DAIO Defense AI Observatory

Turning Experimentation Into Military Advantage

Defense AI in Portugal

João Vicente

DAIO Study 26|36

Ein Projekt im Rahmen von

dtec.bw
Zentrum für Digitalisierungs- und Technologieforschung der Bundeswehr

Finanziert von der Europäischen Union
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About the Defense AI Observatory

The Defense AI Observatory (DAIO) at the Helmut Schmidt University in Hamburg monitors and analyzes the use of artificial intelligence by armed forces. DAIO comprises three interrelated work streams:

- Culture, concept development, and organizational transformation in the context of military innovation
- Current and future conflict pictures, conflict dynamics, and operational experience, especially related to the use of emerging technologies
- Defense industrial dynamics with a particular focus on the impact of emerging technologies on the nature and character of techno-industrial ecosystems

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1 Summary

Artificial Intelligence (AI) is rapidly emerging as a transformative technology with profound implications for military power, operational effectiveness, and national security. This study examines the current state of defense AI in Portugal, assessing how national policies, military institutions, industry, academia, and international partnerships are shaping the country's trajectory toward AI-enabled defense capabilities.

While Portugal does not yet possess a dedicated defense AI strategy, the analysis demonstrates that significant progress is already occurring through a combination of digital transformation initiatives, the North Atlantic Treaty Organization (NATO) and European Union (EU) frameworks, experimentation programs, service-level strategies, and dual-use innovation ecosystems.

At the national level, Portugal's AI policy has evolved from the strategic vision to the more implementation-oriented agendas. Although these initiatives are not defense-specific, they provide the essential foundations upon which future military AI capabilities can be built. Consequently, Portuguese defense thinking views AI primarily as an enabling technology that supports decision superiority, operational effectiveness, resilience, and technological sovereignty rather than as a standalone military capability.

Portugal's conceptualization of defense AI is strongly influenced by NATO and EU approaches to trustworthy and responsible AI. The study finds broad convergence around principles such as meaningful human control, accountability, transparency, interoperability, robustness, and legal compliance. These principles increasingly serve as implicit constraints governing military AI adoption, particularly as Portugal participates in international initiatives such as the definition of NATO's AI strategy and the Responsible AI in the Military Domain process.

A defining characteristic of the Portuguese approach is the leading role of experimentation. Through several defense flagship initiatives Portugal has positioned itself as an important operational laboratory for testing autonomous systems, AI-enabled decision-support tools, cyber capabilities, and multi-domain operational concepts. As a result, Portugal is increasingly recognized as an experimentation and integration hub within NATO and the European defense innovation ecosystem.

The study also highlights the growing maturity of Portugal's defense innovation ecosystem. AI-related development is occurring through a combination of Euro-

pean Defense Fund projects, NATO innovation frameworks, national recovery and resilience investments, and partnerships involving industry, academia, and government institutions.

Within the Armed Forces, AI adoption is progressing through a distributed and federated model. The Ministry of National Defense (MND) is establishing common digital foundations centered on secure infrastructure, data governance, interoperability, and computational resources, while the Joint Staff and the Services pursue operationally focused AI initiatives. The Army and Air Force have already published dedicated AI strategies, while the Navy has embedded AI within broader technological transformation initiatives. Across all Services, common themes include phased implementation, mission-oriented adoption, strong governance requirements, data-centric approaches, and the preservation of effective human oversight.

Operationally, AI adoption remains at an early but promising stage. Particularly noteworthy is the Air Force's rapid development of sovereign space capabilities, including satellite constellations, AI-enabled space surveillance, and automated intelligence exploitation. Similarly, the Navy's "Silicon Sailor" initiative and the Army's experimentation activities illustrate how AI is already generating practical operational value in support of decision-making and data analytics while remaining under human supervision. These areas of application also constitute the core of Portugal's current defense AI development activities that also include the use of AI to advance intelligence, surveillance, and reconnaissance, situational awareness, and the use of unmanned systems. In parallel, Portugal is expanding the digital and data infrastructure, for which the MND can also tap into funds made available by the government to advance public sector digitalization.

The study finds that Portugal's defense AI maturity gradually moves from initial ideas into more formal commitments. Although significant pilot projects and niche operational capabilities exist, large-scale institutional integration has not yet been achieved. The principal challenges are therefore not technological alone. Recruitment and retention of highly qualified personnel, the transformation of financial investments into operational capabilities, the avoidance of technological fragmentation across Services, and the establishment of coherent governance mechanisms emerge as critical determinants of future success.

Looking toward 2030, several trends are likely to shape Portugal's defense AI trajectory. These include the potential development of a dedicated defense AI strategy, the creation of Defense-wide AI governance structures, expansion of sovereign computing and data infrastructures, growth of space-based intelligence capabilities, wider adoption of autonomous systems, and deeper integration of AI into multi-domain operations. Given Portugal's resource constraints, future success

will likely depend on focusing on niche areas of comparative advantage while leveraging NATO, EU, and industry partnerships to access broader technological ecosystems.

The central conclusion of this study is that Portugal's greatest strength in Defense AI does not currently reside in large-scale operational deployment, but rather in its ability to serve as a trusted experimentation, innovation, and integration hub within allied frameworks. The decisive challenge for the coming decade will be transforming numerous promising initiatives into a coherent defense AI ecosystem. If successfully achieved, this evolution has the potential to generate sustainable military advantage, strengthen national resilience, and enhance Portugal's contribution to NATO and European security in an increasingly AI-enabled strategic environment.

2 Thinking About Defense AI

2.1 National AI Strategy and Public-Sector Framing

The evolution of AI policy in Portugal reveals a trajectory of increasing strategic maturity, marked by the transition from a guiding vision to a national execution agenda.

This path began with the National AI Strategy, AI Portugal 2030,[1] published in 2019, which set the ambition of positioning Portugal as a knowledge-intensive economy, supported by strong scientific capacity, an innovative industry, and a more efficient public administration using AI.

From 2024 onwards, with the approval of the National Digital Strategy,[2] AI came to be considered a cross-cutting technology for the country's digital transformation, assuming a central role in economic, social, and administrative modernization. This integration was consolidated in 2026 with the approval of the National AI Agenda[3] (NAIA), which transformed the strategic principles defined in 2019 into a structured action plan, with objectives, governance mechanisms, and concrete initiatives for the period up to 2030, with the explicit ambition of making Portugal a responsible AI innovation hub.

The NAIA is based on four fundamental pillars: Infrastructure and Data; Innovation and Adoption; Talent and Skills; and Responsibility and Ethics. This structure seeks to simultaneously address the need to strengthen national computing capacity, accelerate AI adoption by companies and the public sector, develop specialized skills, and ensure safe, transparent use aligned with European values.

One of the most relevant aspects of Portugal's strategic evolution is the growing attention given to AI governance. While the 2019 strategy addressed ethics and safety mainly from a guiding perspective, the NAIA and the Responsible AI Guide for Public Administration[4] introduce concrete mechanisms for oversight, algorithmic transparency, risk assessment, and the protection of fundamental rights, aligned with the emerging European regulatory framework.

In the economic domain, national policy simultaneously seeks to stimulate scientific research, promote the development of national technologies, and increase AI adoption by companies, particularly small and medium-sized enterprises.

1 AI Portugal 2030.
2 Portugal Digital Strategy.
3 National Artificial Intelligence Agenda.
4 Guia para a Inteligência Artificial.

Despite the consistency of the national strategic vision and the strengthening of governance instruments, the various documents converge on identifying the main challenge for the coming decade: execution. The availability of specialized talent, the ability to translate funding into concrete projects, the effective adoption of AI by the business sector and public administration, and the creation of robust monitoring mechanisms are decisive factors for the success of the national strategy.

In summary, Portugal currently has a coherent AI policy, aligned with European priorities and supported by a long-term vision that has remained consistent since 2019. The strategic challenge is no longer to define the direction, but to ensure that the planned initiatives deliver concrete results in terms of productivity, competitiveness, innovation, and technological sovereignty by 2030.

2.2 Conceptualization of Defense AI

Portugal does not yet have a stand-alone defense AI Strategy. In Portugal, reflection on AI in defense is based on two layers: a national and cross-sector layer, centered on the National Digital Strategy, AI Portugal 2030, and the NAIA, and a defense-specific layer, which is still under development.

Portugal's National AI Strategy defines AI as a general-purpose technology intended to transform the economy, strengthen scientific research, and modernize public services. The strategy focuses on data-driven innovation, trustworthy AI, and human-centric development but stops short of defining a specific "defense AI" concept separate from broader AI policy. While focused primarily on economic competitiveness and public sector transformation, it situates defense AI within a wider digital sovereignty narrative, where AI is expected to increase efficiency, support better decisions and contribute to national and European resilience.

