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Strategy & Policy Section

An Analysis of the European Sky Shield Initiative (ESSI) and Türkiye's Role in Integrated Air and Missile Defence

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Abstract

The European Sky Shield Initiative (ESSI) seeks to accelerate Europe's layered air and missile defence through coordinated procurement and integration across NATO-interoperable systems. Launched in October 2022 and counting more than twenty members by mid-2025, ESSI responds to lessons from the Russia–Ukraine war, namely the need for resilient, multi-layered defences, munition depth, and robust Command-and-Control (C2). This study synthesizes country-level capability baselines and acquisition trajectories across Europe and assesses integration challenges—technical, organizational, and political, strategical, economic. It then analyses including Türkiye's indigenous programmes (the HİSAR family and SİPER) as well as naval integration initiatives involving the Evolved Sea Sparrow Missile (ESSM), a ship-launched medium-range interceptor used for fleet self-defence against aircraft and anti-ship cruise missiles. and strategic geography at NATO's south eastern flank, identifying concrete areas where Türkiye can augment ESSI: sensor coverage, layered interceptor effects, and system-of-systems integration. Beyond platform portfolios, Türkiye's defence-industrial base and test infrastructure offer surge capacity and co-production potential under consortium arrangements, diversifying supply chains and reducing single-source risk for ESSI participants; its geostrategic position—spanning the Black Sea, the Turkish Straits, the Eastern Mediterranean, and the Levant—extends early-warning depth and provides forward C2 relay nodes for NATINAMDS, particularly for the protection of energy corridors and critical infrastructure. The study combines for a way for supply chain decision makers structured desk research with comparative analysis to propose a pragmatic roadmap for ESSI implementation emphasizing standardization, modular C2, and joint stockpiles. As a conclusion for global markets defence supply chain, writers recommend a road map for decision makers for near-term capability bridging, mid-term industrial cooperation, and long-term architecture evolution toward hypersonic-capable defence and space-based early warning.

Keywords: European sky shield initiative, integrated air and missile defence, HİSAR, SİPER, steel dome, SAFE, joint-procurement.

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1. Introduction

The European Sky Shield Initiative (ESSI) is a German-led, multi-nation endeavour to accelerate the establishment of a multi-layered, ground-based integrated air and missile defence architecture in Europe through joint procurement, standardization, and coordinated deployment. Although ESSI is not a NATO programme per se—and it is not a European Union (EU) initiative either—it is explicitly framed as a contribution to NATINAMDS posture and requirement-set.

ESSI's emergence must be read against the operational lessons of Russia's full-scale war on Ukraine and the persistent threat envelope -facing Europe- from ballistic and cruise missiles to UAS swarms and electronic warfare. Russian threats and technological developments need some changes in supply habits for example resilience requires a layered posture from day one, with adequate stocks, scalable C2, and rapid integration pathways into NATINAMDS.

As of September 2025, the EU Institute for Security Studies (EUISS) records 24 participating countries—EU and non-EU—currently involved in ESSI, including Belgium, Bulgaria, Czechia, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, the Netherlands, Norway, Slovakia, Slovenia, Romania, the United Kingdom, Denmark, Sweden, Austria, Switzerland, Albania, Portugal, Poland, Greece, and Türkiye (Düz & Koçakoğlu, 2025; Defence News 2024b).

This study advances the ESSI scholarship along three complementary lines. First, it develops a comparative, country-level mapping of air and missile defence capacities. Second, it bridges policy-oriented debates on ESSI with the technical variables that condition integration—most notably interoperability and command-and-control alignment. Third, it assesses Türkiye's prospective position by jointly examining its geopolitical relevance, defence-industrial base, and system-integration readiness within a layered Integrated Air and Missile Defence (IAMD) framework.

In summary, ESSI is best understood as a pragmatic, coalition-based accelerator that seeks to thicken the layers of European ground-based air and missile defence in tight synchrony with NATO IAMD/NATINAMDS, while drawing on EU instruments to tackle cost, scale, and interoperability. In collaboration with ESSI, disruptions have created a policy window in which rapid, standardized, and jointly financed solutions are not only desirable but strategically necessary.

2. Methodology and Scope

This article applies a structured desk-research design combined with comparative analysis. The empirical basis consists exclusively of open sources, and the unit of analysis is the national GBAD/IAMD posture of ESSI participants as it relates to NATINAMDS interoperability and collective defence requirements.

