the electromagnetic spectrum, reducing exposure to electronic warfare theats or interference with other radio communication systems. Part of the "Military communications in complex environments" objective.
11.2.2. Digital tactical data links and platform integration	Development of solutions based on tactical data links (TDL) to support information exchange in cooperative operations and to enhance interoperability between platforms and allies, in accordance with NATO standards. Efficient integration in multilink networks deployed in theatres of operation will be addressed, together with the development of tactical link management capabilities and adaptability to the radio-electrical environment. Solutions based on the VMF protocol for digital interoperability between land, naval and air forces will also be included, promoting their deployment on manned and unmanned platforms. Integration of these links into modular, secure architectures compatible with the tactical combat cloud will be promoted.
11.2.3. Wireless communications for sensor interconnection	Research, development and deployment of wireless communication technologies enabling the interconnection of large numbers of remotely located sensors, both static and mobile, ensuring secure real-time information exchange. Priority will be given to solutions offering resilience against failure of one or more network nodes, with self-organisation, dynamic and automatic reconfiguration capabilities. These communications must integrate into distributed information architectures, facilitating data fusion and intelligent exploitation within the combat cloud, as well as interoperability with C2 nodes and allied systems.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.2. TACTICAL COMMUNICATIONS	
11.2.4. Next-generation mobile networks	Development of technological solutions based on next-generation mobile networks (5G, 6G), aimed at rapid deployment of interconnected, secure, low-latency and high-capacity tactical networks, even in hostile or degraded environments. Distributed architectures with edge computing capabilities, network slicing, M2M communications and compatibility with tactical combat cloud services will be prioritised. These technologies must be adaptable to mobile platforms and command nodes, with secure integration into multi-level networks and advanced spectrum management capabilities. Part of the “Military communications in complex environments” objective.
11.2.5. Underwater communications	Research and development of technologies enabling effective communications in the underwater domain, addressing efficient use of low-frequency bands as well as robust, adaptive and low-distortion modulation techniques. Solutions for mitigation of interference, fading and variability of the acoustic channel will be included, together with evaluation of hybrid technologies (acoustic, optical and RF) for communications between manned and unmanned platforms (UUV, USV). These capabilities must be compatible with distributed maritime surveillance networks and naval C4ISR infrastructures. Part of the “Unmanned surface and underwater vehicles for defence missions” objective.
11.2.6. Free-space optical communications	Research and development of laser optical communication systems covering space-to-space (inter-satellite), space-to-ground, air-to-space and air-to-air links on tactical platforms. These systems must exploit their high bandwidth, low detectability and resistance to electromagnetic noise, overcoming challenges such as beam acquisition, tracking and pointing (ATP), atmospheric turbulence compensation, terminal miniaturisation for small satellites and robustness under adverse weather conditions. Integration into hybrid RF-optical and quantum architectures will be promoted, including secure communication protocols such as quantum key distribution (QKD) to protect information against interception.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.3. SIMULATION	
11.3.1. Advanced training through simulation	Development of innovative solutions based on simulation systems enabling optimal preparation and training of Armed Forces personnel across cognitive, physical and psychological dimensions, encompassing doctrine for operational execution, use of materiel (platforms, weapons, etc.) and recreation of conditions close to real operations across land, maritime, air and cyberspace domains. Part of the "Advanced training and decision-support through simulation" objective.
11.3.2. Interoperability between simulators	Development of technological solutions based on interoperability standards enabling different simulators to interact jointly and in combination during exercises. Implementation of interoperability standards in simulation systems facilitates the extension of training capabilities, as well as the integration of different types of simulation (LVC), enabling consolidation of diverse target audiences that previously operated in isolation within a single simulation exercise. Part of the "Advanced training and decision-support through simulation" objective.
11.3.3. Simulation as a decision-making tool	Development of simulation-based technological solutions (digital twins, wargaming, synthetic environments, numerical simulations) supporting problem solving, protocol development and decision-making related to capability acquisition and development, operational process management, requirements analysis, concept and doctrine development and experimentation, operational (crisis and anticipatory) and strategic planning, and mission support and rehearsal, among others. Part of the "Advanced training and decision-support through simulation" objective.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.4. SYSTEM AND INFORMATION SECURITY	
11.4.1. Automation of responses to cyberattacks	Development of advanced tools to automate responses to cyberattacks, adapted to the operational specificities of the defence environment, ensuring minimal reaction times to cyber incidents and continuity of system operations in highly complex scenarios. These solutions will address the protection of both information systems and weapon systems, integrating defensive cyber capabilities enabling early detection and response to cyber incidents through incident recovery mechanisms, forensic analysis and technical attribution of cyberattacks, and detection and analysis of new advanced persistent threats (APT). Adoption of Zero Trust security architectures will also be promoted, strengthening protection and resilience against cyber threats.
11.4.2. Cyber intelligence for predictive vulnerability analysis	Development of technological solutions to collect and analyse information enabling the generation of intelligence on emerging cyber threats, identifying patterns and correlations with global threat indicators and trends to facilitate early detection of vulnerabilities and anticipation of potential future cyberattacks through predictive algorithms. These solutions will incorporate advanced predictive analytics and machine learning techniques to enhance response capability and support decision-making, application of AI for filtering and prioritisation of cyber defence events, threat and incident analysis support, pattern identification and technical attribution of cyber incidents. It includes the development of solutions to reduce the attack surface while enhancing operational resilience. Part of the “Technological solutions for cyber operations” objective.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.4. SYSTEM AND INFORMATION SECURITY	
11.4.3. Technologies supporting cyber operations	Development of advanced technological solutions enabling active, balanced and proportional response to cyberattacks, in accordance with the principle of self-defence. In addition, development of capabilities to conduct offensive cyber operations (CNA - Computer Network Attack) aimed at disrupting, denying, degrading or destroying critical information in adversary infrastructures will be promoted, using specific tools that enable controlled and precise action in cyberspace in compliance with applicable legal frameworks. Part of the "Technological solutions for cyber operations" objective.
11.4.4. Cryptographic systems for defence	Research and development of cryptographic systems ensuring confidentiality, integrity and authenticity of information in military environments, strengthening security of tactical and strategic networks and critical infrastructures. This line prioritises continuous improvement of classical cryptographic mechanisms essential for communications protection, while progressively incorporating post-quantum techniques resistant to attacks by quantum computers, as well as quantum technologies such as quantum key distribution (QKD). In this context, availability of verifiable entropy provided by quantum random number generators (QRNG) constitutes a key element for reinforcing the trust base of both classical and quantum cryptographic systems. Exploration of hybrid architectures integrating traditional, post-quantum and quantum solutions in a coordinated manner will be promoted, enabling a secure and gradual transition towards infrastructures resilient to future threats. Part of the "Quantum technologies applied to defence" objective.

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES	
11.5. APPLICATION OF ICT TECHNOLOGICAL ADVANCES TO DEFENCE	
11.5.1. Mitigation of risks and limitations in the use of AI in defence	Research and development of algorithms and tools to reduce or mitigate risks and limitations associated with extensive use of AI in defence systems, as well as malicious use of these technologies by other actors. These include lack of clarity and explainability in many algorithm decision logics, particularly deep learning; difficulty in detecting false multimedia content generated from similar datasets; lack of robustness or intentional introduction of training data that alters or biases learning; assurance and privacy of data throughout the process; unpredictable behaviour in situations not foreseen during training; cascading failures when integrating multiple AI modules in complex systems; need for large data volumes for algorithm training; and complexity of incorporating ethical criteria into decision-making processes, among others. Part of the “Application of artificial intelligence to defence” objective.
11.5.2. Application of speech and text analysis technologies to defence	Application of speech and text analysis technologies supporting defence operations and information systems, incorporating advances in generative AI for semantic understanding, machine translation, speech synthesis and generation of useful content in operational scenarios, also including information extraction, disinformation detection and real-time decision-making support. Part of the “Application of artificial intelligence to defence” objective.
11.5.3. Application of high-performance computing (HPC) capabilities to defence	Development and application of high-performance computing (HPC) capabilities to solve complex defence-related problems, leveraging existing national and international infrastructures. Priority will be given to research on the use of supercomputers for modelling and simulation of operational scenarios, logistics optimisation, analysis of large data volumes, artificial intelligence and advanced materials design. This line will promote integration of defence-specific methods and algorithms into HPC architectures, development of efficient and secure software for parallel environments and experimentation under realistic conditions. Actions must maximise interoperability with existing systems and explore synergies with other emerging technologies, such as hybrid quantum-classical computing, heuristic or probabilistic computing, as well as research in quantum computing to complement and enhance existing HPC capabilities.

List of R&D&I Lines

1.	**WEAPONS AND MUNITIONS**
1.1.	**PRECISION LETHALITY AND EXTENDED RANGE**
1.1.1.	Low-cost terminal guidance and programmable fuzes
1.1.2.	Advanced propulsion for indirect fire (extended range and MLRS)
1.1.3.	Robust navigation for munitions
1.1.4.	Scalable and selective effects munitions
1.2.	**ADVANCED SYSTEMS AND SMART MUNITIONS**
1.2.1.	Multimodal seekers and AI for ATR
1.2.2.	Autonomy, swarm collaboration and data links
1.2.3.	Non-hypersonic propulsion for tactical missiles and loitering munitions
1.3.	**WEAPON-SPECIFIC TECHNOLOGIES AND APPLICATIONS**
1.3.1.	Directed energy weapons using high-power lasers
1.3.2.	RF directed energy weapons
1.3.3.	Technologies for kinetic electromagnetic weapons (railguns)
1.3.4.	Smart mines
1.4.	**ASYMMETRIC DEFENCE SYSTEMS AND COUNTERMEASURES**
1.4.1.	Low-cost effectors for C-UAS / C-RAM
1.4.2.	Effectors for robotic and asymmetric counter-mining
1.5.	**LIFE-CYCLE SUPPORT TECHNOLOGIES FOR WEAPONS AND MUNITIONS**
1.5.1.	Munitions life cycle
1.5.2.	Impact reduction in weapons and munitions processes

2.	**SENSORS AND ELECTRONIC SYSTEMS**
2.1.	**ELECTRONIC TECHNOLOGIES**
2.1.1.	High-performance RF antennas, devices and modules
2.1.2.	Application of photonic technology to RF systems
2.1.3.	SMRF architecture
2.2.	**RADAR**
2.2.1.	New radar architectures and processing algorithms
2.2.2.	Air defence radar systems
2.2.3.	SAR/MTI system
2.3.	**OPTRONIC SENSORS AND SYSTEMS**
2.3.1.	Systems based on EO/IR detectors
2.3.2.	Night vision systems
2.3.3.	Laser-based systems for telemetry, LIDAR, guidance and target designation
2.4.	**ACOUSTIC SENSORS**
2.4.1.	Underwater acoustic sensors
2.4.2.	Atmospheric acoustic sensors
2.5.	**PNT TECHNOLOGIES AND EMERGING SENSORS**
2.5.1.	Technologies for robust PNT in GNSS-denied environments
2.5.2.	Quantum sensors for defence applications
2.6.	**SENSOR DATA COMPUTING, FUSION AND PROCESSING**
2.6.1.	Sensor fusion
2.6.2.	Onboard hardware for intensive AI-based processing
2.6.3.	Automatic and intelligent analysis of large volumes of sensor data
2.7.	**OPTRONIC COUNTERMEASURES**
2.7.1.	DIRCM-based protection on air platforms
2.7.2.	Pyrotechnic decoys, flares and smoke canisters
2.8.	**ELECTRONIC WARFARE**
2.8.1.	Non-communications electronic warfare systems
2.8.2.	Communications electronic warfare systems
2.8.3.	Multiplatform and cooperative electronic warfare
2.8.4.	RC IED jammers

3.	**TECHNOLOGIES COMMON TO DEFENCE SYSTEMS**
3.1.	**LIFE CYCLE**
3.1.1.	Platform maintenance
3.1.2.	Data intelligence applied to predictive platform maintenance
3.1.3.	Open modular architectures, digital engineering and simulation for the life cycle
3.1.4.	Protection against corrosion and degradation processes
3.1.5.	Incorporation of circular economy processes
3.1.6.	Development of technological solutions to reduce the use of critical materials in defence
3.1.7.	Industrial resilience and scaling of military system production
3.2.	**MATERIALS**
3.2.1.	Weight reduction in platforms
3.2.2.	Platform passive protection systems
3.2.3.	Platform signature reduction through materials
3.2.4.	Materials for high-temperature applications
3.3.	**ENERGY**
3.3.1.	High-power energy systems
3.3.2.	Environmental energy harvesting systems
3.3.3.	Electrical energy microgeneration systems
3.3.4.	Fuel cell systems for military environments
3.3.5.	Electrical energy storage systems for military environments
3.3.6.	Wireless energy transmission systems
3.4.	**LOGISTICS**
3.4.1.	Water management systems
3.4.2.	Waste management processes
3.4.3.	Alternative non-fossil fuels

4. BASES AND FACILITIES
4.1. PROTECTION OF BASES AND FACILITIES
4.1.1. Sensor networks for the protection of facilities and land deployments
4.1.2. Sensor networks for the protection of maritime areas
4.1.3. Protection against explosive threats in infrastructures
4.2. ENERGY IN BASES AND FACILITIES
4.2.1. Energy systems in bases and facilities
4.2.2. Smart electrical energy networks for defence
4.2.3. Fuel self-production
4.2.4. Integrated and efficient climate control and DHW
4.3. MODERNISATION OF BASES AND FACILITIES
4.3.1. Incorporation of Industry 4.0 technologies within bases, facilities and Department processes
4.3.2. Intelligent and efficient buildings for bases and camps
4.3.3. Test facilities for defence