Nonetheless, the AI strategy is relevant for defense, primarily as an enabling framework. It promotes skills, data, digital infrastructure, innovation, and trust in AI use, all essential elements for adoption in the defense sector. Therefore, the national AI strategy is useful for defense when it is turned into four lines of action: reliable data, secure infrastructure, specialized talent, and robust governance.

On the academic front, NATO's documents on AI and emerging and disruptive technologies, which are extensively discussed at the Military University Institute seminars and studies, shape Portuguese defense thinking by framing AI as both a transformative enabler and a source of strategic vulnerability when used by

adversaries.[5] These documents also influence how Portuguese armed forces think about the likely impact of AI on warfare in view of the digital transformation of the military function of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and support for decision-making; the expanded use of autonomous and semi-autonomous systems; growing complexity and speed of cyber operations; the need for space domain awareness; as well as increasing reliance on simulation and virtual environments for training and planning, including metaverse-like "live-virtual-constructive" (LVC) concepts, and requirements to support the development of new, experimentation-heavy concepts that are at the core to future Multi-Domain Operations (MDO).

In summary, Portugal's approach to defense AI is indirectly strategic. Defense AI adoption relies strongly on NATO/EU frameworks, but there is still no single all-encompassing Defense-level document which defines specific AI priorities, ethical red lines and capability targets. Nonetheless, as this study will show, at the Joint and Service-level there are already some relevant AI-related initiatives aiming to govern, develop, experiment, regulate and employ AI-enabled capabilities.

2.3 Principles and Concerns

The combination of AI Portugal 2030, the NAIA and public-sector AI guidance yields a set of implicit principles for defense AI, advising for an ethical, transparent, and responsible governance of AI, placing the technology at the center of public value creation, and identifying principles of accountability, explainability, fairness, and human rights which, although not exclusive to the defense sector, are applicable to military AI systems operated by public entities.

While there is no explicit Portuguese "principles of war for AI" document, adherence to NATO doctrine and the EU's emphasis on human-centric, trustworthy AI implies de facto principles such as maintaining meaningful human control over weapons, ensuring reliability and robustness, and preserving alliance interoperability as key constraints on defense AI use.

Portugal is also bound by the EU's trustworthy AI principles[6] and the AI Act,[7] both of which stress human agency and oversight, technical robustness and safety, privacy and data governance, transparency, non-discrimination and accountability. Although the AI Act formally excludes military applications, Portuguese policy

5 Esteves, (Coord.), Inteligência Artificial: Estudos Pioneiros em Contexto Militar; Monteiro, (Coord.), As áreas funcionais do Exército 2025: desafios do novo ambiente operacional – Impacto da Inteligência Artificial.
6 European Commission, "Ethics guidelines for trustworthy AI."
7 European Union, "The AI Act Explorer."

documents make clear that the same ethical and legal concerns, such as opacity, bias or loss of control, are relevant AI risks in defense settings, adapted through operational supervision, auditability, and command responsibility. This implies that any defense AI applications must respect requirements on transparency, robustness, oversight and accountability, mirroring broader European concerns about algorithmic opacity and bias. This, combined with NATO work on responsible use of AI,[8] suggests that meaningful human control, alliance interoperability and legal compliance act as implicit "principles of war" for defense AI in the Portuguese context.

Hence, with defense excluded from the EU AI Act, Portugal should turn NATO's AI principles into binding defense practice through national doctrine, legal review procedures for AI-enabled weapons, standard procurement clauses, targeted training for military personnel, and participate actively in NATO's AI governance and testing mechanisms, because the technical standards developed there will shape real access to allied defense value chains.[9]

Moreover, the Responsible AI in the Military domain (REAIM) summit "Pathways to Action,"[10] held in February 2026, reinforces that military AI must be governed through strong emphasis on international law, responsible design, human oversight, legal compliance, and robust testing, which is directly relevant to Portugal's defense modernization agenda. Portugal, along with 44 other nations, endorsed a roadmap which turns prior REAIM principles into concrete steps for responsible military AI governance. It acknowledges that military AI can improve protection, decision-making, and compliance with international law, but it also brings risks such as miscalculation, bias, loss of control, escalation, cyber threats, and manipulation. At the national level, it recommends involving operators early, training personnel, and conducting recurring risk assessments as systems and threats evolve. It also encourages clear chains of command, doctrine and procedures for AI-enabled operations, and even a national focal point such as Chief Responsible AI Officer. Internationally, it supports confidence-building measures, shared understandings of AI capabilities, regional workshops and exercises, crisis-communication arrangements, and capacity-building for developing countries. It also invites stronger engagement with industry, academia, and civil society to address security, reliability, and human-machine interface challenges.

Current defense AI concerns are framed by the sovereignty issue, and include dependence on third-country technologies, vulnerabilities of critical infrastructure, risks of loss of meaningful human control, and the possibility of new forms

8 NATO, "Summary of NATO's revised Artificial Intelligence (AI) strategy."
9 Soares, "Os princípios da NATO para uma inteligência artificial responsável - e o que exigem de Portugal."
10 "Pathways to Action."

of escalation or miscalculation in conflicts where AI-enabled decision-making is widespread. There is also a strategic recognition that over-reliance on opaque AI systems, especially in lethal or strategic contexts, could undermine political accountability and public trust, even if these concerns are framed more generally under "responsible use of technology" than under a narrow "defense AI" heading.

Considering the principles and concerns for military AI, the main impact for Portugal Defense is practical: stronger needs for AI governance, the requirement for test, evaluation, verification, and validation of AI systems, cyber resilience, data protection, training, and clearer command responsibility as AI-enabled systems enter operations and procurement. It also creates an opportunity for Portugal to align its defense investment, NATO interoperability, and industrial development with international standards on responsible military AI, while helping shape regional cooperation and capacity-building.

2.4 Relation to Multi-Domain Operations and Future War

In Portuguese defense policy, AI appears mainly in the context of cyber defense, digital transformation and support to Command-and-Control (C2) and decision-making, which are consistent with NATO concepts of MDO and data-centric warfare. Such MDO-concept alignment is reflected by its hosting of multiple NATO structures such as the Naval Striking and Support Forces (STRIKFORNATO), the NATO Communications and Information Academy, the Joint Analysis and Lessons Learned Centre, two Defense Innovation Accelerator for the North Atlantic (DIANA) centers, and the organization of flagship experimentation exercises, as well as, participation in several NATO-wide exercises.

At allied level, Portugal is one of the host nations of NATO's DIANA,[11] hosting both an accelerator site and a test center. These centers, operational since 2023, are core instruments of the Alliance's agenda for emerging and disruptive dual-use technologies, including AI, and in practice function as an important part of Portugal's defense AI posture even though they sit in a multinational framework. Additionally, they connect Portuguese companies and research institutions to a transatlantic network of dual-use innovators in AI, autonomy and advanced analytics.

11 Diplomatic Portal, "Portugal hosts two NATO innovation centres."

The Navy Robotic Experimentation and Prototyping using Maritime Uncrewed Systems (REPMUS) exercise, conducted annually off the Portuguese coast, is widely recognized as one of NATO's largest experimentation campaigns for unmanned maritime systems and MDO-relevant technologies, and is explicitly used to explore how autonomy, robotics and AI can enhance coalition operations across surface, subsurface, air and cyber domains.[12] It illustrates Portugal's role in fielding and operating AI-enabled unmanned maritime systems in coalition settings, including navigation, sensor fusion and autonomous behaviors tested in real-world conditions. Portugal and its allies are learning about the interoperability challenges of networking AI-enabled unmanned systems from multiple nations, including data standards, C2 integration and rules of engagement for autonomous behaviors, although detailed lessons remain in restricted NATO channels.

The Army Technological Experimentation Exercise (ARTEX)[13] is another flagship instrument that contributes to AI-adoption. The 2026 edition includes a European dimension through the integration of the European Defense Agency's (EDA) HEDI-OPEX26 campaign. Conducted in operational conditions, the exercise will test emerging technologies such as AI, autonomous systems and robotics, smart sensors, electronic warfare, resilient communications, and human-machine teaming. This initiative is particularly significant for AI development in defense because it provides operational validation of AI systems in realistic military environments, moving beyond laboratory demonstrations to assess their effectiveness in supporting decision-making, situational awareness, logistics and autonomous operations. It also enhances a collaborative innovation framework that connects defense stakeholders with academia and industry, accelerating the development, testing and maturation of AI-enabled capabilities. Furthermore, it lowers the acquisition model risk, allowing new AI solutions to be evaluated before major investment decisions are made. Finally, it promotes European and NATO interoperability, ensuring that AI-enabled capabilities are developed and tested within multinational frameworks and according to common operational standards.