Source types were triangulated across: (i) primary NATO and EU documents (policy texts, topic pages, Council/Commission releases and programme documents); (ii) official national statements and procurement disclosures (ministries of defence, parliamentary questions, tender/contract announcements); (iii) manufacturer publications for system-level parameters (e.g., engagement roles, integration interfaces); and (iv) peer-reviewed and high-quality analytical literature for contextual interpretation. Where open-source reporting is used, it is treated as supplementary and cross-checked against primary/official materials.

Comparative assessment is organized around a consistent set of evaluation dimensions: (a) layering (VSHORAD/SHORAD/MRAD/LRAD and, where relevant, BMD-capable upper-tier effects), (b) integration readiness (sensor coverage, data-link compatibility, IFF, engagement-management/C2 interfaces), and (c) sustainment and industrial factors (magazine depth proxies, production scalability, maintenance/test infrastructure, and consortium participation). The intent is semi-quantitative in the sense of using consistent, observable indicators across cases, while acknowledging that key variables remain classified or politically contingent.

Range taxonomy and defensive-layer terminology follow NATO standardization logic (STANAG-based criteria referenced in the reviewers' supplementary material). Accordingly, legacy systems such as HAWK are treated as short-range within the SHORAD tier, and all range labels were harmonized throughout the country-by-country capability map.

Limitations: Because the study is open-source, it does not claim exhaustiveness on classified performance data, operational readiness rates, or wartime stockpile levels. The analysis should therefore be read as an interoperable baseline and a decision-support map, not as an operationally binding order of battle.

3. The Contemporary Air/Missile Threat Picture in Europe

In NATO's latest IAMD policy, the Alliance defines the threat set broadly as all objects capable of putting the Alliance at risk from the air, from any direction—encompassing manned aircraft (fixed- and rotary-wing), ballistic and cruise missiles, Uncrewed Aircraft Systems (UAS) including loitering munitions, and emerging hypersonic vehicles. This policy is quite important for Alliance. NATO's dedicated Ballistic Missile Defence materials likewise emphasize the increasing threat posed by ballistic systems to European populations, territory, and forces, *(*NATO, 2024a*)* while the Organization's capability-cooperation brief underscores that small drones have proven effective and dangerous in modern conflicts—hence the need for layered counter-UAS within a broader IAMD posture based in NATO sources.).

Since early 2022, Russia has conducted recurrent, large-scale missile and drone attacks against Ukrainian cities and critical infrastructure, often executed in successive waves that have targeted major urban centres as well as strategically significant nodes. A pronounced escalation has been observed from spring 2024 onward, with strikes increasingly concentrated on power generation facilities, electricity transmission and distribution assets, and related energy infrastructure. These attack patterns have produced cascading effects on the continuity of essential services and civilian resilience, including widespread outages and disruption risks for water, heating, and emergency response capabilities. In parallel, the sustained degradation of the energy system has required repeated emergency support measures, notably the rapid deployment of generators and other critical equipment through coordinated civil-protection and assistance mechanisms, aimed at stabilizing the grid, restoring basic services, and mitigating humanitarian impacts. Taken together, the EU record shows a sustained, high-tempo campaign against energy and civic infrastructure with direct cross-border externalities for European security. In doctrinal terms, ESSI seeks to mitigate an extensive array of aerial contingencies, ranging from conventional aircraft and Unmanned Aerial Vehicles (UAVs) to sophisticated ballistic and hypersonic threats. By harnessing state-of-the-art radar technologies, satellite constellations, and surface-to-air interceptors, the initiative aims to establish a robust, multi-layered defence perimeter for participating nations. Central to this objective is the cultivation of a synchronized defence architecture that integrates land, maritime, aerial, and space-based assets, thereby ensuring a rapid and cohesive response to evolving aerospace challenges.