5. LAND PLATFORMS	
5.1.	**LAND PLATFORM DESIGN**
5.1.1.	Design of next-generation land platforms
5.1.2.	Architecture and integration in land platforms
5.2.	**ENERGY AND MOBILITY OF LAND PLATFORMS**
5.2.1.	Hybrid and electric propulsion and electrification of land platforms
5.2.2.	Conventional propulsion and transmission systems
5.2.3.	Advanced mobility systems
5.3.	**INTEGRATED SYSTEMS**
5.3.1.	Platform crew situational awareness
5.3.2.	Integration and interoperability of weapons with land platforms
5.3.3.	Active and reactive protection systems
5.4.	**GROUND ROBOTICS**
5.4.1.	Conversion of platforms or groups of platforms into unmanned systems
5.4.2.	Advanced UGV functionalities based on robotic autonomy
5.4.3.	Robotics for specific defence missions
5.4.4.	Biomimetic robotics

6. NAVAL PLATFORMS	
6.1.	**NAVAL PLATFORM DESIGN**
6.1.1.	Design of surface naval platforms
6.1.2.	Design of submarine naval platforms
6.2.	**NAVAL CONTROL, ENERGY AND PROPULSION**
6.2.1.	Propulsion systems for naval platforms
6.2.2.	Propulsion systems in submarines
6.2.3.	Power generation systems for naval platforms
6.2.4.	Manoeuvrability of naval platforms
6.3.	**INTEGRATED SYSTEMS IN NAVAL PLATFORMS**
6.3.1.	Evolution of combat systems in naval platforms
6.3.2.	Digital ship
6.3.3.	Integration of unmanned vehicles in surface platforms
6.4.	**UNMANNED MARITIME VEHICLES**
6.4.1.	Unmanned underwater vehicles
6.4.2.	Unmanned surface vehicles
6.4.3.	Swarms of unmanned naval vehicles and motherships

7. AIR PLATFORMS	
7.1.	**AIR PLATFORM DESIGN**
7.1.1.	Development of manned fixed-wing air platforms
7.1.2.	Development of manned rotary-wing air platforms
7.1.3.	Development of vehicles for hypersonic flight
7.2.	**ENERGY AND PROPULSION**
7.2.1.	Energy and propulsion systems for air platforms
7.2.2.	Propulsion for hypersonic regimes
7.3.	**INTEGRATED SYSTEMS IN AIR PLATFORMS**
7.3.1.	Air avionics systems
7.3.2.	Mission systems
7.3.3.	Weapon systems on air platforms
7.3.4.	Air-to-air refuelling solutions for military aircraft
7.3.5.	Integration of UAS into airspace
7.4.	**UAS**
7.4.1.	Unmanned air systems
7.4.2.	Multipurpose unmanned air systems
7.4.3.	Logistic unmanned air systems
7.4.4.	Swarms of unmanned air systems

8.	**SPACE SYSTEMS**
8.1.	**SPACE DOMAIN AWARENESS (SDA)**
8.1.1.	Technological solutions supporting Space Domain Awareness (SDA)
8.1.2.	Space traffic management (STM) systems
8.2.	**SATCOM COMMUNICATIONS**
8.2.1.	Satellite technologies for satellite communications (SATCOM)
8.2.2.	SATCOM user terminals
8.3.	**INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (ISR)**
8.3.1.	ISR payloads
8.3.2.	Data exploitation for ISR
8.4.	**GNSS CAPABILITIES**
8.4.1.	GNSS capabilities in LEO/VLEO orbits
8.4.2.	High-performance GNSS receivers
8.5.	**OTHER SPACE APPLICATIONS FOR DEFENCE**
8.5.1.	Space-based early warning capabilities
8.5.2.	METOC capabilities in LEO orbits
8.5.3.	On-orbit satellite servicing
8.6.	**ENABLING AND RAPID RESPONSE SOLUTIONS IN THE SPACE DOMAIN**
8.6.1.	Devices and systems forming the structure of a satellite
8.6.2.	Defensive protection against ASAT threats
8.6.3.	Small satellites
8.6.4.	High-altitude pseudo-satellites
8.6.5.	Small satellite launchers

9. SOLDIER	
9.1.	**SOLDIER SYSTEM**
9.1.1.	Soldier passive protection systems
9.1.2.	Soldier signature reduction systems through materials
9.1.3.	Soldier energy systems
9.1.4.	Improvement of soldier comfort
9.1.5.	Reduction of soldier load
9.1.6.	Integrated and connected soldier system
9.1.7.	Integration and interoperability of individual weapons with the soldier
9.2.	**HUMAN FACTORS**
9.2.1.	Control and improvement of soldier performance
9.2.2.	Advanced human–machine interfaces
9.2.3.	Human–unmanned system interaction in missions
9.2.4.	Integration of personnel into platforms
9.3.	**SOLDIER HEALTH**
9.3.1.	Early medical response
9.3.2.	Technologies supporting healthcare in operations

10. CBRNe
10.1. C-IED TECHNOLOGIES
10.1.1. Intelligent remote sensing of explosive devices and substances in land environments
10.1.2. Remote detection of explosive atmospheres with early warning systems
10.1.3. Advanced forensic analysis techniques
10.1.4. Detection and neutralisation of explosive threats in the naval environment
10.1.5. Integrated technological solutions for defence against aerial threats (C-UAS/C-RAM)
10.2. CBRN DEFENCE
10.2.1. Remote or standoff CBRN detection
10.2.2. Point detection and identification of CBRN agents
10.2.3. CBRN decontamination
10.2.4. Intelligent CBRN personal protective equipment
10.2.5. Collective CBRN protection
10.2.6. Medical countermeasures against CBRN agents
10.2.7. CBRN situational awareness

11. INFORMATION, COMMUNICATIONS AND SIMULATION TECHNOLOGIES
11.1. INFORMATION SYSTEMS FOR C4I
11.1.1. Advanced C2 functionalities for operational planning and conduct
11.1.2. Interoperability of C4I systems
11.1.3. Intelligent exploitation of multiple information sources
11.1.4. Architectures and technologies for the tactical combat cloud
11.1.5. Real-time command and control architectures for interconnected defence systems
11.2. TACTICAL COMMUNICATIONS
11.2.1. Software-defined radio and cognitive radio
11.2.2. Digital tactical data links and platform integration
11.2.3. Wireless communications for sensor interconnection
11.2.4. Next-generation mobile networks
11.2.5. Underwater communications
11.2.6. Free-space optical communications
11.3. SIMULATION
11.3.1. Advanced training through simulation
11.3.2. Interoperability between simulators
11.3.3. Simulation as a decision-making tool
11.4. SYSTEM AND INFORMATION SECURITY
11.4.1. Automation of responses to cyberattacks
11.4.2. Cyber intelligence for predictive vulnerability analysis
11.4.3. Technologies supporting cyber operations
11.4.4. Cryptographic systems for defence
11.5. APPLICATION OF ICT TECHNOLOGICAL ADVANCES TO DEFENCE
11.5.1. Mitigation of risks and limitations in the use of AI in defence
11.5.2. Application of speech and text analysis technologies to defence
11.5.3. Application of high-performance computing (HPC) capabilities to defence

Table 7. Complete list of R&D&I Lines

Relationship between the ETID 2026 Areas and the EID 2023 Essential Defence Capabilities

	1. Weapons and munitions	2. Sensors and electronic systems	3. Technologies common to defence systems	4. Bases and facilities	5. Land platforms	6. Naval platforms	7. Air platforms	8. Space systems	9. Soldier	10. CBRNe	11. 11.Information, communications and simulation technologies
Guided munitions and missiles	X										
Navigation and control systems	X										
Missile defence systems	X	X									X
Sensors		X									
Electronic warfare		X									
Propulsion systems					X	X	X				
Land platforms, design and development (D&D), integration					X						
Naval platforms, design and development (D&D), integration						X					
Air platforms, design and development (D&D), integration and certification							X				
Combat / mission systems					X	X	X				
Unmanned vehicles					X	X	X				
Satellite observation and communications systems								X			
C-UVS (Counter-Unmanned Vehicle Systems)										X	
Command and control systems											X
Combat cloud											X
Tactical communications											X
Simulators											X
Cyber defence											X
Encryption and cryptography											X

Table 8. Traceability of the ETID 2026 Areas to the EID 2023 Essential Defence Capabilities

Annex B. Technological Objectives

This annex describes the scope of each of the technological objectives included in the DTIB, as well as the main technological challenges associated with each of them and the actions planned to be implemented over the coming years (see Table 9).

As explained in Chapter 3 of the Strategy, these technological objectives are structured on three levels, according to the scale and characteristics of the systems and technologies involved and the type of actions envisaged for their achievement (see Figure 22).

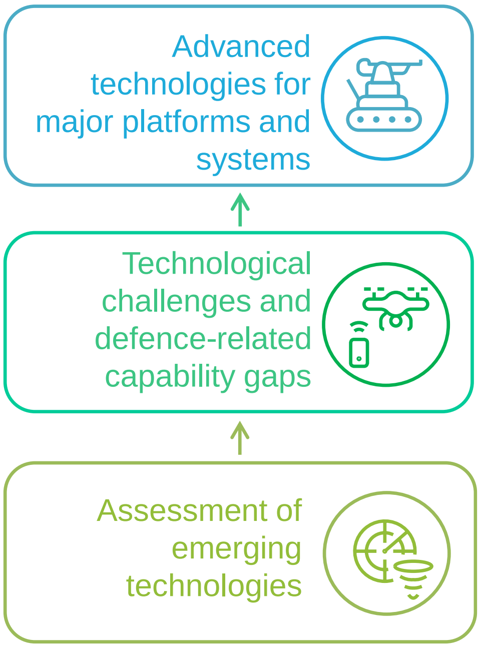


Figure 22. Levels of organisation of the technological objectives

Whereas the first and third levels include a single descriptive factsheet (the first and the last, respectively), summarising the scope and purpose of the technological objectives considered at each level, the intermediate level includes one factsheet for each objective, given the greater heterogeneity of the objectives it encompasses[40].

The following table presents the full set of technological objectives included in this annex.

[40] All technological objective factsheets include an AI-generated image representing the objective.

Specific action domain	Technological Objectives
Development of advanced technologies for future major platforms and weapon systems	Technologies for the development of future major platforms and weapon systems operated by the Armed Forces
Defence applications with high technological requirements	Advanced guidance and control technologies for munitions
	High-performance electronic technologies
	Electronic-warfare solutions adapted to current and future electromagnetic environments
	Military communications in complex environments
	Tactical combat cloud for defence
	Technologies for robust PNT
	Technological solutions for cyber operations
Defence against asymmetric threats	Enhanced systems for remote detection of land-based IEDs
	Technologies for protection against unmanned maritime vehicle threats
	Technological solutions against low-altitude aerial threats
	CBRN threat control
Leveraging civilian technological progress	Application of artificial intelligence to defence
	Technologies to support the life-cycle management of military systems
	Improvement of defence industry production processes
	Unmanned ground platforms for defence missions
	Unmanned underwater and surface vehicles for defence missions
	UAS for defence missions
	Materials for application in platforms and for the dismounted soldier
	Innovative solutions for defence in the space domain
Enhancement of military personnel capabilities	Technologies for the dismounted soldier
	Advanced training and decision support through simulation
Energy sustainability	Energy generation, storage and efficiency in isolated bases and infrastructures
	New propulsion technologies for manned platforms and unmanned systems
Foundational national technological capability development	Technologies for the development of directed-energy and electromagnetic weapons
	Technologies for hypersonic vehicles
	Quantum technologies applied to defence

Table 9. Technological objectives by specific domains.

ADVANCED TECHNOLOGIES FOR MAJOR PLATFORMS AND SYSTEMS
Technologies for the development of future major platforms and weapon systems operated by the Armed Forces
Development of advanced technologies for incorporation into future major platforms and weapon systems employed by the Armed Forces across the land, naval, air, space, and cyberspace domains. These platforms and systems derive from requirements identified in the Military Capability Objective (OCM) and the Long-Term Force Objective (OFLP), and their development acts as a driving force for technological development across a wide range of industrial sectors, as well as a catalyst for the creation of high-quality employment in these sectors.

Given the nature and complexity of the threats the Armed Forces must address, it is essential to field major platforms and weapon systems across the land, naval, air, and space domains that can integrate state-of-the-art technological advances and deliver superior capabilities in highly contested environments. By their very nature, such developments entail large-scale programmes requiring significant investment, long development timelines, and, in many cases, international cooperation to ensure interoperability and long-term technological sustainability.

As these systems are designed to remain in service for several decades, it is necessary to anticipate the associated technology programmes through initiatives that enable the incorporation of the most advanced technologies into the system's critical functions. To this end, technological demonstrators are used to validate the maturity of developments and reduce integration risks in the final systems, ensuring that capabilities reach the required performance levels before industrialisation.

At European level, collaborative projects are being promoted under the European Defence Fund (EDF) and other multinational initiatives to develop next-generation platforms and weapon systems across all domains. These include, notably, air systems-of-systems integrating manned and unmanned aircraft within collaborative combat architectures; new modular land-platform designs with demanding requirements for protection, systems integration, and mobility; and next-generation naval platforms oriented towards network-centric warfare, interoperability, and the integration of unmanned systems for littoral and open-ocean operations. In addition, European secure communications systems are being pursued to ensure resilient connectivity in multidomain scenarios, as well as defence capabilities against hypersonic threats, including advanced sensors, interceptors, and early-warning architectures.