These experimentation examples turn Portugal into an operational laboratory for coalition testing of autonomous surface, subsurface, and aerial systems, as well as C2 and sensor-fusion solutions, with lessons that extend directly to future MDO. ARTEX and REPMUS are more than technology experimentation exercises. They are defense innovation accelerators that enable the operational testing, validation and maturation of AI and emerging technologies, positioning Portugal as a European hub for defense experimentation and helping transform AI from a promising concept into a trusted military capability.

12 Luxton, William, "REPMUS25 NATO exercise – Portugal."
13 Lopes, "Portugal acolhe pela primeira vez campanha europeia de experimentação militar."

Additionally, the Portuguese Armed Forces participate in NATO exercises such as the Coalition Warrior Interoperability eXercise (CWIX),[14] the premier digital interoperability event and the Alliance's largest venue for testing, validating and improving C2 capabilities and information technology services. Another example is NATO's Locked Shields,[15] the world's largest and most complex international live-fire cyber defense exercise, which tests digital interoperability, C4ISR systems and cyber defense tools, many of which rely on AI or advanced analytics.

Portuguese participation in these innovation and experimentation initiatives exposes personnel to AI-enabled training and operational environments, reflecting a view that autonomy, unmanned systems and AI-enabled decision support will reshape MDO, with Portugal positioning itself as an experimentation hub rather than a first mover in large-scale autonomous weapon systems.

14 "CWIX 26 Strengthens NATO's Digital Interoperability and Operational Readiness."
15 "Locked-Shields."

3 Developing Defense AI

Portugal's defense Research & Development (R&D) priorities are heavily influenced by EU and NATO frameworks. Defense AI development in Portugal is primarily achieved through embedding AI into existing capability programs financed by European Defense Fund (EDF), Security Action for Europe (SAFE) instrument, and national AI/digital-related agendas, rather than via a dedicated defense AI R&D line. Portugal participates in multiple AI-relevant initiatives at NATO and EU level, which, though not always labeled as "defense AI," strongly shape its development trajectory. Within these domains, AI is treated mainly as a cross-cutting enabling layer: a technology for data analytics, autonomy and decision support across those domains, rather than a standalone programmatic pillar labeled "defense AI." Consequently, current defense AI development projects primarily focus supporting situational awareness, data analytics and knowledge management, decision support, Intelligence, Surveillance and Reconnaissance (ISR) in combination with unmanned systems, space-based ISR and specific applications in select areas such as air defense as well as strengthening the foundational data and digital infrastructure.

Portugal has a reasonably dynamic defense and dual-use industrial and scientific ecosystem. Defense AI development is deeply embedded in multilateral ecosystems, which consists of defense primes and small and medium-sized enterprises working on communications, missiles, space and cyber; research technology organizations and universities which have started to integrate AI into concrete projects, via the EDF consortia, the SAFE instrument and other EU programs, and national High Performance Computing (HPC) initiatives; and innovation frameworks that explicitly blend defense and civilian tech communities.

3.1 Development Through EDF and Other European Programs

The EDF is the main external driver of Portuguese defense innovation, including AI-relevant technologies. Under the EDF, 20 Portuguese entities participate in 11 collaborative projects (R&D and capability development). These projects span critical capability areas highlighted by the EDF 2025 Work Program, including air and missile defense, drones and counter-drone, C4ISR, cyber and secure communication, and space capabilities, where AI is an enabling technology for data processing and autonomy rather than a separate capability line.[16]

16 Marcela, "Domestic companies to get 5% of European defence fund spending"; "European Defence Fund: 2025 Work Programme."

One of these projects, in the air and missile defense domain, is the Boosting European Advanced Missile System Technologies (BEAST) that illustrates the interplay between AI, digitalization and advanced analytics. Critical Software[17] is the only Portuguese participant in a 26-entity, 12-country consortium, which aims to embed AI in missile defense systems as a response to advanced threats such as 5th/6th-generation aircraft, unmanned aircraft, electronic warfare and cruise missiles. The company is responsible for developing a machine-learning (ML) operations platform that aims to automate the deployment of AI models into missile system core software, managing data flows, model updates and validation processes within safety-critical weapon systems. This underscores how AI is not only used for target recognition or guidance, but also for the digital backbone of complex systems. This makes also clear that Critical Software's AI/ML operations platform will be embedded into the core software of European missiles, so AI will be operating in live operational systems once the project delivers.[18]

Additionally, the importance of advanced computing and data infrastructure for Portugal's AI ambitions, including defense, must be highlighted. The StartCampus project is a multibillion-euro hyperscale data center infrastructure development in Sines, designed to support AI, cloud computing, and HPC workloads.[19] Portugal also participates in the expansion of MareNostrum 5 supercomputer as a Euro HPC AI Factory, together with Spain and Turkey, in a €129M investment in accelerated capacities for ML, language models and other AI applications. In parallel, the Deucalião supercomputer, also co-funded by Euro HPC, provides national high-performance computing capacity suitable for simulation, optimization and data analysis tasks that underpin AI development, including defense-relevant use cases.[20]

Portugal's active push to attract major digital infrastructure investments for AI, cloud services, and advanced computing and its participation in Euro HPC, while positioning Portugal as a major European technology hub, indicate a high degree of openness to dual-use cooperation and knowledge exchange, with defense exploiting developments in the wider AI ecosystem rather than operating in isolation.

17 For more, see: https://criticalsoftware.com/en (last accessed 14 August 2026).
18 "Portugal: Domestic AI to be used in European missile system."
19 For more, see: https://www.startcampus.pt/, (last accessed 14 August 2026).
20 "Supercomputador europeu otimizado para inteligência artificial com envolvimento português."

3.2 Development Through the National Resilience and Recovery Plan

The Portuguese Resilience and Recovery Plan (RRP) is also funding several major projects that are linked to defense, security and dual-use technologies, directly contributing for the development of defense AI. These initiatives aim to increase industrial autonomy, NATO interoperability, digital resilience, and operational readiness by integrating AI, cybersecurity, robotics, and space capabilities.

On the maritime domain, they include a multifunctional naval platform, an operations center, a naval robotics lab and a new AI assistant for sensitive documentation:

- **Multipurpose Naval Platform**
  The Multipurpose Naval Platform,[21] soon to be operated by the Portuguese Navy, is a dual-use vessel designed for environmental monitoring, maritime surveillance, fisheries inspection, resource protection, hydrographic and scientific research, and emergency transport or evacuation if needed. Additionally, it is intended to test advanced robotic and sensor-based technologies and contribute to national technology development. Moreover, the the platform will be paired with an Operations Center, which adds a digital, data-driven operational layer to improve maritime awareness and decision support.[22]

- **Silicon Sailor**
  "Silicon Sailor"[23] is an AI platform built on the Portuguese first Large Language Model (LLM) Amália[24] and deployed entirely within Navy-controlled infrastructure. The initiative aims to transform large volumes of operational, technical, logistical, and administrative data into actionable knowledge for decision-makers. As an AI use case already implemented, the project is particularly significant because it demonstrates how generative AI can be adopted in a defense environment while preserving digital sovereignty, security, and control of sensitive information. Rather than relying on external cloud-based services, the solution runs locally and enforces existing access controls, ensuring that users can only access information they are already authorized to view. The platform supports capabilities such as semantic search, document summarization, knowledge extraction, information analysis, and decision support, enabling personnel to locate, process, and exploit information more efficiently. From

21 Schepen, "Damen's construction of Portuguese drone carrier progresses."
22 "Navy inaugurates projects within the scope of the Recovery and Resilience Plan."
23 Marcela, "Marinha usa IA Amália e investe cerca de um milhão em Marinheiro de Silício."
24 For more, see: http://ia.gov.pt/amalia (last accessed 14 August 2026).

a strategic perspective, the "Silicon Sailor" initiative represents one of the first examples in Portugal of a sovereign, defense-oriented LLM ecosystem, providing a reference model for other public-sector and defense organizations seeking to leverage AI while maintaining security, resilience, and national technological autonomy.

These projects relate to the introduction of defense AI because they create the operational, digital, and data infrastructure that AI needs to work in real missions. The Maritime Operations Center, the naval robotics lab, and the new AI assistant for sensitive documentation all point to a defense model where AI supports situational awareness, knowledge management, and faster decision-making. In practice, the naval platform and the operations center expand the Navy's ability to collect, fuse, and exploit maritime data, while the robotics lab and "Silicon Sailor" add AI-enabled experimentation, analysis, and secure document processing. Together, these projects show a gradual move from traditional naval modernization to a more AI-enabled defense ecosystem, where autonomy, data governance, and decision support become central to maritime security and operational effectiveness.