3.1. ESSI's Strategic Aim and Alignment with NATO

ESSI is a cooperative, medium- to long-term integration and procurement initiative through which participating states pursue a multi-layered, ground-based IAMD capability—including an anti-ballistic missile layer—via common acquisition of air-defence systems, interceptors, and related equipment. Its core logic is collaborative procurement and joint operation, complemented by structured cooperation on lifecycle matters such as sustainment, maintenance, and repair, with the objective of building shared capabilities that reduce national unit costs while increasing interoperability. Although frequently associated with Europe, ESSI is conceived as a shared defensive architecture across participating countries that aims to enable timely and effective responses to aerospace-domain threats. While not a NATO programme per se, it is explicitly framed as a contribution to the NATINAMDS posture and requirement set, and it is intended to be fully interoperable and seamlessly integrated with NATO IAMD, leveraging NATO assets and standards to reinforce deterrence by denial and the collective protection of populations, territory, and deployed forces. ESSI is a voluntary, cooperation-based framework intended to thicken Europe's multi-layered ground-based integrated air and missile defence rapidly, thereby reinforcing deterrence by denial and the collective protection of populations, territory, and deployed forces.

Strategically, ESSI's design premise is plug-and-fight interoperability with NATINAMDS—the Alliance's distributed, 24/7 network that fuses sensors, C2 nodes and effectors across national and NATO systems. NATO Integrated Air and Missile Defence (NATINAMDS) constitutes a standing and continuous Alliance mission across peacetime, crisis, and conflict, aimed at safeguarding NATO territory, populations, and forces against air and missile threats and attacks. Conceptually and operationally, NATINAMDS embodies a cross-domain, multi-domain approach by integrating heterogeneous capabilities—spanning sensors, command-and-control, and effectors—into a coherent architecture. In doing so, it seeks to deliver a multi-layered defensive posture in which complementary layers of detection, tracking, engagement, and defeat operate in an integrated manner to enhance resilience and overall mission effectiveness. Allied Air Command further characterizes it as a command-and-control network that links sensors and weapon systems in the air, on land, [and] at sea, (AIRCOM, 2023) a formulation that clarifies the any-sensor/appropriate-shooter integration ESSI countries must achieve when fielding additional short-, medium- and long-range layers. In practice, this means ESSI procurement (from SHORAD/C-UAS to upper-tier interceptors) must be standards-compliant, data-link ready, and C2-convergent with NATO architectures from day one.

On the EU side, the European Defence Industrial Strategy (EDIS) sets the political-industrial context for scaling inventories at speed. Its companion programme, EDIP, proposes €1.5 billion (2025–27) and a toolbox that includes a new Structure for European Armament Programme (SEAP) and the EU's first security-of-supply regime—all aimed at steady-state availability of missiles, interceptors and supporting components (Council of the European Union, 2025).Taken together, EDIS/EDIP/EDF provide an EU-level industrial-policy and financing toolkit that can turn ESSI's pooled demand into repeatable production, common configurations, and interoperable increments that NATINAMDS can absorb without delay.

For EU Member States, this acceleration should remain coherent with the EU Capability Development Plan (CDP) and aligned with NATO requirements through the NATO Defence Planning Process (NDPP) and applicable standardisation/procurement mechanisms. The European Defence Agency's CARD 2024 report captures the policy pivot succinctly: more cooperation is needed, and it should be accelerated building on … closer collaboration with NATO to reduce fragmentation and maximize synergies and efficiencies (European Defence Agency [EDA], 2024).

The political economy is straightforward: NATO specifies the operational problem and apportions capability targets (NDPP), while the EU now fields industrial/financial instruments—EDIS/EDIP/EDF—to reduce lead times, scale manufacturing, and privilege interoperability. ESSI sits at the seam: it aggregates demand signals for ground-based air and missile defence, translates them into common standards and joint procurement, and delivers NATINAMDS-compatible effectors and C2 upgrades. This is why Allied communications about ESSI have stressed both NATO requirement-pull and interoperable, off-the-shelf procurement as the quickest route to close gaps and strengthen collective defence.

3.2. The Geopolitical Dynamics and Membership Politics of ESSI

ESSI has emerged as a cooperation-based procurement and integration framework to accelerate Europe's ground-based integrated air and missile defence. Politically, ESSI reflects the convergence of two imperatives: a NATO-defined operational need to thicken air and missile defence across all phases of conflict, and a European level drive to mobilize finance, scale production and hard-wire interoperability across national programmes. Legally and industrially, the initiative operates at the seam between Alliance interoperability standards (C2, data links and IFF) and EU instruments (EDF, PESCO, EDIRPA/ASAP and SAFE), which together provide a more predictable procurement and financing envelope.