At national level, technology programmes and projects linked to the Special Modernisation Programmes (PEM), within the *Industrial and Technological Plan for Security and Defence*, have also been launched in recent years to reduce technological risks for future platforms and major systems across all operational domains.

Within the scope of this objective, both projects in which Spain participates under international cooperation programmes and nationally developed projects applicable to these future major platforms or weapon systems are envisaged.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
Advanced guidance and control technologies for munitions
Enhancement of munition performance through the integration of guidance, navigation, and control systems, including actuators, onboard electronics, onboard processing capabilities, and sensor integration (C4I), in order to maximise the effectiveness of fire support while minimising collateral damage.

The growing relevance of guided and smart munitions stems from their ability to combine precision, proportionate lethality, and a reduced logistical burden. By integrating inertial and satellite guidance subsystems, compact high-dynamic actuators, and adaptive control algorithms, a single munition can neutralise a target with fewer rounds, a lighter warhead, and greater certainty at the point of impact. Mission electronics and embedded microsensors enable advanced functions such as in-flight mission abort, pre-impact environmental reconnaissance, or post-detonation effects confirmation, delivered in real time and with resilience to GNSS-denied conditions. This dynamic in-flight adaptability significantly expands operational options in unpredictable scenarios, particularly in urban and mountainous terrain or under high electromagnetic interference.

The shift towards munitions with embedded intelligence poses technological challenges across multiple domains: miniaturisation of inertial and electro-optical sensors; robust data fusion in the presence of decoys or interference; lightweight actuators capable of withstanding extreme accelerations; secure, low-latency communications links for in-flight reprogramming; and learning-enabled algorithms that support autonomous trajectory replanning based on new information about the target or the environment. This is compounded by the need to adapt each solution to different calibres, launch environments, and ballistic profiles, requiring intensive test campaigns on instrumented ranges. The integration of these technologies should follow a modular and scalable approach to facilitate reuse across different munition families.

Building on technological developments undertaken in recent years, a set of actions will be promoted to consolidate the capabilities achieved and to deliver solutions with higher levels of autonomy, precision, and resilience. In addition, specific lines of effort will address the development of munitions intended to counter next-generation aerial threats, including C-UAS and C-RAM capabilities, as well as loitering or "kamikaze" munitions, which demand a particularly stringent cost-effectiveness balance. These solutions are expected to become key elements of smart fires in the near term, strengthening deterrence, proportionality in the use of force, and operational effectiveness in both hybrid and conventional scenarios.

The planned actions will combine the Ministry of Defence's efforts with national and international cooperation programmes, aimed at accelerating the transition from R&D to fully operational systems. Industrial collaboration will also be encouraged to facilitate the transfer of dual-use technologies, optimise the supply chain, and reduce dependence on critical externally sourced components.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
High-performance electronic technologies
Improvement of the performance of devices and components within military radio frequency (RF) systems by leveraging applicable technologies and developments, to deliver advanced capabilities in radar, electronic warfare, and communications systems.

RF systems provide essential capabilities for modern defence systems, with technical requirements far exceeding those of civilian applications. Improvements in their underlying devices directly translate into enhanced performance of the overall systems, providing a technological advantage that can be decisive in the operational theatre. Their implementation also has a significant impact on reducing size, weight, and power (SWaP), which is critical for air platforms (particularly UAS), land platforms, and complex munitions, where such constraints are especially stringent.

Within the scope of this objective, R&D&I activities are envisaged to develop active electronically scanned array (AESA) antennas, transmit/receive (T/R) modules, solid-state power amplifiers (primarily based on gallium nitride, GaN), photonics-based components and subsystems, and hybrid integration of electronic and photonic technologies, resulting in solutions that are more compact, efficient, and robust, as well as advanced antenna technologies (e.g., compact low-frequency and conformal antennas) and metamaterials applied to RF components. Although some of these technologies currently exhibit limited maturity, they have high potential to transform military systems over the medium and long term.

Key technological challenges for AESA antennas include achieving multibeam and simultaneous operation for tracking multiple targets, very high beam-steering agility, and even adaptive capabilities for interference cancellation. The associated T/R modules must be compact, high-power, and high bandwidth, which underpins the focus on GaN. In parallel, photonics-based RF components will help overcome current limitations related to bandwidth, losses, size, and electromagnetic interference.

Finally, there is also interest in developing electronic technologies suitable for integration into vehicles subject to high dynamic loads, such as highly manoeuvrable unmanned platforms, missiles, or munitions, ensuring the survivability of onboard systems. In this regard, electromagnetic ruggedisation technologies will be promoted to protect components and circuits against threats such as high-power microwave (HPM) pulses.

Throughout the duration of the Strategy, developments in AESA antennas, T/R modules, and GaN (already reaching a certain level of maturity) will coexist with lower-maturity efforts focused on technologies such as metamaterials and compact low-frequency or conformal antennas, together with new developments expected to be launched to address the technological challenges outlined above. This will be pursued by combining the Ministry's investment with external funding sources through national and European programmes.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
Electronic-warfare solutions adapted to current and future electromagnetic environments
Development of advanced electronic warfare solutions in the domains of communications and non-communications, including electronic support measures (ESM) and electronic countermeasures (ECM), adapted to the current and emerging electromagnetic environment, and integrating advances in multifunction antennas, radio-frequency technologies, and cognitive warning and intelligence algorithms.

The primary objective of electronic warfare (EW) is control of the electromagnetic spectrum, ensuring its effective use by friendly forces to fully deploy their combat potential, while denying or degrading its use by the adversary.

These capabilities have proven to be fundamental in current conflicts, making it critical to keep EW and self-protection systems on all defence platforms continuously updated. At the same time, it is essential to ensure national autonomy in this domain and to extend EW capabilities from the strategic and operational levels down to the tactical level.

As the threat environment becomes increasingly complex, current trends point towards EW systems covering both communications and non-communications functions, often operating across shared frequency bands. This creates significant technological challenges related to shared apertures between different RF systems and their integration into platforms, driving the development of multifunction systems. In addition, the distinct characteristics of communications and non-communications EW systems entail specific and differentiated technological challenges for each. The application of recent advances in artificial intelligence will play a decisive role in future developments, enabling the emergence of cognitive electronic warfare capabilities.

In the air domain, efforts will focus on enhancing system modularity through the development of reconnaissance and electronic attack PODs, avoiding the need for dedicated platforms. In parallel, growing interest is observed in electronic warfare activities in the space domain, encompassing both the development of SIGINT systems primarily onboard small satellites and constellations, as well as systems for monitoring the satellite spectrum and associated countermeasure capabilities.

The development of this objective will benefit from advances achieved at component and subsystem level under high-performance electronic technologies, allowing efforts to be focused on delivering complete systems with medium to high levels of technological maturity.

In the coming years, the execution of a set of ongoing R&D&I projects across the land, naval, and air domains, for both manned and unmanned systems, will be combined with the launch of new electronic warfare system developments, including the space domain. These new systems will incorporate the latest technological advances to enhance performance and introduce new capabilities.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
Military communications in complex environments
Development of advanced tactical communications solutions capable of operating reliably and securely in complex and electromagnetically contested environments, through dynamic spectrum adaptation, the integration of software-defined radio technologies, and the deployment of 5G networks to enable the agile exchange of large volumes of information. The objective is to strengthen resilience, interoperability, and technological autonomy in critical communications systems for the multidomain operational environment.

The transformation of the operational environment towards greater digitalisation and connectivity is driving the need for more robust, resilient, and adaptive tactical communications networks. The massive deployment of sensors, the proliferation of distributed computing nodes, and the growing requirement to share information in real time between platforms and systems demand solutions that ensure communications availability and security even in electromagnetically contested scenarios.

Current military operations take place in environments characterised by high spectral congestion, where interference, infrastructure degradation, or deliberate denial-of-service attempts seriously compromise communications continuity. In this context, it is essential to incorporate technologies that enable reliable and secure operation, optimising spectrum usage and dynamically adapting to changing environmental conditions.

Software-defined radio (SDR) has emerged as a key enabling technology, thanks to its real-time reconfigurability, spectral efficiency, and resistance to interference. The development of new waveforms tailored to specific operational environments, together with research into advanced modulation, coding, and signal-processing techniques, will enhance the performance, interoperability, and security of tactical communications. In addition, the development of cognitive radio capabilities will enable dynamic spectrum management, allowing the identification of available spectrum opportunities, the avoidance of interference, and rapid responses to electronic warfare attacks.

In parallel, the deployment of tactical 5G networks will provide new high-throughput, low-latency data transmission capabilities, enabling applications such as the combat cloud, the massive connection of sensors in IoT environments, and the integration of edge-computing nodes for distributed information processing. These capabilities will increase situational awareness, accelerate decision-making cycles, and improve the operational effectiveness of deployed units.

Throughout the duration of the Strategy, defence R&D&I actions will be launched to mature these capabilities, with the aim of strengthening national autonomy in critical radiocommunications technologies and ensuring their effective integration into defence infrastructures. The Ministry's investments will be complemented by national and European cooperation initiatives, ensuring alignment with NATO standards and future operational requirements.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
Tactical combat cloud for defence
Enhancement of the Force's capabilities at the strategic, operational, and tactical levels through the secure capture, processing, and real-time distribution of information, enabling a synchronised, hyperconnected, and interoperable operational environment that supports a more effective and coordinated response to threats in multidomain operations, both at national level and within coalition frameworks.

The transformation of the operational environment, together with the advancement of technologies such as artificial intelligence, 5G networks, edge computing, and distributed sensing, is driving a new model for the conduct of operations based on the efficient and decentralised management of information. In this context, the concept of the tactical combat cloud emerges as a high-performance digital environment in which data, services, and applications can be shared in an agile, near real-time, secure, and ubiquitous manner among sensors, command-and-control nodes, and response platforms, generating an adaptive operational network across all levels of combat.

This new paradigm seeks to break down barriers between the land, maritime, air, space, and cyber domains, as well as across command echelons, promoting the full integration of heterogeneous systems such as satellites, manned and unmanned platforms, field sensors, and deployed units. The combat cloud will enable the creation of a shared and dynamic common operational picture, reduce OODA (Observe, Orient, Decide, Act) cycle times, and provide the Force with decisive information superiority. It will also contribute to enhancing operational resilience in spectrum-denied scenarios, ensuring continuity of command and control even under conditions of interference or network saturation.

The development of this capability will require advancing key technologies to ensure connectivity in contested environments, including resilient tactical networks, embedded edge-computing solutions, distributed synchronisation mechanisms, and data prioritisation and fusion algorithms. In parallel, the adoption of open and interoperable architectures will be promoted, enabling the integration of national and allied systems under common regulatory and cybersecurity frameworks, while ensuring data protection and continuous operational availability.

The long-term vision is for a multidomain combat cloud to act as the backbone of the Armed Forces' system-of-systems, enabling the sharing of critical information at the right time and facilitating the joint planning and execution of operations. Its progressive development will support the transition towards more distributed, collaborative, and adaptive operational models, aligned with emerging multidomain warfare concepts adopted by leading international defence organisations.

Throughout the duration of the Strategy, defence R&D&I actions will be launched combining the Ministry's investment effort with national cooperation programmes in dual-use technologies and international frameworks, particularly those promoted within the EU and NATO, in order to accelerate capability maturation and ensure their effective integration into the Armed Forces' command-and-control systems.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS

Technologies for robust PNT

Development of innovative solutions to ensure robust and secure positioning, navigation, and timing (PNT) capabilities tailored to the operational requirements of the defence environment, both through the enhancement of GNSS receivers, particularly those based on the Galileo Public Regulated Service (PRS) signal, and through alternative technologies that ensure operability in GNSS-denied or degraded environments.

The growing dependence of military systems on GNSS signals for critical functions such as tactical navigation, sensor georeferencing, system synchronisation, and platform guidance represents a significant operational vulnerability. This dependence is particularly critical in scenarios where GNSS signals may be degraded, jammed, or spoofed through interference or deception. This is further compounded by inherently complex contexts, such as dense urban areas, underground environments, high-latitude regions, or underwater operations, where reliable access to GNSS signals is limited or non-existent.

In this context, it is essential to field resilient, versatile, and autonomous PNT capabilities that ensure operational continuity across all types of missions. To this end, this technological objective drives the development of complementary solutions organised into two main lines of effort.

The first line focuses on the development of advanced GNSS receivers, optimised for governmental signals such as Galileo Public Regulated Service (PRS), capable of operating in hostile electromagnetic environments and under demanding tactical conditions. These receivers shall offer increased immunity to interference and spoofing, capabilities to detect and mitigate cyberattacks, and compatibility with other allied GNSS systems. Particular attention will be paid to miniaturisation, low power consumption, and adaptability to constrained form factors, such as handheld radios, communications equipment, light drones, or smart munitions, as well as interoperability with existing mission architectures and secure configuration and cryptographic key management options, among other advanced features.

The second line concentrates on developing alternative or complementary technological solutions to GNSS, designed to provide autonomous and reliable PNT capabilities without reliance on satellite signals. These will include technologies such as advanced inertial navigation, magnetic and gravimetric sensors, AI-enabled visual navigation, multisource fusion, signals of opportunity, and digital environmental maps. These solutions shall prioritise operational autonomy, scalability, modularity, and resilience against cyber compromise, with the potential for integration into manned, unmanned, or soldier-portable systems.