In addition to the maritime domain, the RRP funds the Aero.Next and New Space agendas[25] with the objective to strengthen the national aerospace cluster, as well as, to deliver a space capability with dual-use applications.[26]

Within the Aero.Next agenda, Tekever deserves special recognition for its expertise and capabilities in the field of AI, which will be reflected in the ARX unmanned aircraft system[27]. Tekever should be viewed not simply as a drone manufacturer, but as a provider of an AI-enabled ISR and autonomous operations ecosystem that integrates unmanned aerial platforms, advanced sensors, AI, data exploitation and mission-management capabilities into a single operational framework.[28] By combining real-time mission monitoring with AI-driven analytics, solutions such as the Atlas platform enhance situational awareness, accelerate intelligence processing and support faster, better-informed decision-making. Embedded across operational systems already in use by the Armed Forces, such as the AR3 and AR5, and further expanded in the ARX project, these AI capabilities, including automated object detection, target recognition, video analytics, geospatial correlation and pattern analysis, act as force multipliers, increasing operational effectiveness, reducing cognitive workload and strengthening the Armed Forces' ability to conduct persistent surveillance, maritime domain awareness and MDO.

25 "As Agendas Mobilizadoras contratualizadas para o Cluster AED."
26 "Portugal vai conceber e construir o primeiro avião e sete satélites, avança Castro Almeida."
27 For more, see: https://arx.tekever.com (last accessed 14 August 2026).
28 For more, see: https://www.tekever.com/ (last accessed 14 August 2026).

Regarding space initiatives, the Air Force is an active contributor to the New Space Agenda,[29] participating in the Atlantic Constellation working package (WP3)[30] and leading WP10,[31] a space-based ISR program aiming to provide Portugal with a sovereign, all-weather space-based ISR capability built around Synthetic Aperture Radars (SAR) satellites, especially valuable for defense and security operations.

Portugal cannot aspire to full technological autonomy across all advanced defense systems because of critical mass and investment scale, so it should cooperate through the EU and NATO frameworks and focus on niches where Portuguese creativity and industry can compete, such as unmanned aircraft systems, with Tekever as an example of a Portuguese company competing internationally.[32]

In summary, these initiatives all point to a defense model where AI supports situational awareness, knowledge management, and faster decision-making.

29 For more, see: https://www.newspaceportugal.org/en (last accessed 14 August 2026).
30 "WP3 Atlantic Constellation."
31 Batalha, "WP10."
32 Fernandes, "Inteligência artificial redefine indústria de defesa portuguesa."

4 Organizing Defense AI

The integration of defense AI should be understood as a vector of institutional and operational modernization, embedded in a broader digital transformation oriented towards decision superiority. In this context, AI is not treated as an end, but as an enabling capability designed to strengthen decision superiority, interoperability, operational effectiveness, and readiness. The strategic premise is that AI should support the mission while remaining subordinate to human control, institutional legitimacy, and the ethical and legal requirements of military action.

4.1 Ministry of Defense

Portugal's organizational approach to defense AI is mostly distributed and layered rather than centralized. At the Ministry of National Defense (MND) level, a formal Defense AI Strategy and a dedicated AI governance structure are essential to ensure coherent strategy implementation, systematic maturity assessment, and full alignment with NATO and EU; however, such AI-specific strategy and structure have yet to be formally instituted. Moreover, there is still no clearly designated national "defense AI authority" with a holistic mandate to set data requirements, certify AI-enabled systems ethically and technically, and manage the technology lifecycle within the Armed Forces. Such dual structure, strategic and technical nature, although not yet formally established, should constitute a practical blueprint for future Defense-wide AI governance.

Despite the abovementioned shortfalls, the integration of AI in Portuguese defense is taking shape as a multilevel framework, combining a common digital foundation established by the MND, a Joint digital transformation agenda with Service-specific strategies. While the Joint Staff establishes strategic architecture for this evolution, the Services' strategies translate this framework into concrete capabilities, timelines, and use cases.

The MND has adopted a federated model for AI adoption, led by the Secretary-General (SGMND), based on the premise that successful AI deployment requires a combination of trusted data, secure infrastructure, common governance, and organizational coordination. Rather than allowing each military Service to develop isolated AI infrastructures, the SGMND provides a common digital foundation that centralizes data governance, cyber security, computing resources, and interoperability while preserving the autonomy of the Armed Forces and the Joint Staff.

At the core of this approach[33] is the planned AI Infrastructure for Defense Management, a federated, interoperable, and secure environment built upon data available through the Integrated Defense Management System. The infrastructure is designed to share storage, computational, and AI-modelling capabilities across Defense, avoiding duplication of investments and generating economies of scale. At the same time, segregated environments enable the Joint Staff and each Service to develop and operate their own AI applications independently, while remaining connected to a common Defense-wide ecosystem.

The SGMND is responsible for ensuring data sovereignty, security, interoperability, and compliance, while the Armed Forces retain responsibility for developing mission-specific AI applications aligned with their operational requirements. This governance structure enables the development of common services such as LLM, retrieval-augmented generation solutions, and enterprise AI applications, while simultaneously supporting Service-specific capabilities in areas such as logistics, personnel management, decision support, predictive maintenance, and cyber defense.

From a strategic perspective, the SGMND model functions as the enabling backbone for defense AI transformation. By providing trusted data, sovereign and resilient infrastructure, shared computational resources, and common standards, it creates the conditions necessary for scalable AI adoption across the Defense enterprise. As a result, the focus of the Armed Forces can shift from building parallel technology infrastructures towards exploiting AI to enhance operational effectiveness, organizational efficiency, and decision superiority.

At the Joint-level, the Digital Transformation Action Plan 2025-2030[34] establishes the structural conditions for this evolution by prioritizing people, processes, technology, and data, with security, resilience, and interoperability as transversal principles. Within this architecture, AI is positioned as part of a wider digital backbone and as a support mechanism for data-driven decision-making, joint C2, and MDO. This is a significant point: the plan does not present AI as a standalone technological layer, but as a capability that depends on mature governance, reliable data, and organizational adaptability.

33 Francisco, "Inteligência Artificial na Defesa Nacional - Componente Gestão."
34 Plano de Ação para a Transformação Digital no Estado-Maior-General das Forças Armadas 2025-2030.

4.2 Joint Staff and Military Services

Within this context the Joint Staff acts as an enabler for interoperability and MDO. First, it integrates a joint cyber defense operations command, responsible for monitoring networks, detecting incidents and coordinating incident responses in close cooperation with the National Cybersecurity Centre and NATO structures, indicating the use of AI and ML-based cyber defense solutions.[35] This also exposes that rapid technological change, including AI and advanced analytics, is reshaping how Portugal protects military networks and critical infrastructure. Second, integrating joint C2 structures under the Military Operations Joint Command, enabled by common networks and shared situational awareness tools. Third, coordinating joint efforts to enhance operational capabilities and processes through the Joint Staff Innovation and Transformation Directorate.

At the Service-level, both the Army and the Air Force have publicly released their formal AI strategies, while the Navy has yet to publish such a document:

- **Army**
  The Army AI strategy[36] defines AI as a secure, sovereign, and responsible capability integrated into processes, operational employment, and leadership. Its implementation logic is explicitly phased, beginning with low-risk productivity tools, advancing toward an on-premises sovereign platform, and later extending to edge AI for more sensitive and operational contexts. This approach reflects a deliberate effort to balance innovation with control, allowing the force to capture early gains while progressively internalizing technical expertise, data governance, and operational validation. The Army also emphasizes formal governance structures, a technical nucleus for AI, modular training, and a portfolio of prioritized use cases spanning administrative support, logistics, maintenance, personnel management, and decision support.

- **Air Force**
  The Air Force strategy[37] follows the same strategic logic, while placing greater emphasis on mission execution across air, space, and cyber domains. Here, AI is framed as a means of accelerating the decision cycle, improving situational awareness, strengthening ISR exploitation, and supporting logistics, maintenance, and cyber defense. Like the Army, the Air Force adopts formal governance and technical structures, a phased implementation model with clear gates for transition, performance indicators, and institutional maturity criteria.

35 Defesa Nacional, "Enquadramento da Ciberdefesa."
36 Estratégia para a Inteligência Artificial no Exército. Período 2026-2029.
37 "Portuguese AIr Force:" Estratégia para a integração da Inteligência Artificial na Força Aérea Portuguesa 2026-2030.

This reveals a common institutional pattern where experimentation is acceptable, but only if it leads to validated capability and measurable operational value.