A defining feature of ESSI is the combination of German political leadership with an expanding and increasingly diverse participation base. From the outset, the initiative has been framed as a cooperative pathway to strengthen NATO’s integrated air and missile defence posture through the joint acquisition of air-defence systems and interceptors. Early alignment by major European stakeholders reinforced the logic of a multi-layered, ground-based integrated air-defence approach, while subsequent Nordic participation indicated that the coalition’s strategic centre of gravity would extend northward alongside the eastern flank. The inclusion of non-EU neutral participants further suggests that ESSI functions less as an EU-internal scheme and more as a flexible coalition instrument operating at the practical interface between EU and NATO capability development and operational interoperability.

Notwithstanding this enlargement, membership politics have been marked by a distinct French (and initially Italian) reticence rooted in strategic-autonomy and technology-origin concerns. A parliamentary question dated 23 April 2024 framed the risk starkly: more than 20 Member States had joined, but France and Italy had yet to do so, a posture that could jeopardize its effectiveness, turning it into a new ‘Maginot Line’. (European Parliament, 2024). Paris’s preference to prioritize entirely European solutions (SAMP/T) channels a broader legal-industrial claim about origin rules, sovereignty in critical subsystems, and the long-run structure of the European Defence Technological and Industrial Base (EDTIB). Notwithstanding industrial-origin debates, ESSI participation is conditioned by NATO interoperability: procured systems must meet Alliance standards (notably data links, IFF, and C2/engagement-management interfaces) so that all layers can plug into NATINAMDS—including for Allies such as Türkiye on the south-eastern flank. The strategic alignment between ESSI and NATO is twofold. First, NATO conceptualizes Integrated Air and Missile Defence (IAMD) as an essential and continuous mission spanning peacetime, crisis, and conflict, operationalized through NATINAMDS as a networked architecture connecting national and NATO systems. This framing entails a stringent interoperability constraint for any ESSI-related procurement: platforms and effectors are not merely purchased as standalone assets but must be capable of integrating into the Alliance’s sensor–command-and-control–effector ecosystem, including compliance with relevant data-link standards, Identification Friend or Foe (IFF) procedures, and the applicable command-and-control architecture. Second, the Alliance’s post-summit emphasis on strengthening the credibility and coverage of IAMD logically presupposes both increased magazine depth (available interceptors/munitions) and greater node density (the number and dispersion of sensors, command nodes, and launchers) within NATINAMDS. Doctrinally, this situates ESSI within the any sensor/appropriate shooter logic: the defensive system is conceived as an integrated construct in which distributed sensors, command-and-control facilities, and weapon systems are networked to enable timely cueing, engagement allocation, and coordinated interception across the battlespace.

Several key EU instruments supply the complementary legal-financial scaffolding that enables ESSI to move from concept to fieldable capacity. This can be exemplified by; The European Defence Fund (EDF) underwrites collaborative R&D and development to deliver innovative and interoperable defence technologies and equipment, giving a structured path to standardization across ESSI's sensor-effector-C2 stack (European Commission, n.d.). As a rule, EDF support is limited to eligible entities established in EU Member States (and associated countries), subject to the applicable eligibility, security, and ownership-control conditions; third-country participation is therefore structurally constrained. IMLAMD's added value lies in developing an open, modular BMC4I-oriented reference architecture that can federate sensors and effectors across layers, validate interfaces through joint testing/demonstrators, and mature integration governance for future multi-layer GBAD. In the near term, two additional instruments address bottlenecks exposed by the war in Ukraine: EDIRPA (Regulation (EU) 2023/2418) establishes a common procurement instrument, while ASAP (Regulation (EU) 2023/1525) aims to bolster and speed up EU manufacturing capacity for ammunition and missiles. Together they de-risk joint buying and expand production lines, thereby improving both readiness and sustainment. Finally, SAFE—the Security Action for Europe regulation adopted in 2025—introduces up to €150 billion in competitively priced long-maturity loans to co-finance major defence investments and joint purchases, with governance arrangements designed to favour European supply chains and reduce dependencies (Council of the European Union, 2025).