The actions envisaged under this objective will combine the Ministry of Defence’s own investment with national cooperation programmes on dual-use technologies, as well as with European and transatlantic initiatives, thereby strengthening strategic autonomy and technological sovereignty in a domain that is critical to military operational effectiveness.

DEFENCE APPLICATIONS WITH HIGH TECHNOLOGICAL REQUIREMENTS
Technological solutions for cyber operations
Development of advanced technological tools and solutions that strengthen the cyber intelligence capabilities of the Armed Forces, contribute to ensuring freedom of action in cyberspace, and enable the execution of active and proportionate responses to hostile actions, within the framework of legitimate defence.

The increasing digitalisation of military operations, together with the evolution towards a multidomain environment and pervasive hyperconnectivity, has significantly expanded the exposure surface in cyberspace. Not only information networks and systems are at risk, but also weapon systems, sensors, unmanned platforms, and a wide range of capabilities that rely on cyberspace to operate. At the same time, the rapid pace of technological change, the diversity of threats, and the complexity of attribution make cyberspace a unique operational domain, in which adaptive, resilient, and technologically advanced capabilities are essential.

This technological objective promotes the development of solutions to enhance military cyber intelligence, understood as the capability to observe, understand, anticipate, and assess threats in cyberspace. Technologies will be fostered that enable the collection of information from multiple sources, its analysis through advanced techniques, including artificial intelligence, and the generation of a comprehensive cyber operational picture, in near real time, to support the operational commander's decision-making.

In parallel, the development of active cyber defence capabilities will be encouraged, enabling rapid and proportionate responses that limit the adversary's freedom of action in cyberspace, based on the principle of a balanced and proportional response to hostile actions. These responses may include preventive or neutralisation measures against cyberattacks, disinformation campaigns, or hybrid hostile actions affecting own capabilities.

The systems developed must be scalable, interoperable, and capable of operating in persistent conflict environments, securely incorporating emerging and disruptive technologies. They must also be able to evolve rapidly to adapt to new techniques, attack vectors, or changes in the operational environment. Particular attention will be paid to the automation of repetitive tasks, anomaly detection, technical characterisation of hostile campaigns, and the continuous training of artificial intelligence systems using data specific to the military environment.

Throughout the duration of the Strategy, R&D&I actions will be implemented combining departmental investment with national and international cooperation programmes, fostering the development of a technological and industrial base that provides autonomy and resilience in the field of cyber operations.

DEFENCE AGAINST ASYMMETRIC THREATS
Enhanced systems for remote detection of land-based IEDs
Development of advanced solutions for the remote detection of improvised explosive devices (IEDs), incorporating advanced sensors, multisensor technologies, artificial intelligence, large-scale data analytics, and early warning systems. These capabilities aim at optimising the protection of military units in asymmetric warfare scenarios, improving operational effectiveness, and reducing personnel risk.

The threat posed by IEDs remains one of the main concerns in asymmetric and hybrid operations, where non-state and non-conventional actors employ low-cost means with high operational impact. Early and stand-off detection of these devices constitutes a critical capability for Force Protection and civilian population safety, requiring technological solutions that are increasingly accurate, fast, and reliable. Technological evolution is enabling progress towards systems that not only identify threats more effectively, but also improve decision-making and reduce personnel exposure.

The combined use of unmanned ground and aerial platforms equipped with heterogeneous sensors provides a distributed sensing capability that significantly increases the reach and coverage of detection systems. These systems can operate cooperatively, scanning terrain from multiple perspectives and improving the quality of the information collected. The use of AI and deep-learning algorithms enables the detection of anomalous patterns and the classification of potential threats with greater accuracy, significantly reducing false-alarm rates and facilitating automated responses to indications of explosive devices.

The development of multisensor architectures is a key element to improve detection reliability. Technologies such as ground-penetrating radar (GPR), hyperspectral imaging, infrared detection, and spectral-signature sensors can be combined to identify anomalies associated with IEDs, whether buried or concealed in the environment. In addition, chemical and spectroscopic detection techniques, based on nanomaterials, ion mobility spectrometry, LIBS, SERS, THz, or gamma sensors, make it possible to detect the presence of explosive compounds or their vapours under adverse operational conditions.

The integration of big data and predictive analytics capabilities also enables the correlation of historical and real-time data to identify recurring patterns in IED emplacement and anticipate higher-risk areas. Early warning systems based on video analytics, multispectral vision, and algorithms for detecting dynamic terrain changes complement this approach, enabling automated alert generation and continuous updates to situational awareness.

Throughout the duration of the Strategy, defence R&D&I projects will be promoted to validate these solutions under realistic conditions, combining in-house developments with national and international cooperation, in order to increase the maturity and operational readiness of these critical protection capabilities.

DEFENCE AGAINST ASYMMETRIC THREATS
Technologies for protection against unmanned maritime-vehicle threats
Development of integrated technological solutions for the detection, protection, and effective neutralisation of hostile unmanned maritime vehicles, with the aim of defending ships, ports, naval bases, and other critical maritime infrastructure against asymmetric attacks.

Unmanned maritime vehicles, particularly unmanned surface vehicles (USVs), represent a growing threat in critical naval environments. These are low-cost, hard-to-detect, highly manoeuvrable platforms capable of carrying offensive payloads with high precision. Their small size, limited radar signature, and ability to operate at low speed amid sea clutter make detection and tracking difficult, especially at night or under poor visibility conditions. This threat is exacerbated when USVs are employed in saturation attacks, either as swarms or in coordination with other vectors, such as aerial drones or electronic attacks.

Countering this type of threat requires a layered defensive architecture integrating advanced detection capabilities, kinetic response, and non-kinetic neutralisation. Detection demands the deployment of multi-sensor networks combining short-range coastal and naval radars, electro-optical and infrared sensors, acoustic devices, and satellite or airborne surveillance capabilities, all integrated into command-and-control systems enabling real-time tracking. In addition, electromagnetic spectrum monitoring and the identification of anomalous behavioural patterns are emerging as key tools to detect hostile USVs and the potential "motherships" responsible for their deployment.

With regard to neutralisation measures, a combined approach is envisaged, bringing together conventional means, such as naval gunfire, man-portable weapons, and perimeter protection systems, with other technologies offering greater effectiveness and operational sustainability. In this context, electronic warfare is of particular relevance for disrupting USV navigation and communications systems. Over the longer term, the development of directed-energy systems, such as high-power lasers, is envisaged, capable of engaging low-signature targets with very short reaction times and minimal operating cost.

This challenge is further compounded by the underwater threat posed by unmanned underwater vehicles (UUVs), which are difficult to detect and potentially lethal against critical infrastructure. Countering this threat requires specialised underwater surveillance capabilities, including active and passive sonars, acoustic sensor networks, autonomous patrol vehicles, and advanced signal-processing technologies to identify anomalous patterns in highly dynamic environments.

Overall, the technological challenges associated with this objective range from the development of sensors adapted to naval platforms to improvements in data-fusion algorithms and efficient integration into existing combat systems. Given the distinctly dual-use nature of many of these technologies, demonstrators and prototypes will be advanced through departmental defence R&D&I programmes, in coordination with national and European technological cooperation initiatives, with particular emphasis on the participation of the national technological and industrial ecosystem.

DEFENCE AGAINST ASYMMETRIC THREATS
Technological solutions against low-altitude aerial threats
Development of technological solutions for the detection, tracking, and neutralisation of low- and very-low-altitude aerial threats, covering both traditional threats (rockets, artillery, and mortars) and emerging threats derived from Unmanned Aerial Systems (UAS), loitering munitions, or kamikaze systems. The objective is to enable their integration into Force Protection systems (C-UAS and C-RAM capabilities) and into the self-protection of land, naval, and air platforms, within the scope of Active Protection Systems (APS).

In today's conflict environments, aerial threats have evolved rapidly, combining traditional means such as rockets, artillery, and mortars with UAS, particularly those that are low, slow, and small (LSS). This threat set, including kamikaze drones and loitering munitions capable of operating autonomously or in swarms, poses significant defence challenges due to its low signature, manoeuvrability, and relatively low cost compared to conventional countermeasure systems.

This transformation of the operational environment requires highly accurate, scalable, and adaptable capabilities for early detection, tracking, and neutralisation. The technological objective is focused on developing C-UAS and C-RAM solutions that enhance detection, warning, and engagement performance across this growing spectrum of aerial threats. These solutions should be based on the intelligent combination of technologies such as air-surveillance radars, electro-optical and infrared (EO/IR) sensors, and acoustic sensors, enabling effective location, classification, and target confirmation, even under adverse or highly saturated conditions.

Sensor interoperability, integration into open command-and-control architectures, and connectivity with both kinetic and non-kinetic neutralisation systems (hard-kill and soft-kill) will be key to delivering a coordinated and effective response. The implementation of active protection systems on military platforms also requires seamless integration with existing self-protection suites, ensuring minimal reaction times and high operational reliability.

A critical aspect will be the use of AI to increase responsiveness, improve discrimination between real threats and false alarms, and enable dynamic adaptation to new adversary tactics. These tools will help automate parts of the decision cycle, reduce operators' cognitive burden, and increase defensive effectiveness against simultaneous or saturated attacks.

The development of these solutions will be pursued through a combination of departmental investment and national and European cooperation initiatives, with particular emphasis on technology maturity, integration into existing systems, and the delivery of demonstrators tailored to real operational requirements.

DEFENCE AGAINST ASYMMETRIC THREATS

CBRN threat control

Development of technologies that enhance detection, identification, and monitoring (DIM) capabilities, physical protection, decontamination, and the development of specific medical countermeasures, with the aim of rapidly and effectively mitigating or neutralising the effects of CBRN threats, minimising their impact on military operations and the civilian population.

Controlling the CBRN threat remains a strategic priority to ensure the security of deployed forces and critical infrastructure, as well as to guarantee a rapid and effective response to intentional or accidental incidents. Nevertheless, limitations persist in the ability to secure affected areas or operate in contaminated environments, particularly with regard to detection and early warning, individual and collective protection, efficient decontamination, and the medical diagnosis and treatment of casualties.

Advances in CBRN sensing technologies and their integration with communications systems, data fusion, artificial intelligence, and autonomous vehicles are enabling the development of high-precision portable and stand-off systems. These make it possible to identify and characterise threats at a distance, reducing personnel exposure and improving real-time situational awareness. In addition, the use of onboard sensors in unmanned ground or aerial platforms provides an operational advantage for CBRN reconnaissance tasks. At national level, notable capabilities exist in chemo-resistive sensors, biosensors, laser-based technologies, and metal–organic frameworks, among others.

With regard to decontamination, solutions are being developed that minimise the use of liquids, particularly suitable for sensitive equipment, or are optimised for direct application on personnel. Among the most promising approaches are cold plasma, ultraviolet light, ozone generation, vapour-phase oxidant delivery, nanomaterial-based coatings, catalytic agents, and supercritical fluids. There is also a growing trend towards integrating some of these technologies into robotic systems, enabling faster, safer, and more controlled operations.

Individual and collective protection must also evolve towards smarter systems. The development of personal protective equipment (PPE) with self-decontamination capabilities is sought, reducing the risk of secondary contamination. The integration of sensors into suits, filters, or ventilation systems will enable continuous detection of CBRN agents as well as monitoring of filtering material depletion.

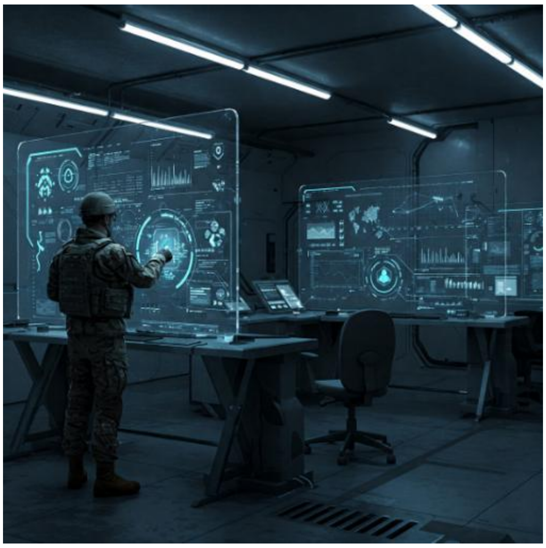
In the medical domain, progress is required in specific countermeasures, including antidotes, vaccines, decorporation agents, and early diagnostic tools that can be rapidly deployed in operations. Their stability under variable conditions and the ability to scale up production will be key factors for operational availability.

Given the high dual-use value of these technologies, this objective will support their development through national and international cooperation, directing departmental investment towards adaptation to the military environment, the development of demonstrators, and validation in operational exercises in order to achieve high levels of technological maturity.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS

Application of artificial intelligence to defence

Promotion of the development of capabilities based on Artificial Intelligence (AI) for its ethical, efficient, and responsible application in defence, as an enabling technology to enhance situational awareness, automate critical functions, support decision-making, and enable multidomain operations at all levels.



AI is becoming firmly established as an essential enabler of the digital transformation of the defence sector, enabling new ways of operating, analysing complex environments, and coordinating interconnected systems in real time. Its ability to identify patterns in large volumes of data, integrate heterogeneous information sources, and generate predictive models provides a significant advantage in critical functions such as command and control, surveillance, decision support, and resource management. In this regard, AI is not an isolated technology, but a transversal capability that impacts all operational domains and all levels of military command, from the strategic to the tactical level.