- **Navy**
  Although not publicly released as a standalone AI Strategy, the Navy has several strategic orientations that shape AI's adoption.[38] The Navy's main objective is to turn the force into a data-driven, technologically advanced, and operationally distributed organization. AI is alongside Big Data and autonomous systems as one of the Navy's three priority technological pillars, aimed at improving operational superiority, decision support, and MDO. This approach is further detailed by formalizing the Navy's data architecture, with centralized storage, operational analytics, security, and an LLM-based assistant called "Silicon Sailor". The Navy wants AI to support a networked C2 structure in which humans and autonomous systems work together in a secure, interoperable, and resilient way. This includes using AI for pattern recognition, predictive analysis, real-time dashboards, and decision support across operational and support functions. In practical terms, the Navy's AI strategy is not about isolated tools; it is about building an integrated digital ecosystem that improves readiness, speed of decision, and operational effectiveness. The end state is a more autonomous, resilient, and interoperable Navy able to exploit AI without losing human oversight or institutional control.

All three Services make clear that AI must be governed through accountability, explainability, traceability, and strict data protection. In practical terms, the biggest challenge will not be only technological, but organizational: collecting consistent data, ensuring interoperability across functional areas, and building analytical habits among users.

Across the Defense enterprise frameworks, several themes recur with remarkable consistency. First, AI is embedded in a mission-centric logic, where the primary criterion for adoption is operational value rather than technological novelty. Second, governance is treated as a prerequisite, not an afterthought, with emphasis on coordination, accountability, and control. Third, data is recognized as a strategic asset, whose quality, accessibility, and governance determines whether AI can produce reliable results. Fourth, implementation is intentionally phased, reflecting the need to manage risk, build confidence, and ensure that adoption remains aligned with operational realities. Finally, human control remains central, not only as a safeguard, but as a defining condition of legitimacy and effectiveness in military decision-making.

38 Diretiva 07/CEMA/2024, "Tecnologias Emergentes Disruptivas;" Diretiva 16/CEMA/2024, "Diretiva de Dados da Marinha."

Substantively, this strategic architecture suggests that Defense is moving from scattered initiatives toward a disciplined model of AI adoption, anchored in NATO interoperability, effective human control, information security, and the treatment of data as a strategic asset. The significance of this shift lies not merely in the introduction of emerging technologies, but in the ability to integrate them sustainably into command, decision-support, sustainment, and operational employment processes, generating measurable gains in readiness, efficiency, and institutional credibility.

In that sense, AI becomes both a technological enabler and an organizational catalyst, driving changes in governance, doctrine, training, and the distribution of responsibilities across the defense system. The Portuguese case therefore illustrates a broader lesson for military institutions, in which, the value of AI depends less on isolated technical deployments than on the alignment of people, processes, data, and governance around mission outcomes.

5 Funding Defense AI

5.1 National Funding Schemes

Although Portugal does not publish a discrete "defense AI" line in its budget, several funding mechanisms clearly underpin defense AI-relevant activities, revealing that the overall trend is a rising AI-related investment profile.

The NAIA[39] is clear regarding its economic ambition: it estimates that the rapid adoption of AI could add €18-22bn to the Gross Domestic Product (GDP) over the next decade and increase the contribution of productivity to growth by 2.7 percentage points, defining AI as a "historic opportunity" for Portugal. However, the Agenda emphasizes that a significant portion of the financial effort will depend on European funds and private investment. Although it quantifies the potential macroeconomic gains it does not create an earmarked, fenced envelope for defense AI. Rather, it provides enabling national capabilities in four areas: public-sector AI adoption, advanced computing infrastructure, AI talent development, and research and innovation ecosystems. Therefore, defense organizations can leverage these national assets to accelerate military AI adoption, but operational military AI capabilities still require Defense-specific prioritization, governance, security frameworks, and investment.

The NAIA foresees investments above €400M euros between 2026 and 2030, mostly from EU funds, framed as a strategic investment with budgetary discipline and a focus on competitiveness and digital sovereignty.[40] The Agenda is aligned with the forthcoming European AI Factories initiative, in which Portugal participates via the EuroHPC AI Factory around MareNostrum 5.[41] Beyond public funding, national policy to attract hyperscalers and large private AI infrastructure investments, such as Microsoft's announced 10-billion-dollar AI infrastructure investment around the Sines data center, and StartCampus's €8.5bn campus and advanced chip projects, significantly boosts the national AI ecosystem, indirectly creating favorable conditions for dual-use and defense-relevant AI applications.[42]

Additionally, the RRP financing instrument, although focused on the civilian sector, has a dual-use application, in projects such as Aero.Next and New Space, or maritime capabilities and infrastructure. These dual-use enablers, even if not labelled as defense per se, form the financial and technological backbone on which defense AI projects can be built.

39 National Artificial Intelligence Agenda.
40 "Portugal invests €400,000 in AI."
41 "Portugal contributes to €129 million European Union investment in strengthening AI supercomputing with MareNostrum 5."
42 "Portugal participates in one of Europe's first Artificial Intelligence factories"; Carvalho, "Microsoft to invest more than $10 billion in AI infrastructure in Portugal."

5.2 Defense-Specific and External Funding Channels

NATO does not establish a specific R&D expenditure target. However, NATO encourages investment in technological modernization through its equipment-spending objectives, while the EDA recommends that member states collectively allocate 2% of defense expenditure to Defense Research & Technology. While overall defense spending is increasing, available public data suggests that Portugal's R&D investments remain modest when compared with leading European allies and with the EU average level of defense R&D effort.

Portugal is a beneficiary of EU defense-related instruments (such as EDF and SAFE) and participates in NATO-linked innovation frameworks (e.g., DIANA), which provide additional resources and accelerator services for AI-relevant projects even if not labeled as "defense AI" in national documents. These external streams are central to scaling up AI-heavy capabilities in missiles, communications, space, cyber and training.

At the EU level, EDF and SAFE are designed to scale up funding over the coming years for cutting-edge technologies, including AI, with Portugal already well positioned to benefit through its current portfolio. Participation in the EDF continues to provide project-level financing for R&D and capability development in key domains, including technologies for unmanned systems, information systems and advanced sensors, several of them with strong AI components. Portuguese entities have secured €53.4M, across 11 projects, representing 5% of total EDF funds, supporting projects that integrate AI into sensors, C4ISR, missiles and space systems.[43] Despite Portugal's relatively small economic size, this indicates a strong capacity to attract EU defense innovation resources, including for AI-relevant technologies.

In defense-specific terms, Portugal is earmarked to receive about €5.84bn euros in long-term loans under the SAFE instrument, to support military modernization and industrial upgrading, including in areas such as unmanned systems, surveillance, air defense, data fusion, predictive maintenance, or decision support, where AI will appear as a critical enabling technology.[44]

Additionally, Portugal's commitment with the NATO pledge to invest 5% of the GDP in defense expenditure until 2035 will leverage the acquisition of new capabilities, which, by design, have already AI-embedded functionalities, like air defense systems in which AI helps process sensor information and support

43 Marcela, "Domestic companies to get 5% of European defence fund spending."
44 "Defence investment programme will have an autonomous oversight structure."

detection, analysis and response to complex air threats. Such acquisitions will be reflected in the 2027 Military Procurement Law, spanning 12 years' future growing defense investment.

6 Fielding and Operating Defense AI

6.1 General Approaches and Initial Lessons Identified

Portugal's approach is incremental and experimentation-driven. It leverages AI embedded in existing systems via upgrades and software integration, multinational exercises and test ranges to trial AI-enabled unmanned and C2 systems and leverage cyber command structures to operate AI-enhanced defense tools in cyberspace. This approach underscores the value of experimentation environments for de-risking AI deployment, the need for strong cyber and data governance to underpin defense AI, and the importance of leveraging dual-use ecosystems rather than building purely defense-only AI capacity.

Portuguese MND and the Armed Forces are already involved in several AI-related projects across different domains. Examples include decision-support tools, data-analysis systems, situational awareness and (space-based) ISR or training and exploratory applications in C2, logistics, predictive maintenance and intelligence, although many projects are at pilot or early operational stages. Other authors identify multiple operational application areas such as intelligence processing, decision support, situational awareness, cyber defense, autonomous systems and support functions. They also note that AI can serve as an analytical facilitator, information disruptor or force multiplier, depending on how it is integrated into doctrine and capabilities.[45]

Several Armed Forces' initiatives demonstrate practical applications of robotics, autonomy, AI and digital ecosystems within military operations. However, the level of adoption should not be presented as "generalized AI in operational use". AI maturity is mainly between the Initial and Committed levels, with relevant pilot projects across Services and functions, combined with a growing operational use in the space domain, but without full, sustained integration into systems and processes.