These instruments are not without constraints. Origin requirements and buy-European preferences can create friction with the speed and unit-cost advantages of certain off-the-shelf solutions. Yet, each instrument has some advantages, the legal-financial package enables a workable compromise: EDF de-risks early-stage integration and interoperability; PESCO structures multi-state commitments and technical governance; EDIRPA/ASAP provide near-term joint-procurement and production uplift; and SAFE scales capital for big-ticket acquisitions. In other words, NATO sets the operational problem (coverage, readiness, integration), and the EU provides tools to translate that problem into funded, standardized industrial outputs, while ESSI functions as the coalition programme office knitting these vectors together. This way, the problem is addressed holistically.

In this light, the politics of membership take on a functional cast. A broad ESSI coalition—UK and Nordics included—narrows the gap between Alliance-wide IAMD requirements and national acquisition cycles. At the same time, French concerns about strategic autonomy force a healthy debate on industrial policy and technological sovereignty, ensuring that short-run fixes do not hollow out the EDTIB over the long run. If interoperability and readiness are the binding operational constraints, and industrial resilience the binding strategic constraint, ESSI's success will hinge on balancing both: integrating quickly into NATINAMDS while steadily increasing European content, production capacity and stockpiles. On current evidence, that balance is attainable within the available legal architecture, provided participants hold the line on standards, financing discipline and credible timelines for delivery.

3.3. Capacity Map: Capabilities and Gaps (Country-by-Country)

The ground-based air and missile defence (GBAD) posture across ESSI member states remains heterogeneous by tier (VSHORAD/SHORAD/MRAD/LRAD). Participants are attempting to reconcile operational requirements—area coverage, magazine depth, and assured NATINAMDS interoperability—with legal-industrial constraints such as budget ceilings, joint-procurement rules, origin/compliance provisions, and export-control regimes. Within this framework, ESSI functions as a coordination mechanism to compress timelines, standardize interfaces, and pool demand for interceptors, sensors, and C2.

This section examines the current and programmed capabilities of ESSI members, detailing extant GBAD inventories, in-flight acquisition contracts, and integration approaches (C2/data-link/IFF) relevant to alliance operations. Non-ESSI European states fall outside the analytical scope.

3.3.1. Albania

Albania's ground-based air defence remains concentrated at the very-short-range layer, complemented by NATO's standing Air Policing cover over the Western Balkans. A modernization drive has focused first on the sensing layer: a long-range air-surveillance radar on Mida Mountain is integrated into NATO's air picture, and a new Ground Master 400 Alpha has been contracted to expand coverage and improve low-altitude detection. These steps, alongside the NATO-funded upgrade of Kuçova Air Base into a regional operating hub, strengthen Albania's role as a surveillance and basing node even as its interceptor inventory is limited (NATO, 2024b). Within ESSI, Tirana is positioned as a sensor-rich, shooter-light contributor whose value lies in radar pickets, air-picture fidelity, and host-nation support to allied GBAD deployments and exercises.

3.3.2. Austria

Goldhaube, Austria's air defence system that consists of mobile stations and fixed sites for radar, is functional since 1988 (Federal Ministry of Republic of Austria, n.d.). Press conference held in 2023, the government announced that from 2027, long-range air-defence missiles would be added to strengthen national air defence. Two weapon systems are under evaluation (types not specified), with main candidates believed to be Patriot (U.S.) or Arrow 3 (U.S.–Israel). Since the war's outbreak and Austria's ESSI participation, Vienna has made significant efforts to strengthen its capacity (Defence Industry Europe, 2023a).

3.3.3. Belgium

Belgium is counted among countries with relatively weak air-defence (Defence News, 2025). The inventory includes Mistral MANPADS (very short range), while—per open sources—there are no short-, medium- or long-range systems. Belgium participates in NATO's two new High Visibility Initiatives in 2025. The project aims to acquire more effective solutions to low level air threats and for passive air surveillance (NATO, 2025).

3.3.4. Bulgaria

Very short-range includes ZU-23-2, SA-7 Grail (9K32 Strela-2), SA-14 Gremlin (9K34 Strela-3), SA-16 Gimlet, SA-18 Grouse (9K38 Igla), and 9K35 Strela-10. Short range includes 2K12 Kub and 9K33 Osa; short-to-medium includes S-125; medium range includes S-300 and S-200. The technological obsolescence of these systems and uncertainties about their effectiveness under attack are debated; more importantly, their contribution to a common air-defence network remains uncertain—an obstacle to regional cooperation. However, in August 2025, Bulgaria has approved the procurement of IRIS-T missile systems which modernize its air defence systems and supports it to adjust with ESSI (Missile Defence Advocacy Alliance, 2025).