Its integration into defence systems can represent a qualitative leap in terms of efficiency, adaptability, and operational superiority. AI enables the automation of information processing from distributed sensors, the anticipation of adversary behaviour through multisource analysis, the optimisation of logistical deployment, and the generation of decision recommendations in scenarios characterised by high uncertainty and the speed of modern conflict. This ability to act with agility in highly dynamic environments is key to maintaining the initiative and reducing the cognitive burden on human operators.

Among its most promising applications are the enhancement of situational awareness through dynamic representations of the operational environment; autonomous guidance of individual platforms or swarms; prediction of enemy movements based on integrated intelligence; coordination of sensors and effectors within networked combat architectures; and the generation of advanced simulations for planning and training. Furthermore, in active defence systems, AI enables threat prioritisation, real-time response adaptation, and the efficient coordination of kinetic and non-kinetic resources.

The effective deployment of these capabilities requires overcoming technological barriers such as limited availability of operational data in certain scenarios, constraints on the use of classified data, and computational limitations on embedded platforms. In this context, technologies such as synthetic data generation, federated learning, generative AI, and explainable models will play a key role. At the same time, development efforts must ensure compliance with ethical principles and standards that guarantee transparent, auditable solutions compatible with the values of the Armed Forces.

Given its enabling and transversal nature, this objective will be addressed in coordination with the different areas of the Ministry of Defence, prioritising applications with the greatest operational impact. This will be pursued through a combination of departmental investment, national efforts in dual-use technologies, and European and transatlantic initiatives, with the aim of consolidating a robust and sovereign ecosystem for AI applied to defence.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS

Technologies to support the life-cycle management of military systems

Development and application of advanced technologies supporting the life-cycle management of military systems across all domains (land, maritime, air, and space), with the objective of ensuring their operability and availability, extending their service life, and optimising the resources and assets employed throughout their entire life cycle, up to end of service.

The life-cycle management of military systems constitutes a strategic axis for maintaining the operability and effectiveness of the Armed Forces, while optimising resources and reducing dependence on strategic materials. This approach encompasses all phases of the system, from development and manufacturing, through in-service maintenance, to decommissioning at the end of its service life.

During the initial design and development stages, the objective is to achieve the best possible performance while incorporating sustainability and efficiency criteria, prioritising the use of accessible materials with low strategic impact, as well as configurations that enhance system maintainability and modularity. In this context, research and development in Modular Open Systems Approach (MOSA) and Model-Based Systems Engineering (MBSE), together with the use of digital twins, will be promoted to enable agile design, modular integration, and interoperability of complex systems, reducing life-cycle costs and accelerating the incorporation of new capabilities.

During the operational phase, efficient maintenance is essential. Emerging technologies such as advanced sensing, digital twins, predictive maintenance, new repair and inspection techniques, and autonomous diagnostic platforms make it possible to anticipate failures, optimise logistical resources, and reduce downtime. These capabilities are being progressively integrated into military platforms, enabling maintenance operations both at national bases and in deployed environments. Artificial intelligence further enhances this ecosystem by enabling real-time analysis, prioritisation of interventions, and automation of sustainment decisions.

Life-cycle digitalisation also enables full traceability of components, materials, and subsystems through interconnected management systems, facilitating dynamic inventory management, improving operational logistics, and enabling more effective planning for equipment replacement or upgrades.

In the final phase, the incorporation of circular economy principles is promoted to enable system upgrades, recovery of usable parts, and recycling of critical materials, with the aim of reducing demand for strategic resources and minimising environmental impact. This approach also contributes to greater technological autonomy.

In the coming years, technology projects will be promoted to mature these capabilities, validate them in simulated and operational environments, and support their integration into the sustainment of defence systems. Given their strong dual-use character, collaboration with the civilian industrial base, access to national funding, and coordination with international programmes will be encouraged, maximising the strategic and economic return of these initiatives.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS
Improvement of defence-industry production processes
Development and application of advanced technologies to drive the transformation of the DTIB, in order to enhance the speed, flexibility, and resilience of production processes. The objective is to evolve production models from approaches optimised for efficiency and cost reduction towards agile, scalable, and digitalised industrial ecosystems, capable of responding to high-demand scenarios and sustaining technological superiority.

The current strategic context, marked by accelerated technological change and the possibility of high-intensity conflict, demands a profound transformation of the production processes of the DTIB.

The objective is to evolve from traditional models focused on efficiency and cost reduction towards agile, scalable, and digitalised industrial ecosystems, capable of rapidly responding to high-demand scenarios, maintaining technological superiority, and ensuring sovereignty over the life cycle of defence systems.

A specific challenge lies in the need to bifurcate the production model: sustaining the ability to manufacture complex, high-value platforms, while simultaneously developing optimised processes for the mass production of low-cost systems, such as autonomous systems.

This transformation is structured around the adoption of new production paradigms, including integrated digital engineering, which connects all phases of the life cycle through unified data models; distributed and expeditionary manufacturing, enabling production at the point of need and enhancing logistical resilience; open modular architectures, which reduce dependencies and facilitate technological upgrades; and Industry 5.0, which promotes advanced collaboration between humans and machines, enhancing both production and in-field maintenance.

The deployment of these paradigms relies on a set of key enabling technologies, notably digital twins and advanced simulation to optimise processes and anticipate high-demand scenarios; software-defined manufacturing, enabling flexible and reconfigurable production lines; additive manufacturing, which facilitates rapid production of components even in remote environments; advanced and collaborative robotics, which automate and support critical tasks; applied artificial intelligence, essential for predictive logistics and real-time quality control; and secure data networks, ensuring the reliable and confidential transmission of critical information.

The actions under this objective will be carried out in cooperation with other Government departments, maximising dual-use potential and the exploitation of civil innovation, and ensuring alignment with the EID. The ultimate goal is to catalyse the evolution of the DTIB towards a model based on strategic resilience, speed of adaptation, and on-demand scalability, ensuring that the defence industry is able to sustain and replenish materiel at an appropriate pace under any scenario.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS
Unmanned ground platforms for defence missions
Development of new robotic ground vehicles capable of executing missions in an unmanned mode, integrating mission-specific functionalities in accordance with the requirements of each operation and the desired level of autonomy, with the aim of reducing personnel exposure to the risks inherent to operational environments.

Certain military missions entail a high level of personnel risk, as is the case in Counter-IED (C-IED), Explosive Ordnance Disposal (EOD), or CBRN operations; reconnaissance in remote areas; casualty evacuation; combat actions; and tasks typically carried out by combat engineers. In addition, other functions require significant physical effort, such as the transport of materiel. In this context, the use of Unmanned Ground Vehicles (UGV) helps to reduce human exposure and increase operational efficiency.

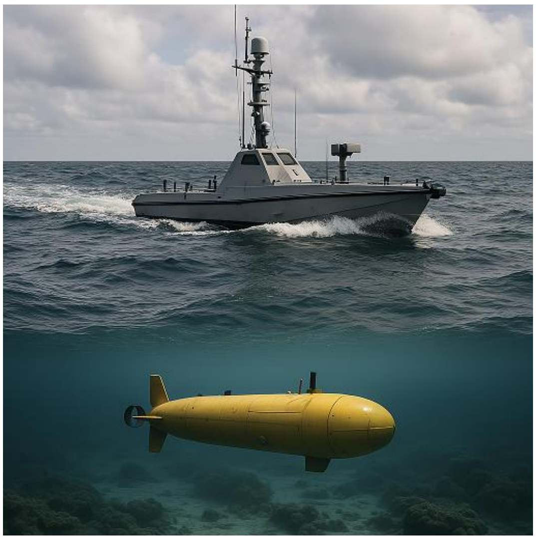
The development of these capabilities poses a range of technological challenges, notably the need for robust perception and autonomous navigation systems in hostile environments; secure coordination among multiple platforms; cyber protection of control links; integration of complex payloads; and autonomous decision-making under high uncertainty conditions. These challenges are compounded by the difficulty of designing modular and versatile solutions capable of adapting to varied and demanding operational scenarios.

In recent years, a number of UGVs have been developed nationally for specific military applications and increasing levels of autonomy. Building on these advances, the technological objective is to expand current capabilities through the creation of new platforms for missions not yet covered and the enhancement of existing systems. The planned actions will include both the robotic conversion of in-service manned vehicles and the development or adaptation of dedicated unmanned platforms, according to operational requirements.

To cover a broad range of missions, the design of UGVs with different mobility performance, sizes, and payload capacities is envisaged, from heavy platforms to miniaturised systems. Based on these modular designs, specialised variants will be developed for specific applications such as C-IED and CBRN operations, surveillance, combat, logistic support, medical evacuation, engineering, or operations in urban environments. These platforms may operate individually or in a coordinated manner, including cooperative configurations such as swarming. Both automated driving and autonomous payload management will be addressed, with autonomy levels tailored to each mission profile. It will be essential to account for the specific conditions of the military environment: unstructured terrain, GNSS-denied navigation, or the need to avoid using active sensors. In all cases, the use of weapons on UGVs will always require human intervention.

The delivery and fielding of these systems will require active involvement by the Ministry of Defence, including the conduct of field trials to validate the operational capabilities of the platforms in real environments. Given the distinctly dual-use nature of this technology, it is envisaged that part of the developments may benefit from external funding sources, both national and European.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS
Unmanned underwater and surface vehicles for defence missions
Development of unmanned maritime vehicles with advanced capabilities in autonomy, interoperability, and operational versatility, enabling the safe and efficient execution of missions while reducing human intervention during deployment, operation, and recovery phases, and expanding their use across a broader spectrum of tactical scenarios.



Unmanned maritime vehicles, both underwater (UUV) and surface (USV), are assuming an increasingly strategic role in the defence domain. Recent conflicts have demonstrated their operational utility, notably through the use of USV swarms in attacks against naval platforms and UUVs in reconnaissance tasks. Their contribution to surveillance, deterrence, and combat missions reinforces the need to continue advancing the development of these capabilities.

In recent years, the Ministry of Defence has launched a number of initiatives that have made it possible to directly identify the needs of the Armed Forces and to steer technological development towards real operational application. Having moved beyond the initial phase focused on intelligence, surveillance, and reconnaissance (ISR), mine countermeasures (MCM), and rapid environmental assessment (REA), the objective is now to extend the use of unmanned systems (UxV) to new areas such as anti-submarine warfare (ASW), surface warfare (ASuW), protection of critical infrastructure, amphibious operations, advanced countermeasures, and seabed analysis.

This operational leap requires addressing significant technological challenges. Effective cooperation between manned and unmanned platforms will be essential, as will their full integration into the combat systems of naval vessels and interoperability with allied systems. The improvement of launch and recovery systems (LARS), oriented towards automated and versatile solutions, will be key to enabling operations from conventional ships or even from other unmanned platforms.

Artificial intelligence will constitute a fundamental pillar in this evolution, enabling autonomous navigation, obstacle avoidance, threat identification in dynamic environments, and real-time decision support. Progress will also be required in GNSS-independent navigation technologies and in highly reliable underwater communications, in order to ensure precision and safety in operations where traditional signals are limited or unavailable.

The development of lightweight platforms, such as gliders, as well as extra-large unmanned underwater vehicles capable of operating at greater depths and with increased autonomy, will also be promoted. In response to asymmetric scenarios, offensive capabilities of these systems are expected to be enhanced in order to provide greater operational versatility.

These actions will be articulated through defence R&D initiatives promoted by the Ministry of Defence, complemented by national and European cooperation programmes, with the aim of accelerating technological maturity and increasing strategic autonomy in this critical domain.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS
UAS for defence missions
Development of a new generation of unmanned aerial systems (UAS) for defence missions by strengthening national capabilities in order to deliver versatile, intelligent, and resilient systems, capable of operating autonomously or collaboratively across multiple scenarios, ranging from logistics to combat, while ensuring the highest level of national technological sovereignty in this domain.

UAS have become established as a transformative element in modern conflicts, providing a significant advantage in multidomain operations. Their ability to operate persistently over areas of interest, with reduced risk to human life and lower operational costs, gives them a central role in achieving information superiority and force projection. Consequently, their continuous evolution requires moving beyond the traditional intelligence, surveillance, and reconnaissance (ISR) mission set and progressing towards technologically sovereign solutions that ensure maximum effectiveness and resilience in hostile and degraded environments.

The scope of this technological objective ranges from enhancing Class I systems, expanding the range of defence applications in which they are currently employed, to the development of medium- and long-range Class II/III platforms, both fixed-wing and rotary-wing. Research will be promoted into new platform designs aimed at improving performance in terms of speed, range, and operational ceiling, including vertical take-off and landing (VTOL) capabilities.

To this end, several key technological challenges are addressed. First, a significant leap in autonomy and artificial intelligence is sought, through the development of modular and integrated avionics that reduce operator workload and enable more efficient mission management. This includes robust navigation systems capable of operating in GNSS-denied environments, as well as increased onboard processing capacity to enhance situational awareness. Another fundamental challenge lies in the design of flexible system architectures enabling the creation of multipurpose UAS, capable of integrating interchangeable payloads to execute a wide range of missions, from decision support to kinetic strike. New applications will also be explored, such as the development of unmanned aerial systems for transport and logistics in operational theatres.