6.2 Maritime Domain

The Navy emerges as a leading force in digital innovation and AI adoption through three flagship initiatives,[46] which were detailed in previous sections: (1) The Multipurpose Naval Platform, NRP D. João II, the EU's first drone carrier, conceived as a digital platform integrating autonomous air, surface and underwater systems; (2) REPMUS, recognized as the world's leading maritime unmanned

45 Esteves, (Coord.), Inteligência Artificial: Estudos Pioneiros em Contexto Militar.
46 Correia, "A transformação digital nas Forças Armadas Portuguesas: Revisão em 2026."

systems experimentation exercise, bringing together NATO, industry and academia; and (3) the "Silicon Sailor" project, AI-based assistants built using Portuguese LLM, operating securely within Navy infrastructure and supporting knowledge management and decision-making, thus illustrating a practical application of AI in areas that are becoming critical force multipliers in modern military organizations.

Additionally, the Navy's Operational Experimentation Centre in Tróia, which also hosts the DIANA test center, provides a platform for trials of autonomous vehicles, advanced sensors and C2 systems, many of which embed AI algorithms for navigation, sensor fusion and decision support.

6.3 Land Domain

A recent study about the AI impact in the Portuguese Army also frames AI as a cross-cutting topic across functional areas (intelligence, human resources, training, C2, logistics, finance, education, health, and military decision-making), but much of that content is analysis, proposals, or studies, not evidence of already institutionalized capabilities.[47]

However, within this context, AI is not treated as a standalone technology, but as a force multiplier for the Army's overall functioning. In practical terms, points to AI being applied mainly to four functions: better observation, faster decision-making, stronger force support, and better resource management. At the same time, it stresses that military use of AI requires human oversight, cybersecurity, ethics, data quality, and organizational adaptation. Therefore, as stated in the Army AI Strategy, AI employment is explicitly tied to C2, ISR, logistics and predictive maintenance use-cases, while insisting on proportional human supervision according to risk and context.

Multiple examples point to a Portuguese Army that is in an active phase of exploring, experimenting with, and institutionally preparing for AI, but with uneven adoption across areas. The most concrete case directly linked to AI is Automated Modelling, Identification and Damage Assessment of Urban Terrain (AMIDA-UT), a PESCO project led by the Portuguese Army for 3D urban modeling/digital twins, automatic structure identification, and damage assessment, using drones/sensors, cloud computing, and AI to support decision-making, targeting, maneuver, force protection, and training/simulation.[48]

47 Monteiro, As áreas funcionais do Exército 2025.
48 "Automated Modelling, Identification and Damage Assessment of Urban Terrain."

Another example is in the experimentation domain, in which the ARTEX series provide relevant insights for future defense AI solutions. More than a technology showcase, the exercise serves as a platform to validate operational concepts, assess military utility and accelerate the transition of innovation into deployable capabilities. For example, during ARTEX25, almost 30 industrial entities tested more than 50 technological solutions, including 20 unmanned air systems, five unmanned ground vehicles, two anti-drone systems, six C2 solutions, and two maintenance/additive-manufacturing solutions.[49] As mentioned in previous sections, ARTEX 26, integrating the EDA HEDI-OPEX26 campaign, represents a major milestone in military technology experimentation by providing a realistic operational environment to test AI in an MDO environment. Ultimately, demonstrates how operational experimentation can accelerate the responsible adoption of AI while enhancing military effectiveness, decision superiority and multinational cooperation.

At the level of partnerships, the 2024 EID/Army protocol aims to use AI and augmented reality into the modernized communication systems to improve soldiers' cognitive load management, increase cyber-security and enable enhanced terrain mapping and real-time information sharing in the field, which are practical examples of AI being fielded at tactical level. These efforts are embedded in a broader push to create a digitalized, network-centric battlespace interoperable with NATO's Federated Mission Networking standards.[50]

6.4 Air and Space Domains

As a technologically intensive branch, the Air Force is introducing AI in a planned, phased and prioritized way, focusing first on areas where value can be extracted with lower risk.[51] Naturally, AI is seen as another step in a continuous technological evolution rather than a sudden break. Also, due to its reduced critical mass, instead of pursuing the experimentation path, the Air Force is more focused on fielding operational capabilities while leveraging partnerships with specialized national Defense Technological and Industrial Base (DTIB) companies, aiming to create credible mission output.

Within this context, the Air Force is presented as a clear example of how a strategic vision can rapidly generate a new, inherently digital operational capability.[52] In particular, the current Air Force mission expansion to the 5th operational domain,

49 "Chega ao fim o ARTEX 25."
50 "EID and Portuguese Army sign cooperation protocol to future-proof communications systems."
51 Fernandes, "Inteligência artificial redefine indústria de defesa portuguesa."
52 Correia, "A transformação digital nas Forças Armadas Portuguesas: Revisão em 2026."

Space, has created opportunities to introduce several operational AI-enabled capabilities. Its real strategic value comes from combining SAR and optical satellites, cloud-based combat networks, and AI-enabled analytics to provide persistent surveillance, target identification, decision support, and guidance for both crewed and uncrewed military assets. The combination of multiple air and space sensors, AI and an air combat cloud is what makes such initiatives potentially transformational for Portuguese defense.

The most relevant DTIB partnerships include Neuraspace in the Space Surveillance and Awareness (SSA)/Tracking (SST) domain and AI/ML for space traffic; Iceye and Geosat in satellite operations and space ISR data fusion; UAVision and Tekever in wildfire and maritime surveillance unmanned aircraft systems; and OutSystems in digital systems for HR, logistics, and maintenance.

Currently, operating two Iceye SAR satellites, launched early in 2026, the Air Force will enlarge its constellation with additional two SAR satellites in October this year, and another two very-high resolution satellites in early 2027. Finally, in 2028/29 it will launch four SAR satellites, allowing increased coverage and revisit rates. The rapid expansion of the Portuguese Air Force's sovereign satellites, significantly enhances Portugal's ability to rapidly collect and exploit space-based intelligence over the Atlantic and its Exclusive Economic Zone, as well as contribute to other national or international defense and security missions.[53]

Established in 2024, the Air Force Space Operations Center conducts AI-enabled satellite operations through cloud-connected systems and AI agents to reduce the need for constant manual monitoring. Additionally, AI tools are used in satellite imagery analytics, processing high-resolution imagery to extract actionable information, detect changes, identify objects or features, support border/area monitoring, maritime surveillance and disaster response. The Center also has the responsibility for Space Domain Awareness (SDA) employing several capabilities to monitor space activities, including space weather, which can have impact on national/allied satellites and space services.

Regarding the SDA capability, which includes SSA/SST functions, it's worth mentioning the partnership with Neuraspace,[54] a leading Portuguese space development company. The first operational deliverable from this partnership became operational in 2024 with the installation of Neuraspace's optical telescope at Air Base No. 11 in Beja, linked to an AI/ML-based platform for space monitoring and for turning complex data into useful knowledge for defense and civil protection.[55]

53 "Portugal acquires two additional ICEYE SAR satellites to scale sovereign intelligence from space."
54 For more, see: https://www.neuraspace.com/ (last accessed 14 August 2026).
55 "Neuraspace inaugurates its first fully operational optical telescope."

Concerning available operational applications, the Neuraspace DEF[56] is an AI-powered space-defense platform designed to protect space infrastructure by combining AI, terrestrial and orbital sensors, and automated data analysis to detect threats, track satellites, and support autonomous decision-making. In practical terms, the system turns space monitoring into actionable intelligence for military decision-making. It also enables continuous and predictive surveillance of the space environment, helping anticipate risks earlier and supporting the protection of critical infrastructure and operational planning. Early participation in the development, testing and validation of this AI-tool enables the Space Operations Center to conduct its SST/SSA responsibilities, as well as provide further operational contributions to improve the AI-tool functionalities.

Neuraspace also acts as national coordinator within a €160M consortium for the European Military Integrated Space Situational Awareness and Recognition capability (EMISSARY) to strengthen Europe's SSA, providing AI-based solutions to detect and characterize risks such as collisions and anomalies in satellite constellations.[57] Within this context, AI-driven analytics are being used to process large volumes of orbital data, with clear implications for protecting military satellites and supporting operations reliant on satellite services.