3.3.5. Czechia

Czechia's capacity is limited to Soviet-era systems: only MANPADS in very short-range and 2K12 Kub in short range. In 2021, the Ministry of Defence signed a $627 million agreement to purchase Spyder short-to-medium-range SAMs from Rafael (Israel). (Defence Industry Europe, 2025a).

3.3.6. Denmark

Terma specializes in command-and-control systems for naval platforms, enabling integration of air-defence systems and improving operational efficiency. Weibel Scientific is known for advanced radar technologies and has recently made significant progress in radars for short and very short-range air-defence (notably counter-drone applications). Denmark's technological capabilities could offer critical sensors and command solutions to NATO's broader air-defence architecture. However, its efforts to strengthen national air-defence systems are still deemed insufficient—a shortfall that complicates NATO's effective use of Esbjerg Port facilities for U.S. force movements into Europe. Despite new radar procurements and indigenous technologies, a serious gap remains particularly in short-range systems, potentially undermining NATO's operational flexibility in the region. Accelerating investments and closer allied cooperation are therefore critical (Defence News, 2025).

3.3.7. Estonia

Estonia's VSHORAD foundation has been reinforced by the Piorun MANPADS acquisition (September 2022). In June 2022, the Estonian and Latvian defence ministers also issued a letter of intent to acquire at least four SHORAD batteries, signalling a shift from isolated point defence to a programme-based lower-tier recapitalization. As part of the ESSI, Estonia announced—together with Latvia—plans to procure IRIS-T SLM systems with TRML-4D radar suites (July 2024), a package valued at over €100 million. Estonia is transitioning from VSHORAD-only to a VSHORAD+MR construct. Yet, in the interim, available systems are judged adequate for local protection of small, mobile units, not for the continuous defence of critical centres and large urban areas (Republic of Estonia Defence Forces, n.d.).

3.3.8. Finland

Finland possesses MANPADS and artillery systems for force protection, and also operates an advanced air-defence system such as NASAMS (Norwegian Advanced Surface-to-Air Missile System). Finland is in the process of purchasing David's Sling, a medium-to-long-range missile-defence system developed by Rafael Advanced Defence Systems (Israel) and Raytheon (United States). The most important development for the country has been Finland's accession to NATO in 2023, which strengthened its position in terms of defence cooperation and collective security.

NASAMS is a short- and medium-range, networked air-defence system. Radar range is 120 km, while missile range varies between 30–50 km depending on missile type. It uses AIM-120 AMRAAM missiles, which are widely present in NATO inventories, providing advantages in logistics and re-procurement. The fact that Norway operates the system and Latvia and Estonia plan to purchase it may enable integrated air-defence coordination within NATO. Finland has the widest and densest very short-range air-defence network in the region and also possesses the capacity to protect its forces.

Within PESCO, the TWISTER project, led by France since 2019, aims to enhance Europe's early-warning and interception capability against ballistic missile threats by integrating space-based early warning assets with endo-atmospheric missile defence systems. While Finland will be included in an early-warning system under this project, France's negative stance toward the European Sky Shield Initiative (ESSI), in its role as the TWISTER coordinator, currently renders a direct contribution of TWISTER to ESSI unlikely (PESCO, 2024).

3.3.9. Germany

As ESSI's founder, Germany is also Europe's largest provider of ballistic-missile defence. Long engaged in GBAD research, Germany began in 2008 to develop a land-mobile, laser-based missile-defence system using concentrated infrared laser beams to track, identify, and destroy missiles. Post-2014, NATO's renewed focus on collective defence and Russia's actions increased demand for short- and medium-range SAMs. From 2014 to 2022, Germany accelerated efforts to meet NDPP commitments, restructuring the Bundeswehr for conventional conflict and improving air-defence capabilities.

Germany fields ASRAD and Stinger for very short range and pursues the LVS NNbS programme (led by Rheinmetall, Diehl Defence, Hensoldt) against loitering munitions and cruise missiles (Defence News, 2021). Bases are protected by MANTIS; mobile force protection employs Wiesel 2 with Stinger and a LeFlaSys Ozelot battery. Germany also operates Skyshield 35 (short/medium) and Patriot (medium/long). Notably, more than 12 Patriot batteries are deployed nationwide, and modernization is ongoing.