Platform collaboration constitutes a central axis of this effort, and therefore the development of Manned-Unmanned Teaming (MUM-T) concepts of operation will be promoted, along with, in a disruptive manner, the design of aerial swarm systems. These swarms will be required to operate in a coordinated and autonomous manner as a single system, addressing the challenges associated with their deployment, control, and recovery.

Given the strong dual-use nature of many UAS-related technologies, their development will be driven by combining departmental investment with funding from national and European cooperation initiatives. Emphasis will be placed on achieving the highest possible level of development within the national technological and industrial ecosystem, and on aligning such development with the operational needs of the Armed Forces.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS

Materials for application in platforms and for the dismounted soldier

Development of new materials that enhance the survivability of military platforms and personnel through more effective passive protection systems and signature reduction technologies, capable of being integrated into land, naval, and air platforms, as well as into the individual protective equipment of the soldier.

The protection of the soldier and military platforms against hostile threats remains one of the fundamental pillars of defence research. Despite advances in early detection and preventive neutralisation, as long as the risk of human casualties persists, the development of technological solutions aimed at minimising vulnerability will continue to be a priority. This protection can be addressed through two complementary approaches: on the one hand, by enhancing passive protection systems, and on the other, by reducing detectability.

Improving passive protection entails the development of new materials offering increased resistance to ballistic impacts, explosions, or bladed weapon attacks, while maintaining reduced weight. This requirement is particularly critical in the case of the individual soldier, where achieving an optimal balance between protection, mobility, ergonomics, and comfort is essential to preserve operational effectiveness. For platforms, the challenge lies in strengthening structural protection without adversely affecting manoeuvrability or energy consumption. This requires research into new materials, multilayer structures, and advanced energy absorption solutions.

In parallel, materials designed to reduce the signature of platforms and personnel across different regions of the electromagnetic spectrum must be developed. Lowering radar, infrared, visual, or acoustic visibility enhances concealment capabilities and enables greater tactical effectiveness, while also hindering accurate identification by the adversary. Innovation in absorbent coatings, metamaterials, low-emissivity structural materials, or multispectral solutions capable of addressing multiple signatures simultaneously represents an area of high strategic value.

The development of these materials poses significant technological challenges. In addition to achieving the required performance levels, they must be manufacturable at industrial scale, using reproducible processes compatible with integration into existing systems. Furthermore, their resilience under extreme conditions of temperature, humidity, wear, or chemical exposure must be ensured, both in operational environments and during storage and transport.

In the coming years, efforts will focus on advancing the maturity of technologies initiated in previous programmes, promoting their validation through integrated demonstrators. At the same time, the emergence of new disruptive developments in advanced materials will be encouraged, supporting the transition from laboratory stages to practical applications. These actions will be aligned with national and European technological cooperation programmes, particularly within the framework of dual-use technologies, combining departmental investment with external funding in order to maximise operational and industrial impact.

LEVERAGING CIVILIAN TECHNOLOGICAL PROGRESS
Innovative solutions for defence in the space domain
Development of disruptive and resilient capabilities in the space domain through the application of *New Space* technologies and approaches, in order to enhance core defence applications, ensure autonomous access to space, improve space domain awareness and protect own assets, while responding with agility to the operational needs of the Armed Forces.

The space domain has become established as a strategic arena in which information and communications superiority constitutes a force multiplier, and where any degradation of services has an immediate impact on multiple defence capabilities. The growing dependence on space assets coincides with the emergence of new threats, such as interference, hostile manoeuvres and cyberattacks, as well as an increasingly congested orbital environment. This situation requires the availability of sovereign capabilities that ensure freedom of action and the protection of national interests, in particular by guaranteeing access to orbit from Spanish territory.

This technological objective is aimed at delivering an innovative response to this need, leveraging the significant industrial capabilities of the civil space sector and the agility provided by New Space technologies. The primary focus will be on the development of solutions for critical defence applications: Intelligence, Surveillance and Reconnaissance (ISR) through optical and radio-frequency payloads; resilient satellite communications (SATCOM) enabled by reconfigurable and regenerative payloads with inter-satellite communication capabilities; the enhancement of satellite navigation (GNSS) capabilities; and missile early-warning systems. These solutions will be implemented through dedicated payloads integrated into small satellites operating in LEO constellations, enabling dispersion against attack, rapid replenishment and higher revisit rates, while reducing costs and deployment timelines.

Achieving this objective entails addressing significant technological challenges. These include the miniaturisation of high-performance sensors; the development of rapid response capabilities (responsive space), encompassing additive manufacturing and micro-launchers; and the creation of technologies to protect assets against physical, electromagnetic and cyber threats, including shielding solutions and real-time orbital reconfiguration capabilities. This effort will also promote the development of on-orbit servicing systems, persistent stratospheric platforms and networks of cooperative satellites. Transversally, it is essential to strengthen Space Domain Awareness (SDA), using AI-based processing to detect risks such as non-cooperative approaches and to lay the foundations for a future space command and control system.

Over the coming years, the R&D&I actions promoted under this objective will seek to deploy and mature these capabilities, ensuring convergence with the future NATO and EU space architecture. These solutions will not only provide the Armed Forces with more resilient and autonomous access to space, but will also consolidate the DTIB as a relevant player in a global market of high strategic value.

ENHANCEMENT OF MILITARY PERSONNEL CAPABILITIES
Technologies for the dismounted soldier
Development of technologies that enhance the performance of the various advanced systems and equipment carried by the dismounted soldier, with the aim of increasing operational capabilities, particularly in terms of fire effectiveness, situational awareness and integration with sensors and external systems, as well as strengthening survivability, sustainment, mobility and training capability in demanding environments.

The dismounted soldier faces highly complex missions, often in hostile environments that impose demanding physical, psychological and cognitive requirements. In order to address these challenges effectively, it is necessary to equip personnel with advanced systems that enhance performance, increase protection and improve integration with other assets within the tactical environment. New technologies make it possible to significantly improve the capabilities of personal equipment, and one of the key objectives is their progressive incorporation into the Armed Forces.

Technological development should be oriented towards modular, open and scalable architectures, aligned with evolving international standards. This approach will facilitate subsystem upgrades, platform interoperability and the reduction of external technological dependencies. Priority will be given to the design of a secure digital architecture integrating sensors, communications, weapons, visualisation and navigation, enabling the soldier to operate as a distributed node within collaborative tactical networks. This architecture shall comply with NATO standards, be resilient to cyber and electronic threats, and interoperate with unmanned platforms. In parallel, optimisation of weight, volume, power consumption and subsystem functionality will be required.

Planned lines of progress include enhanced situational awareness through integration with remote sensors, C2 systems and unmanned platforms, as well as the use of augmented reality technologies and positioning solutions in GNSS-denied environments. The use of night-vision and electro-optical/infrared (EO/IR) sensors will also be promoted, together with local information exploitation capabilities. In the energy domain, priority will be given to more efficient power solutions based on advanced batteries, fuel cells or integrated solar cells, and to the adoption of exoskeletons to facilitate mobility and load carriage. In addition, the development of smart textiles, wearable electronics and body thermal regulation systems adapted to extreme environmental conditions will be encouraged. Finally, the availability of real-time physiological monitoring systems has the potential to transform both training and operational personnel management, enabling informed decision-making in situations of extreme stress or fatigue. These data can also accelerate triage and medical support processes in the event of casualties, improving the efficiency of medical response in the operational environment, while fully respecting health data protection regulations.

Given the strong dual-use nature of many of these technologies, their development will be promoted through a combination of departmental investment and national and European cooperation initiatives, with particular emphasis on the participation of the national technological and industrial ecosystem in order to maximise strategic and operational return.

ENHANCEMENT OF MILITARY PERSONNEL CAPABILITIES
Advanced training and decision support through simulation
Development and acquisition of technological tools that enable the training, readiness and evaluation of units, as well as analysis and decision-support in complex situations involving multiple alternatives, with the aim of improving the performance of the Armed Forces in real operational environments.

Advanced simulation has become an essential tool for the Armed Forces, as it enables the controlled and safe representation of real processes, phenomena, devices or systems, with different levels of fidelity, for training, behavioural analysis and operational evaluation purposes. Its value lies in its ability to prepare personnel in a realistic, repeatable, safe and cost-effective manner, facilitating training through theoretical scenarios, skills enhancement, the acquisition of lessons learned and the continuous improvement of performance.

The incorporation of new technological advances is transforming traditional simulation capabilities towards more immersive, adaptive and collaborative models. Progress in virtual, augmented and mixed reality is enabling the development of more realistic, multi-domain simulation environments, in which different users can interact simultaneously within complex scenarios, integrating aerial, naval, land, space and cyber platforms. These environments provide immersive training that strengthens the physical, technical and cognitive readiness of personnel by simulating high-demand operational situations.

Hyperconnectivity, supported by technologies such as 5G, enhances distributed simulation through interoperable architectures that enable remote training and ubiquitous access to simulated environments. This makes it possible to conduct coordinated exercises from different geographical locations, promote joint and cooperative training among units, and simulate a combat cloud with the simultaneous participation of multiple platforms.

The use of artificial intelligence introduces new possibilities for the generation of adaptive scenarios, capable of dynamically adjusting their difficulty and characteristics according to the user. In addition, the integration of biometric techniques makes it possible to measure physical and cognitive parameters during training, assessing capabilities, stress levels, mental workload and attention, thereby supporting mission assignment based on individual profiles and performance.

In parallel, the use of digital twins and wargaming systems contributes to tactical, operational and strategic analysis, providing a robust foundation for decision-support in contexts of uncertainty. Furthermore, strengthening interoperability among live, virtual and constructive (LVC) simulation systems will enable more effective integration of the different training levels, fostering component reuse, the adoption of common standards and greater development efficiency.

Over the coming years, the R&D&I actions promoted under this objective will seek to deploy and mature these capabilities, combining departmental investment with national and international cooperation programmes, and integrating the industrial and scientific ecosystem in the development of solutions tailored to the needs of the military operational environment.

ENERGY SUSTAINABILITY

Energy generation, storage and efficiency in isolated bases and infrastructures

Reduction of dependence on fossil fuels and enhance energy security at bases, camps and other isolated military infrastructures through the development, adaptation and validation of sustainable, secure and efficient energy technologies.

Electric power generation in bases and deployed camps within operational theatres relies largely on diesel generator sets, due to the absence or limited reliability of local power grids. While these systems offer certain tactical advantages, such as immediate availability and robustness, their use entails a high logistical footprint, significant operating costs, security risks in the supply chain, continuous maintenance requirements and low energy efficiency. This challenge also affects other isolated military infrastructures, both within national territory and in international missions, where energy autonomy is critical.

To reduce this dependence and enhance energy resilience, it is necessary to transition towards more efficient, sustainable and operationally adapted solutions. One of the main lines of action will be the integration of on-site renewable generation systems, such as photovoltaic solar and small-scale wind power, enabling a substantial reduction in fuel consumption and logistical vulnerability. In parallel, the deployment of advanced energy-storage systems will be promoted to ensure a continuous power supply despite the intermittency of renewable sources and to optimise generator operation.

The implementation of smart microgrids will represent another key pillar, enabling automated energy management, prioritisation of critical loads, efficient integration of multiple energy sources and remote system monitoring. These microgrids must incorporate strict requirements in terms of cybersecurity, interoperability and resilience against threats specific to the military environment, such as electromagnetic interference or deliberate attacks on control systems. Additional areas for improvement include small-scale on-site production of synthetic fuels or biofuels, optimisation of heating and domestic hot water systems, and the use of construction solutions and materials with high thermal performance, capable of reducing energy demand in infrastructures deployed in extreme environments.

This is a clearly dual-use domain, where many technologies are already mature in the civil sector. However, their application to defence requires specific adaptation to ensure robustness under adverse environmental conditions, ease of transport and installation, low maintenance requirements and rapid integration into complex operational scenarios.

Over the coming years, technical-operational validation projects and the adaptation of existing solutions will be promoted, particularly in the areas of energy storage, smart microgrids and integrated systems. In parallel, access to civilian capabilities will be fostered through national and international cooperation, with the aim of strengthening strategic autonomy in this critical domain.

ENERGY SUSTAINABILITY
New propulsion technologies for manned platforms and unmanned systems
Development of hybrid and electric propulsion systems for manned platforms and unmanned systems, with the aim of reducing the European Union's external technological dependence in this domain while simultaneously improving the mobility, energy efficiency and stealth capabilities of defence systems.

Current operational requirements are driving the need to modernise propulsion systems for military platforms, both manned and unmanned. In the case of manned platforms, factors such as increased weight due to additional protection, the demand for greater tactical mobility, the need to generate power for increasingly electrified onboard systems, and the requirement to operate in stealth mode by reducing thermal and acoustic signatures pose new technological challenges.

In parallel, unmanned systems across all domains (land, air, naval and underwater) require new propulsion solutions capable of overcoming current limitations. There is significant potential for the development of hybrid or fully electric systems based on advanced energy-storage technologies, such as high-density batteries or fuel cells, addressing the gap between small electrically powered platforms and larger vehicles still dependent on combustion engines. In addition, chemical propulsion systems using solid or liquid fuels will continue to complement these needs in high-dynamic or high-speed applications.

To ensure operability in isolated or hard-to-access environments, it will also be necessary to develop recharging solutions adapted to different energy vectors (electricity, hydrogen, synthetic fuels, etc.). These stations must be mobile, secure and compatible with military standards, enabling a level of functional autonomy comparable to that of current systems.