Other AI-enabled applications, in advanced stage of operational introduction, include the LYNCE OS,[58] developed by Geosat, that aims to create an innovative dual-use digital platform designed to enhance situational awareness in defense, security, institutional, and commercial settings. It will be validated in collaboration with the Air Force in pilot environments for both military applications, including classified scenarios, and civilian use cases. The platform will combine satellite data with other sources to provide situational awareness across space, air, surface, and cyber domains, as well as 3D model visualization supported by augmented reality, and use AI-based tools for scenario analysis generation, and automated analysis algorithms for tasks such as object detection, change detection, and route analysis. The result will be operationally tailored products with interfaces that are easier, faster, and more efficient to use.

Additionally, the partnership with Iceye, the world's largest commercial SAR constellation operator and European leader in sovereign intelligence from space, has allowed the Air Force to enhance its space ISR AI-enabled capability.[59] Iceye's AI ecosystem transforms satellite imagery from a mere collection capability into a continuous intelligence and decision-support capability. Instead of simply receiving SAR images, operators gain access to automated detection, classifica-

56 "NeuraspaceDEF."
57 "Neuraspace strengthens Europe's space situational awareness (SSA) with EMISSARY project participation."
58 "Projetos PRR – LynceOS-Dual."
59 "Dark Vessels in Northern Europe – and how ICEYE's satellites find them."

tion, anomaly identification, multi-sensor fusion, predictive analytics, and alert generation. This directly supports the evolution of the Space Operations Center from a monitoring center into an operational Space Intelligence Hub. For the Air Force, Iceyes's AI tools are important not because they produce SAR images, but because they convert persistent space-based sensing into automated intelligence, enabling rapid detection of dark vessels, fusion of multi-source data, and near real-time decision support for national and NATO operations. Furthermore, Iceye's partnership with the Air Force supported the recent company's decision to establish Iceye Portugal, as a long-term commitment to build advanced space technology in Portugal, and Lisbon as a center of excellence to scale sovereign space capability.[60]

Other Air Force space initiatives are focused on the ground segment, being complemented by critical data storage infrastructures supporting the operation of the Atlantic Constellation, providing security in the collection, processing, dissemination, and storage of data and information. Additionally, until the end of 2026 the new Air Force satellite assembly hub will start operations in Alverca. Closing the space ecosystem value chain, the Air Force will open a Space Base in Azores which will enable secure access to space and help eliminate Europe's current dependency on external launch capabilities.

These initiatives are strategically relevant for defense AI because they strengthen national decision superiority, situational awareness and operational autonomy, while supporting defense, security, environmental monitoring and disaster response missions. For the Air Force, it represents a major step towards becoming a data-driven, space-enabled force, providing persistent ISR capabilities, faster revisit rates and improved awareness and responsiveness. More broadly, it positions Portugal among a growing group of European nations investing in sovereign space intelligence as an operational necessity, reinforcing national resilience, NATO interoperability and the foundations for future AI-enabled exploitation of space-derived data.

6.5 Future Challenges

Despite a huge increase in AI-related investment, some challenges remain within People, Processes and Technology dimensions.[61] First and foremost, recruitment and retention of highly qualified specialists. The Armed Forces struggle to attract, train and retain personnel with expertise in AI, data science, cybersecurity or

60 "ICEYE establishes ICEYE Portugal and Lisbon center of excellence to scale sovereign space capability."
61 Correia, "A transformação digital nas Forças Armadas Portuguesas: Revisão em 2026."

software engineering. Second, the ability to convert, in an efficient manner and on time, vast number of financial resources into operational capabilities. Third, the challenge of "Technological Fragmentation." Each Service is progressing independently, creating the risk of digital silos.

Digital Transformation has evolved in the last years from a strategic aspiration into an operational reality within the Portuguese Armed Forces.[62] Currently, there is a strong NATO and EU strategic alignment, access to unprecedented financial resources, and tangible implementation of digital capabilities across all Services. However, the decisive factor for success is no longer funding or technology. The critical challenge is creating a coherent governance framework, common data architecture, interoperable digital ecosystem, and an Armed Forces-wide Digital Transformation/AI Strategy capable of transforming multiple Service-level successes into a coherent, interoperable, data-centric and multi-domain force by 2030.

The AI in the Portuguese defense area is at an initial level of maturity, but that there are concrete use-cases, pilot projects and niche operational capabilities that can be scaled if accompanied by strategic planning and governance. Further evolution can be achieved with the transition from isolated experiments to a coherent portfolio of defense AI capabilities aligned with NATO and EU frameworks.

62 Correia, "A transformação digital nas Forças Armadas Portuguesas: Revisão em 2026."

7 Training for Defense AI

7.1 Public-Sector Training and Broader Ecosystem

Portugal's AI strategies and digital skills programs create a broad foundation for AI literacy, aiming to train up two million citizens in basic and advanced digital competences by 2030, with AI-related skills explicitly mentioned as a key focus area, stressing the importance of training across sectors, including security and defense, to make effective use of AI tools and avoid skills gaps.[63] Thus, such programs create a broader talent pool from which the Armed Forces, defense industry and cyber institutions can recruit personnel able to work with AI systems, reinforcing the triangle between academia, companies and the public sector.

7.2 Skills and Culture in the Armed Forces

The Portuguese government and the Armed Forces' top leadership recognize the importance of adopting innovative technologies, especially AI. For defense AI, this means an increased demand for personnel capable of managing and interpreting outputs from AI-enabled C4ISR and cyber tools; operating and supervising autonomous and semi-autonomous systems; and participating in multidisciplinary teams involving software engineers, data scientists and military operators.

In the defense context, there is no fully public, detailed "AI literacy" program for military and civilian personnel, but AI and data-driven topics are being integrated into innovation initiatives, operational capabilities, advanced training and multinational exercises, indicating that Portuguese forces are already exposed to AI-enabled training and testing environments at alliance level.

7.3 AI-Enhanced Training to Advance Professional Military Education

Building upon the initial technological education at the Military Academies, the Military University Institute promotes several education and training initiatives building an ecosystem that links law, ethics, command, training, and doctoral research around emerging technologies, with strong emphasis on AI and MDO. These initiatives transform professional military education beyond traditional

63 Pacto de Competências Digitais.

doctrine and into the realities of modern operations. By linking AI, Laws of Armed Conflict, and C2 themes, the Institute is helping officers think about how technology affects decision-making, legal compliance, and operational effectiveness. Additionally, they build a shared intellectual framework across ranks and Services. Seminars embedded in courses such as the Senior Officer Promotion Course and the Joint Staff Course ensure that AI is not treated as a niche topic, but as a core competence for military leadership and planning. At the doctoral level, within the Military Sciences course, this agenda strengthens research, doctrine, and institutional learning.

Such framework encourages officers and researchers to examine AI as a force-development issue, not only a technical one, which helps the Armed Forces prepare for MDO, ethical constraints, and future command challenges. Overall, the value for professional military education is that it creates leaders who can integrate emerging technologies with legal, ethical, and operational judgment. That combination is essential for preparing forces that are both technologically credible and doctrinally sound.

From an MDO perspective, the biggest risk is not insufficient AI technology but training fragmentation. Service-level innovation can create speed but also fragmentation if not integrated institutionally. Consequently, one of Portugal's most important defense transformation challenges over the next five years is the preparation of commanders and staffs from all services to operate jointly with AI in a common multi-domain decision environment.

7.4 Service-Level AI Training

The Army's AI Strategy dedicates two objectives, competencies and culture, to human capital development. It foresees a modular training program in AI and data; integration of AI, ethics and digital transformation content into basic and advanced training and promotion courses; awareness-raising activities, workshops, exercises and games to demonstrate AI value in operational and administrative scenarios; and identification of AI focal points in major units and directorates to promote use-cases and best practices. These measures aim to create a culture of co-intelligence across the force, where commanders and staff understand what AI can and cannot do, and where technical specialists have the skills to design, operate and maintain AI systems in demanding environments.

The Air Force training plan aims to create an AI-literate force, AI-enabled leaders, and AI specialists capable of safely employing, supervising, and developing AI solutions across the organization. It is structured around three levels. A basic AI lit-

eracy training for all personnel, to improve the understanding about AI capabilities, limitations, risks, ethics, and responsible use. A functional training for operators and managers, focusing on practical application of AI tools in decision support, administration, logistics, intelligence, and operations. Advanced training for specialists and leaders, regarding AI governance, data exploitation, advanced analytics, ML, and AI integration into MDO. The strategy also foresees the integration of AI into command, staff, planning, and leadership courses; internal certification of AI competencies; creation of AI innovation champions across units; and continuous learning through experimentation, exercises, academia, industry partnerships, and lessons learned. The goal is to ensure that every airman can use AI responsibly, every leader can exploit AI for better decisions, and a core group of experts can build and govern AI-enabled capabilities for Air and Space operations.