Germany, the U.S., and Italy launched MEADS in 2005 (MBDA Deutschland, Lockheed Martin, MBDA Italia) to replace Patriot with a PAC-3-based, versatile system; to reduce costs, IRIS-T SL integration was pursued. The U.S. withdrew in 2011, though work continued to a

2014 prototype. In 2022, Germany sought U.S. approval to procure THAAD; the U.S. approved related items in August 2022. However, reporting indicates Berlin opted for Arrow 3; approvals followed, and in August 2023 Israel announced a $3.5 billion Arrow 3 sale to Germany. On 28 September 2023, Ministers Yoav Gallant and Boris Pistorius signed a Letter of Intent in Berlin; the Bundestag had approved £560 million in June 2023 toward the programme (total expected ~$3.5 billion).

3.3.10. Greece

Greece possesses considerable air-defence system capacity. The foundation was laid in 1964, when Greece and several NATO states signed a Multilateral Agreement on the use and operation of the NATO Missile Firing Installation (NAMFI) on Crete. The inventory includes FIM-92 Stinger, Tor-M1, Rheinmetall Twin AA Gun MK-20, Crotale NG, VELOS, Artemis 30, Phalanx CIWS, and 9K33 for short-range; for medium range, ESSM; additionally, S-300 and Patriot PAC-2 (GEM-T) systems. Under the General Staff's administrative control, NAMFI conducts live-fire exercises with platforms operated by Germany, Greece, and the Netherlands under realistic scenarios (NAMFI, n.d.). This combination of inventory and exercise capability makes Greece a significant air-defence power in the region.

3.3.11. Hungary

Hungary's air-defence capacity is quite limited: only a small number of MANPADS provide very short-range coverage; the absence of artillery and very short-range systems creates a serious vulnerability against UAS threats. In 2023, Hungary ordered the Skyranger 30-gun system for very short-range and UAS threats. For short range, Hungary fields 2K12 Kub. In 2023, Hungary received the first two NASAMS batteries from a 2020 contract, thereby acquiring short-to-medium-range capability; nevertheless, substantial steps remain to establish a multi-layered network (Defence Industry Europe, 2023b). Mentioned delivery also makes Hungary the 6th NATO country to procure NASAMS (Missile Defence Advocacy Alliance, n.d.).

3.3.12. Latvia

Latvia supplemented its VSHORAD posture with RBS-70NG (November 2022). Parallel to Estonia, Riga signed a letter of intent for ≥4 SHORAD batteries, anchoring a joint lower-tier pathway in 2022. In November 2023, Latvia contracted IRIS-T SLM for approximately €600 million, with deliveries expected from 2026; the manufacturer Diehl described this as the largest defence investment in Latvia's more than 30 years of independence. (Defence News, 2023). This MR procurement is embedded in a September 2023 EE–LV–Diehl framework, ensuring contractual coherence and economies of scale. In July 2024, Latvia joined Estonia in announcing TRML-4D-equipped IRIS-T SLM buys under ESSI, valued at >€100 million.

3.3.13. Lithuania

Lithuania initiated MR coverage earlier than its neighbours by procuring NASAMS-3 (2017), with two batteries delivered by 2020—a material uplift over the pre-2017 SHORAD-limited baseline. Even with this head start, the regional analysis groups Lithuania with Estonia and Latvia in facing resource-driven limits on full layering, sustained magazine depth, and contiguous coverage. Lithuania's NASAMS gives it a first-mover MR advantage (Lithuanian Armed Forces, 2020*)*.

3.3.14. Netherlands

The Netherlands fields systems across all ranges: Stinger MANPADS (very short range), NASAMS (short-to-medium), and Patriot (medium-to-long). It also operates advanced detection systems, including TRML mobile radars capable of tracking low-altitude threats. This diverse inventory supports both national and NATO collective defence missions, making the Netherlands an important member under ESSI; however, given its geographical position, the contribution of these systems against the Russia threat is debated among member states. Alongside existing systems, the Netherlands continues capacity increases, modernization, and renewal, partly due to donations (e.g., 200 Stinger MANPADS in 2022). In June 2023, the MoD announced plans to replace existing short- and medium-range systems with a single modern system (from Kongsberg/Raytheon), expected to be operational from 2026. Conforming to that, by December 2025, Rheinmetall announced that the Netherlands ordered Skyranger 30 valued more than 500 million EUR (Rheinmetall, 2025).