The development of these capabilities will be supported by strong progress in dual-use technologies in the civil sector, particularly in electrochemical storage and fuel cells, with major programmes foreseen under the upcoming European budgetary framework. Leveraging this evolution will help accelerate the development of national capabilities and reduce strategic dependence.

In the coming years, efforts will focus on the development of demonstrators to validate the technical and operational feasibility of new propulsion concepts. In the land domain, accumulated experience from previous projects will be used as a basis to advance hybrid or fully electric solutions. For unmanned platforms, the development of electric or hybrid propulsion systems will be promoted, with particular emphasis on air and naval applications. In parallel, the suitability of developing recharging stations adapted to different energy vectors will be assessed, along with the promotion of emerging, lower-maturity technologies such as fuel cells for dual-use applications and, in the naval domain, the application of superconductivity or magnetohydrodynamics to propulsion systems.

FOUNDATIONAL NATIONAL TECHNOLOGICAL CAPABILITY DEVELOPMENT
Technologies for the development of directed-energy and electromagnetic weapons
Design, development and integration of directed-energy weapon systems and kinetic electromagnetic weapons (railguns) for defence and security applications. This includes power supply systems capable of delivering high-power electrical pulses, as well as energy-management technologies associated with high-velocity kinetic effects.

Directed-energy weapons based on high-energy lasers (LDEW) and radiofrequency systems (DEW-RF), together with kinetic electromagnetic weapons (railguns), are undergoing rapid development at the global level. The versatility of these systems, their relatively low cost and reduced logistical footprint, combined with their increasing capability to destroy or neutralise targets, make them an increasingly relevant military technology.

LDEWs are particularly effective for C-RAM and C-UAS applications and are employed to protect land platforms as well as critical facilities and infrastructure. DEW-RF systems, in turn, offer a wide range of applications, including defence against aerial threats (UAS, missiles, complex munitions and conventional aircraft), as well as land combat and indirect fire support, such as the neutralisation of electronic systems and equipment on ground platforms and command-and-control centres. Railguns provide high-velocity kinetic effects to counter asymmetric threats such as UxV swarms and hypersonic systems, and to reinforce capabilities in A2/AD environments through proportional responses with a low cost per shot.

However, the advancement of these systems entails significant technological challenges. In the case of LDEWs, it is necessary to develop more efficient laser active media, avoiding international dependencies, and to optimise critical parameters such as long-range beam quality. For DEW-RF, the main challenge lies in generating high-power RF signals (oscillators, amplifiers and modulators) and high voltages (e.g., Marx generators), as well as components related to the emission of ultrawideband RF pulses (UWB), including antennas and associated subsystems. In electromagnetic weapons, challenges include barrel durability under electromagnetic friction, energy management to sustain firing rates, and adjustable projectiles to enable scalable effects. These systems also require high-power pulses over short intervals, which may induce voltage drops affecting sensitive onboard electronics; this necessitates the development of dedicated energy-storage and power-electronics solutions that meet these requirements without compromising other subsystems.

Accordingly, in the coming years the objective is to promote the development of technological demonstrators and prototypes to strengthen national technological capabilities in LDEW, DEW-RF and railgun systems, as well as the participation of the national industrial base in international partnerships focused on the integrated development of systems with advanced functionalities.

FOUNDATIONAL NATIONAL TECHNOLOGICAL CAPABILITY DEVELOPMENT
Technologies for hypersonic vehicles
Promotion of the knowledge, design and maturation of the enabling technologies required for the development of future hypersonic vehicles, capable of sustained operation at speeds above Mach 5 in atmospheric or exo-atmospheric regimes, for both offensive and defensive purposes, including the development of hypersonic interceptors to counter advanced threats.

Hypersonic vehicles represent a technological vector with high disruptive potential, directly affecting the strategic balance, deterrence, and air and space defence. Their development poses extreme scientific and technical challenges, arising from operation in regimes where aerodynamics, thermodynamics and conventional propulsion reach their limits. Addressing these challenges requires a comprehensive, multidisciplinary and cooperative approach.

One of the main challenges is sustained hypersonic propulsion, which requires the development of scramjets, advanced ramjets or hybrid propulsion systems. This entails fundamental advances in aerothermodynamics, heat transfer and chemical kinetics under extreme conditions, as well as high-fidelity computational fluid dynamics and combustion simulations.

The internal and external aerodynamics of these vehicles present additional difficulties due to phenomena such as shock waves, air ionisation and plasma layer formation. These factors strongly condition the design of air intakes, control surfaces and fairings, which must balance aerodynamic efficiency, thermal resistance and compatibility with the propulsion system. In parallel, advanced structural materials and coatings are required to withstand extreme temperatures, intense mechanical loads and rapid thermal cycles.

Control and guidance of these systems demand high precision over extremely short time scales. Their speed requires detection, decision and neutralisation functions to be executed within seconds. In this respect, research into distributed command and control architectures, ultra-fast sensors, artificial-intelligence-assisted algorithms and communication systems capable of operating through the plasma generated during flight is essential, calling for a reassessment of current radiofrequency and laser technologies.

Finally, a structural limitation in Europe is the scarcity of specialised test infrastructures for these regimes, such as hypersonic wind tunnels, combustion test facilities or dynamic vacuum chambers. The scale and cost of such facilities require a cooperative and shared international approach.

Overall, this objective seeks to foster a national ecosystem capable of integrating into major international hypersonic technology programmes. Applied research projects, technological demonstrators and the qualification of key capabilities will be promoted, with particular emphasis on the maturation of propulsion, aerodynamics, materials, sensors, control and communication technologies. These initiatives will be coordinated with European R&D programmes, NATO multinational cooperation schemes and national efforts in dual-use technologies, ensuring complementarity between public and private investments.

FOUNDATIONAL NATIONAL TECHNOLOGICAL CAPABILITY DEVELOPMENT
Quantum technologies applied to defence
Promotion of the development and progressive adaptation of emerging quantum technologies for defence applications, with the aim of enabling new capabilities in secure communications, advanced sensing, precise timing and synchronisation, complex simulation and, in the medium term, applied quantum computing, thereby laying the technological foundations that will allow the Armed Forces to anticipate future strategic and operational challenges.

Quantum technologies are emerging as one of the most disruptive areas for defence, accelerating critical capabilities. Although many remain at an early stage, their development has been driven by civilian initiatives and growing strategic interest, making it necessary to position the national defence ecosystem to incorporate and exploit them in areas critical to national security.

In secure communications, priority is given to protecting sensitive information and critical communications against current and future threats, such as quantum computing, through post-quantum cryptography (PQC) and quantum cryptography. This includes Quantum Key Distribution (QKD), which ensures physical security, and Quantum Random Number Generators (QRNGs), which provide high-quality, verifiable physical randomness for secure key generation. These solutions enable hybrid quantum-safe architectures combining classical, post-quantum and QKD approaches, reinforcing cybersecurity. Efforts will focus on deploying hybrid networks for secure key distribution and renewal over fibre, RF or satellite links, together with progress in standardisation, certification and interoperability to support integration into C4ISR architectures and multinational environments.

With regard to quantum sensing, efforts will address the development of ultra-high-sensitivity devices to detect magnetic, gravitational, electric, thermal or CBRN-related signals, with applications including surveillance, localisation and underwater detection. Key examples include NV-diamond magnetometers operating at room temperature; quantum accelerometers and gyroscopes enabling GNSS-denied navigation; and portable atomic and optical clocks for synchronisation and positioning of critical platforms. Their maturation will require enabling technologies such as real-time electronics and control, miniaturisation, robust packaging, mechanical stabilisation, vibration isolation, secure synchronisation and communications, and advanced signal processing. At lower TRLs, exploratory work will address quantum optical sensors for surveillance and navigation, as well as quantum RF sensors, including quantum radars, for detection of low-observability signals and targets.

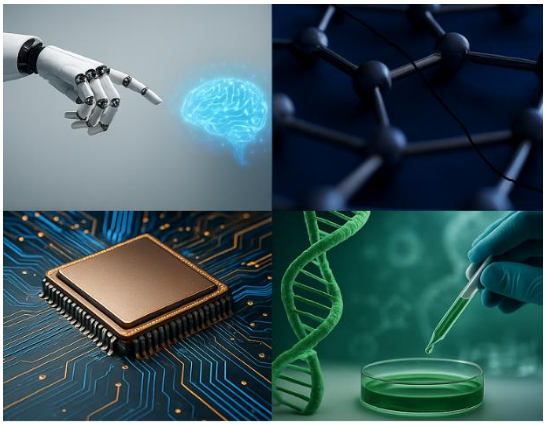
Other areas with high potential include quantum computing and quantum simulation, which can address complex problems such as materials modelling, tactical optimisation or cryptanalysis. Integration with artificial intelligence and high-performance computing will further support the design and validation of hybrid architectures, accelerating the maturation of defence capabilities.

Actions under this objective will focus on technological demonstrators, experimentation in simulated operational environments and the maturation of key capabilities, in collaboration with the national scientific, technological and industrial base. These efforts will be aligned with Spain's Quantum Technologies Strategy and coordinated with European and NATO initiatives to maximise synergies and access to shared validation and testing infrastructures.

MONITORING OF EMERGING TECHNOLOGIES

Emerging technologies with potential future defence applications

Technology watch activities focusing on developments in emerging or low readiness level technologies, the future development of which could open up new possibilities for defence R&D&I or have significant implications, including disruptive effects, in the context of security and defence.



There is a broad range of technologies that are currently at an emerging stage, yet show high potential to drive significant changes in the defence sector. These technologies are primarily being developed within the academic and research communities.

Given their low or very low level of technological maturity, they exhibit a clear dual-use character. As a general principle, the Ministry of Defence does not envisage making specific investments for their development, except in selected cases, as appropriate instruments already exist within the National R&D&I Plan to support such activities. The objective is to maintain active technology monitoring of developments within the national research ecosystem, while acting as a link to any opportunities that may arise within international R&D&I organisations in which Spain participates.

In parallel, the Ministry aims to provide support and guidance to these entities regarding the potential defence applications of their developments. Below is a non-exhaustive list of technologies that will be subject to monitoring, which is expected to be expanded over the lifetime of the Strategy:

- **Emerging Quantum Technologies.** Quantum technologies represent a domain with high disruptive potential for the defence sector, although many of their capabilities remain at an early stage of development. In the field of quantum communications, the development of quantum repeaters is key to extending QKD networks across distributed environments such as C4ISR systems or space platforms, together with quantum memories, high-dimensional QKD (HD-QKD), integrated photonics, and advanced entanglement and synchronisation protocols. These elements are essential to ensure the synchronisation, scalability, security and operational viability of future distributed quantum networks. In sensing applications, advanced quantum optical sensors offer capabilities relevant to surveillance and precision navigation; quantum radio-frequency sensors, including quantum radar, enable the detection and localisation of low-observable signals and targets; cold-atom gradiometry and interferometry support precise geolocation and the detection of gravitational anomalies; and emerging hybrid quantum sensors combining cold atoms and quantum optics allow the measurement of weak fields and low-power RF or THz signals. In computing, progress in NISQ architectures and fault-tolerant technologies, together with the use of quantum simulators, may enable the design of advanced military materials and the optimisation of complex electronic systems. In cryptography, the development of quantum-safe infrastructures, combining post-quantum algorithms, QKD and QRNG, is essential to ensure secure military communications and operations against future threats. Their deployment will require specialised high-performance hardware capable of executing complex cryptographic operations efficiently and securely, with response times compatible with real-time sensitive IP traffic.

- **Bio-inspired and Soft Robotics.** Research into new robotic concepts inspired by living organisms, based on soft, flexible and adaptive materials, aims to enable mobility, manipulation and operation in complex, confined or extreme environments where conventional rigid robots are ineffective. These emerging technologies explore biomechanical and neuromuscular principles observed in animals such as octopuses, insects or snakes, applied to robotic systems with high versatility and the ability to interact safely with humans and their surroundings. Potential defence applications include exploration of subterranean or collapsed infrastructures, discreet infiltration, explosive ordnance disposal, covert surveillance and intervention in contaminated environments, all with minimal acoustic and electromagnetic signatures. Although still at an incipient stage of development, these solutions promise to extend operational capabilities beyond the limits of conventional rigid platforms.

- **Advanced and Ultra-Low-Power Computing.** Research into emerging computing technologies with disruptive potential for military applications, aimed at drastically reducing energy consumption, increasing efficiency and enabling new capabilities in demanding operational environments. This line of work encompasses the exploration of reversible, neuromorphic, probabilistic, optical and molecular computing architectures, as well as ultra-efficient and persistent edge computing techniques, all currently at very early stages of development. In the long term, these solutions could support the deployment of autonomous systems, distributed sensors, energy-sustainable processing platforms and mission-critical devices with minimal signatures, enabling new operational concepts and helping to maintain technological superiority in complex scenarios.

- **Cognitive Radar.** Development of technologies for cognitive radar architectures capable of perceiving, learning from and adapting to the electromagnetic environment in real time. This includes adaptive waveform design, dynamic resource management and cognitive analysis of the environment to optimise system performance. Artificial intelligence and self-learning techniques are key enablers, both in signal processing and in decision-making for the selection of optimal operating parameters in each scenario. These sensors will be able to operate with greater autonomy, enhancing their ability to detect, track and locate threats, while improving robustness against electronic countermeasures and interference or spectrum congestion scenarios. They will also enable more efficient spectrum use and cooperation with other sensors and platforms to deliver more accurate and resilient situational awareness.