The Navy strategic objectives identify as a priority the need to accelerate digital transformation and technological innovation, with a particular emphasis on AI and unmanned systems. Beyond foundational training programs, the Navy will focus on the training requirements arising from major AI experimentation and capability development initiatives, such as REPMUS and the "Silicon Sailor" project, which are being further reinforced by the ongoing acquisition of advanced naval weapon systems, including the Multipurpose Naval Platform and FREMM EVO frigates. Given the significant AI component embedded within these projects, they are expected to act as important catalysts for accelerating AI-related education, training, and workforce development efforts.

The introduction of advanced military capabilities enhances AI training because it creates real operational requirements that drive the development of specialized skills, while simultaneously providing real-world environments for training, experimentation, and validation, thus transforming AI from a generic technological subject into an essential military competency for mission execution.

At the service level, the Navy's leadership in REPMUS and DIANA trials require crews and operators to be trained in planning, deploying and supervising autonomous and AI-enabled systems, while the Army's ARTEX exercises provides familiarization and training to understand and operate AI-enhanced solutions. Furthermore, the Air Force's operational space capabilities require specialized AI training to prepare personnel for the emerging paradigm of AI-enabled space operations. Future operators will need expertise in satellite mission management, space domain awareness, SAR exploitation, multimodal data fusion, predictive analytics, and AI-supported intelligence production. This demands a progressive training framework that develops not only technical proficiency but also the ability to supervise, challenge, and effectively collaborate with AI systems, ensuring that human judgement remains central to operational decision-making.

Furthermore, Portugal already possesses a credible simulation and synthetic training ecosystem, particularly in the Air Force (F-16 and KC-390 tactical flight simulators), Army simulation centers, and defense industry. Most activity is currently centered on LVC training, modelling and simulation, digital twins, immersive technologies (virtual and augmented realities), and experimentation, with AI increasingly being viewed as an enabling layer rather than a separate training domain. However, the transition from conventional simulation to AI-enabled simulation-based training is still at an early stage. Portugal's comparative advantage is not yet AI itself, but rather its growing ecosystem of simulation, experimentation, digital twins, space capabilities, and LVC environments that can serve as the foundation for AI-enabled military training.

7.5 Impact of Defense AI on Training Requirements

There is often skepticism towards AI in areas where it can genuinely add value, such as the analysis of large volumes of data, while excessive trust is placed in areas where AI remains inherently fragile, namely complex moral, ethical, or legal decision-making. This paradox underscores the importance of critical and ethical education, which is every bit as important as technical training.

Defense AI generates huge demand for personnel skilled in data analysis, cyber defense and operation of autonomous systems. Additionally, enables new forms of training, such as AI-enhanced simulations, adaptive learning platforms and more realistic LVC environments. This evolution will require not only technical skills but also doctrinal and ethical training on how to operate and fight in such blended domains.

While no specific "trust in AI" training program for the Armed Forces is public, broader EU and NATO initiatives on trustworthy AI, combined with Portugal's role in DIANA and AI Factories, embed the principle that AI systems must be explainable and governed, which indirectly shapes how training and doctrine approach human-machine teaming. Moreover, several Military University Institute studies and seminars emphasize responsible use, respect for international law and alliance values, and the need for verifiable standards of AI behavior in operational environments.[64]

Portugal possesses robust normative and ethical foundations, as well as a vibrant academic debate. However, it still lacks an official doctrine document capable of translating these principles into specific guidelines governing the use of AI in military operations, weapon systems, C2, and military data management.

64 Esteves, Inteligência Artificial: Estudos Pioneiros em Contexto Militar.

8 Conclusion

Portugal's approach to defense AI reflects a distinctive model among NATO and EU nations: rather than pursuing a large, centrally funded AI modernization program, it has progressively integrated AI through digital transformation, multinational cooperation, operational experimentation, and Service-level innovation. The result is an emerging defense AI ecosystem that remains at an early stage of maturity but already exhibits several characteristics that position Portugal as an important contributor to allied defense innovation.

The study demonstrates that Portugal does not yet possess a comprehensive Defense AI Strategy. Nevertheless, the absence of a single overarching document should not be mistaken for a lack of progress. Across the MND, the Joint Staff, and the three Services, AI-related initiatives are increasingly visible in governance frameworks, experimentation activities, operational capabilities, industrial partnerships, and training programs. The Army, Air Force, and Navy have adopted approaches tailored to their operational realities while remaining aligned with broader NATO and EU principles regarding responsible AI, interoperability, and human oversight.

Several key lessons emerge from the Portuguese experience. First, defense AI is fundamentally a governance and data challenge before it becomes a technology challenge. Throughout the study, successful AI adoption consistently depends on trusted data, secure infrastructure, interoperable architectures, cyber resilience, and clear accountability mechanisms. Second, experimentation has become Portugal's primary strategic advantage. Initiatives such as REPMUS, ARTEX, DIANA, and CWIX demonstrate how operational testing environments accelerate learning, reduce technological risk, and create pathways for transforming emerging technologies into military capabilities. Third, the most immediate military value of AI lies not in autonomous weapon systems but in decision superiority. The most mature Portuguese use cases concern ISR exploitation, knowledge management, cyber defense, predictive maintenance, space operations, and decision-support systems that improve the speed and quality of human decision-making.

The study also reveals the increasingly dual-use nature of defense AI. Many of the technologies shaping Portugal's military AI trajectory originate from broader national investments in digital infrastructure, supercomputing, cloud services, space technologies, and large language models. Partnerships with several key DTIB companies demonstrate that future military capabilities will be intricately linked to the vitality of the national innovation ecosystem. In this sense, Portugal's approach implicitly recognizes that military advantage can no longer be generated solely within traditional defense structures but increasingly emerges from the interaction between defense institutions, academia, industry, and multinational frameworks.

Looking ahead, several trajectories are likely to shape the evolution of defense AI in Portugal. The most important may be the eventual development of a national defense AI Strategy capable of integrating currently dispersed initiatives into a coherent framework. Such a strategy could establish common priorities, governance mechanisms, ethical standards, capability objectives, and implementation milestones. Closely related is the need for dedicated Defense-wide AI governance structures capable of overseeing certification, validation, risk management, and responsible use across the Armed Forces.

Operationally, Portugal appears well positioned to expand AI-enabled capabilities in areas where it already possesses comparative advantages. Space-based ISR, supported by sovereign satellite capabilities and AI-driven analytics, may become one of the most strategically significant domains. Similarly, continued investment in autonomous systems, maritime experimentation, cyber defense, and multi-domain C2 architectures is likely to reinforce Portugal's role as an allied experimentation and integration hub. Rather than competing with larger nations in the development of complete AI ecosystems, Portugal may achieve greater strategic relevance by focusing on niche capabilities, operational experimentation, interoperability, and the rapid integration of emerging technologies into coalition operations.

Despite this progress, several critical questions remain unresolved. The first concerns governance: in the absence of a dedicated defense AI Strategy which institution should be responsible for establishing standards, oversight mechanisms, and certification processes? The second concerns operational employment: how should meaningful human control be implemented across different categories of AI-enabled systems, and what criteria should determine when such systems are sufficiently trustworthy for operational use? The third concerns interoperability and integration: how can the Armed Forces avoid technological fragmentation while preserving the flexibility necessary for service-level innovation?

Human capital represents another major challenge. The ability to recruit, develop, and retain specialists in AI, data science, cybersecurity, and software engineering will determine whether current investments can be translated into operational capabilities. Equally important is the preparation of military leaders capable of understanding both the opportunities and limitations of AI. Future commanders will need not only technical literacy but also the ability to integrate AI-enabled systems into doctrine, operations, and decision-making while maintaining legal, ethical, and strategic judgment.

Finally, questions of technological sovereignty and alliance integration will continue to shape Portuguese choices. Portugal cannot realistically achieve autonomy across all AI domains. The strategic challenge therefore lies in identifying which

capabilities require sovereign control and which can be developed through partnerships within NATO, the EU, and the broader defense innovation ecosystem. Balancing access to cutting-edge technologies with resilience, security, and national autonomy will remain a defining issue for the coming decade.

Ultimately, the Portuguese case illustrates that the value of defense AI depends less on isolated technological breakthroughs than on the successful alignment of people, processes, governance, data, and operational objectives. Portugal's greatest strength today is not the large-scale deployment of AI-enabled military systems, but its growing role as a trusted experimentation, integration, and innovation hub within NATO and the EU. The decisive challenge for the years ahead is therefore not whether Portugal will adopt AI, but whether it can transform a diverse collection of promising initiatives into a coherent defense AI ecosystem capable of generating sustainable military advantage, strengthening national resilience, and contributing meaningfully to allied security by 2030 and beyond.

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