- **Nanophotonics**. Manipulation and control of light at the nanometric scale, where the optical properties of materials and structures differ significantly from those observed at conventional scales. This field is of particular interest due to the unique performance of components manufactured at this scale, such as QWIP (Quantum Well Infrared Photodetectors), which offer very short response times and enable the development of high-speed infrared cameras. Beyond EO/IR detection, nanophotonics supports the development of new types of flat optics, coatings with tailored properties, mirrors with selective behaviour and materials with controllable refractive indices, paving the way for more compact, efficient and specialised sensors. At national level, there is significant R&D&I capability in several of these areas, particularly in design and characterisation, although industrial-scale manufacturing of detectors and other devices is not yet consolidated, representing a strategic opportunity for future development.

- **Emerging Space Technologies.** Research into a set of technologies with high potential to transform military capabilities in the space domain. Key areas include in-orbit manufacturing and assembly of large structures (such as antennas and modular platforms), and the use of smart and adaptive materials, which would enable more flexible and capable systems. In parallel, new propulsion concepts, advanced fuels and high-efficiency energy systems are being explored to support longer-duration and extended-range missions. These lines of development are essential to ensure the resilience and superiority of future satellite architectures.

- **Biotechnology.** The exploitation of biological systems for the development of products and processes, through techniques such as genetic engineering and molecular biology, is of high relevance to defence in areas including biosecurity, CBRN detection and identification, CBRN medical countermeasures, personalised medicine, regenerative treatments and early diagnostics. Some of the technologies involved already have a long track record and a medium-to-high level of maturity, but there remains substantial scope for further technological development to enhance CBRN defence capabilities and medical support. In addition, there is more nascent potential in areas such as decentralised biomanufacturing of materials (medical supplies, food products, biofuels, etc.) using bioreactors deployed in operational theatres to reduce logistical dependency; synthetic biology, enabling the design of biological systems for purposes such as advanced materials production (high-strength, self-healing), sensing and biodegradation of explosives and CBRN agents, or small-scale energy generation in remote locations (bioelectrogenesis); bio-computing, based on the use of DNA molecules for high-performance data storage and processing; bio-hybrid systems combining biological components with electronic systems to create advanced sensors and actuators; and applications aimed at enhancing human performance, both physical and cognitive. While the latter area raises clear ethical dilemmas, it is essential to gain a thorough understanding of the technologies involved and of developments pursued by other countries, in order to be able to counteract their effects if required. At national level, there is R&D&I capability in medical and biosecurity fields, while capacity in the remaining areas is more limited.

- **Non-Invasive Brain–Computer Interfaces (BCI):** Next-generation non-invasive Brain–Computer Interfaces (TRL 2–3) seek to directly connect the operator's cognitive processes with drones or other systems, enabling the control of multiple assets at "the speed of thought". This would significantly reduce latency and enhance the soldier's cognitive capacity to manage information-saturated scenarios. The use of these interfaces requires high bandwidth and intensive user training. The primary focus lies in the development of high-resolution non-invasive neural sensors (helmets, patches) capable of accurately decoding neural signals under physiological stress and movement, while avoiding surgical risks and addressing ethical challenges related to neural data privacy and decision-making responsibility.

- **Compact Nuclear Fusion Technologies.** Although still at early TRL levels, this dual-use technological domain focuses on high power-density systems with the potential to transform strategic autonomy and power projection. Priority is given to monitoring small-scale reactors for the deployment of resilient micro-grids and "energy islands" at expeditionary bases, eliminating the logistical vulnerability associated with fossil fuels and enhancing the protection of critical infrastructure. In the space domain, compact fusion represents a disruptive enabler for direct-fusion propulsion systems, allowing persistent manoeuvrability and the defence of assets against ASAT threats. Its maturation will be key to meeting peak power demands for directed-energy weapons and large-scale edge AI processing in isolated theatres of operations. This area also encompasses superconductors and materials resistant to extreme neutron fluxes, with particular interest in advances stemming from projects such as IFMIF-DONES.

Annex C. Technology Readiness Levels (TRLs)

The term TRL (Technology Readiness Levels), or technological maturity level, refers to a metric used to provide an approximate quantification of the maturity of a given technology (materials, components, devices, systems, etc.), with the aim of assessing its potential integration into a complex system. The use of this metric supports decision-making regarding the adoption of new technologies or systems, by determining whether they are at an appropriate stage of research, experimentation and development for the overall project or mission.

Although different definitions have been developed by various agencies, most of them are broadly consistent. The most widely recognised frameworks are those defined by the United States Department of Defense (DoD) and by the National Aeronautics and Space Administration (NASA). The TRL levels defined by NASA are those illustrated in the figure below and described in the table on the following page.

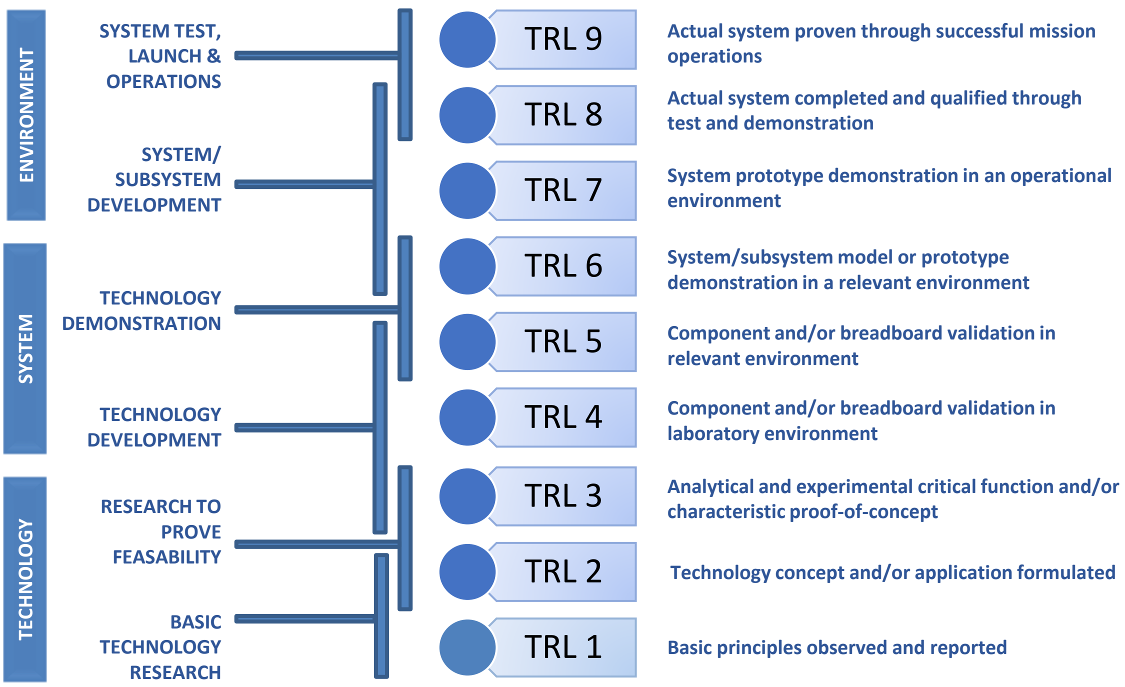


Figure 23. Technology Readiness Levels (TRLs)

Technology Readiness Level (TRL)	Description
TRL 1. Basic principles of the technology are identified and observed.	Basic principles of the technology are observed and reported, and initial potential applications in R&D are identified.
TRL 2. Technology concept or application is formulated.	Once the basic principles have been identified, potential practical applications can be defined. The application of the technology remains theoretical and lacks experimental or detailed analytical validation.
TRL 3. Analytical and experimental proof of critical functions and/or characteristics (proof of concept).	This level includes analytical studies and laboratory experiments to validate, through proof-of-concept, that analytical predictions are correct. These studies and experiments support the validation of the applications or concepts formulated at TRL 2.
TRL 4. Technology components are validated in a laboratory environment.	Following successful proof-of-concept activities, basic technological elements are integrated to verify that they operate correctly together and achieve the performance levels defined for a given component. This validation is designed to support the previously formulated concept and to be consistent with the application requirements of a potential system using the technology.
TRL 5. Technology components are validated in a relevant environment.	At this level, the fidelity of the component under test increases significantly. Basic technological elements are integrated in a reasonably realistic manner with supporting elements, allowing the technology to be tested in a simulated or relevant operational environment.
TRL 6. System or subsystem model or prototype is demonstrated in a relevant environment.	A representative system or subsystem model or prototype, significantly more advanced than that tested at TRL 5, is demonstrated in a more realistic environment. To achieve TRL 6, the demonstration must be fully successful.
TRL 7. System prototype is demonstrated in an operational environment.	This represents a significant step beyond TRL 6 and requires the demonstration of a prototype of the actual system in an operational environment, such as on a platform or as an integral part of a complex system.
TRL 8. Actual system is completed and qualified through testing and demonstration.	The technology has been tested in its final form under controlled conditions. In most cases, this level represents the completion of actual system development for the majority of technological elements. At this stage, integration of the new technology into existing systems may take place.
TRL 9. Actual system is proven through successful mission operations.	The technology has been tested in its final form during real mission operations. In most cases, this level reflects the final refinement phase of the actual system development. At this stage, the technology is fully integrated into operational systems.

Table 10. Description of TRL Levels

Annex D. Glossary of Terms

Term	Description
A2 / AD	Anti-Access / Area Denial
AEE	Spanish Space Agency
AEI	State Research Agency
AESA	Active Electronically Scanned Array
AI	Artificial Intelligence
AIP	Air Independent Propulsion
ASAT	Anti-Satellite Activities
ATR	Autonomous Target Recognition
AUV	Autonomous Underwater Vehicle
C4I / C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CapTechs	Capability Technology Groups (EDA)
CARD	Coordinated Annual Review on Defence
CBRN / CBRNe	Chemical, Biological, Radiological and Nuclear (and explosives)
CDTI	Centre for the Development of Technology and Innovation
CETEDEX	Technology Centre for Development and Experimentation
CFD	Computational Fluid Dynamics
CIED	Strategic Defence Industrial Capability
COINCIDENTE	Scientific Research and Development Cooperation in Strategic Technologies
CNA	Computer Network Attack
C-RAM	Counter-Rocket, Artillery and Mortar
C-UAS	Counter-Unmanned Aerial System
CUD	University Centre for Defence
DDN	National Defence Directive
DEW-RF	Directed Energy Weapon - Radio Frequency
DHW	Domestic Hot Water
DIANA	Defence Innovation Accelerator for the North Atlantic (NATO)
DIRCM	Directed Infrared Countermeasures
DPD	Defence Policy Directive
DTIB	Defence Technological and Industrial Base
ECF	European Competitiveness Fund
ECM	Electronic Countermeasures
EDA	European Defence Agency
EDF	European Defence Fund
EDIP	European Defence Industry Programme
EDT	Emerging Disruptive Technologies
EECTI	Spanish Strategy for Science, Technology and Innovation
EID	Defence Industrial Strategy
ELINT	Electronic Intelligence

Term	Description
EMAD	Defence Staff
ESM	Electronic Support Measures
ETID	Defence Technology and Innovation Strategy
EUDIS	European Defence Innovation Scheme
FOB	Forward Operating Base
GNSS	Global Navigation Satellite System
HAPS	High-Altitude Pseudo-Satellites
HEDI	Hub for EU Defence Innovation
HPC	High-Performance Computing
ICT	Information and Communications Technologies
IED	Improvised Explosive Device
INTA	National Institute for Aerospace Technology
ISR/ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
LEO/MEO/GEO/VLEO	Low / Medium / Geostationary / Very Low Earth Orbit
LDEW	Laser Directed Energy Weapon
LIDAR	Light Detection and Ranging
MEDEVAC	Medical Evacuation
METOC	Meteorology and Oceanography
MLRS	Multiple Launch Rocket System
NIF	NATO Innovation Fund
OCM	Military Capability Objective
OFLP	Long-Term Force Objective
OPEX	Operational Experimentation
OPI	Public Research Organisation
PEM	Special Modernisation Programme
PEICTI	State Plan for Scientific and Technical Research and Innovation
PESCO	Permanent Structured Cooperation
PNT	Positioning, Navigation and Timing
PPI	Public Procurement of Innovative Solutions
PQC	Post-Quantum Cryptography
PRS	Public Regulated Service (Galileo)
QKD	Quantum Key Distribution
QRNG	Quantum Random Number Generator
RAM	Rocket, Artillery and Mortar
R&D&I	Research, Development and Innovation
RF	Radio Frequency
S3	Smart Specialisation Strategies
SAR/MTI	Synthetic Aperture Radar / Moving Target Indicator
SEOT	Spanish Earth Observation System
SIGINT	Signals Intelligence
SMRF	Scalable Multifunction RF Systems
STO	Science and Technology Organization (NATO)

Term	Description
SWaP	Size, Weight and Power
TCCC	Tactical Combat Casualty Care
TRL	Technology Readiness Level
TQC	Transatlantic Quantum Community
UAS	Unmanned Aerial System
UGV	Unmanned Ground Vehicle
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle

GOBIERNO DE ESPAÑA

MINISTERIO DE DEFENSA

DIRECTORATE-GENERAL FOR STRATEGY AND INNOVATION OF THE DEFENCE INDUSTRY

DEPUTY DIRECTORATE-GENERAL FOR PLANNING, TECHNOLOGY AND INNOVATION