3.3.15. Norway

Norway has no very short-range air-defence systems at present. Norway had previously possessed Stinger, whose service life has expired. RBS-70 systems also existed but were sold to Lithuania. In 2022, the Norwegian Defence Materiel Agency (NDMA) signed a contract worth approximately $35 million with Mesko (Poland) to purchase Piorun MANPADS; the first shipment arrived in 2023. This purchase added this category to Norway's inventory for the first time and strengthened its capability against very-low-altitude air threats.

NASAMS (three batteries) is deployed to protect the Ørland and Evenes main air bases; one additional battery protects the single brigade in the north. Launchers are to be upgraded to new, more mobile versions by 2026–2027. Norway sent NASAMS systems to Ukraine in March 2023, December 2023, and early 2024, some directly from its own inventory and some procured. To replace donated systems, Norway placed an order worth 2.7 billion NOK (European Defence Review, 2024). Consequently, the exact number of NASAMS in Norway is not precisely known at present.

3.3.16. Poland

Poland fields a multilayer architecture spanning man-portable and gun-based very-short-range systems, short-range missile batteries under the Narew programme, and medium-to-long-range interceptors under Wisła—networked through the Integrated Battle Command System (IBCS). Recent milestones include an operational IBCS demonstration and live-fire events that validated integration between short-range Narew elements and Patriot batteries (US Army, 2025); parallel contracts add surveillance depth (passive-location and long-range radars) and accelerate deliveries of CAMM-family effectors and Pilica+ fire units.

3.3.17. Portugal

Portugal is rebuilding its ground-based air defence from the base layer upward. Legacy short-range systems have been retired and replaced by a modern, vehicle-mounted very-short-range solution (ForceShield/RapidRanger) using fast-reaction interceptors for point defence of forces and critical infrastructure. Lisbon has also signalled intent—via participation in ESSI—to bridge the medium-range gap through common procurement, while continuing to contribute fighter detachments to NATO Air Policing as an interim air-sovereignty measure (Defence Industry Europe, 2024).

3.3.18. Romania

Romania fields various systems across ranges, many old or approaching end-of-life. Very short-range includes M 1980/77, Oerlikon GDF-003 mobile guns, Gepard, and 9K31 Strela-1 / 9K32 Strela-2 MANPADS. Low-altitude/short-range includes the 9K33 Osa. Additional systems include 2K12 Kub (Soviet medium), MIM-23 Hawk (short range, SHORAD), and S-75 (Soviet medium). To support its existing Patriot batteries, Romania plans to procure 200 PAC-2 GEM-T missiles—reported to Parliament in December 2023—under a joint programme with Germany, the Netherlands, and Spain totalling 1,000 Patriot missiles; Patriot has also been recently delivered to Romania (Reuters, 2025).

Romania’s strategic weight within NATO’s missile defence architecture is primarily anchored by the Aegis Ashore facility at Deveselu. As a foundational element of the European Phased Adaptive Approach (EPAA) since its activation in 2016, this land-based configuration utilizes the SPY-1 radar and SM-3 interceptors to neutralize short and intermediate-range ballistic threats.

3.3.19. Slovakia

Slovakia’s inventory is limited: MANPADS for very short range (service-life expired) and 2K12 for short range (technologically very old). The Defence Minister Robert Kaliňák stated that Patriot purchases from the United States were under consideration to strengthen air-defence capabilities, but he emphasized the plan is long-term, making a short-term order unlikely. At the end of August 2024, Slovakia decided to purchase six units of the Barak MX multi-layer system from IAI (Israel) for approximately €554 million; if negotiations conclude successfully, first delivery is expected by end-2025 (Defence News, 2024a). These developments demonstrate modernization efforts, though significant steps remain to build a comprehensive and effective network.

3.3.20. Slovenia

Slovenia's capacity is limited: in very short-range, only SA-24 9K338 Igla-S MANPADS; otherwise no very short or short-range systems. In the medium-range category—and gaining importance under ESSI—Slovenia signed a contract on 25 January 2024 with Diehl (Germany) to procure the IRIS-T SLM. The order includes one firing unit comprising a radar, a tactical operations centre, and four launchers, as well as IRIS-T SLM missiles and logistics support. Further purchases are expected to increase capacity (Air Force Technology, 2025). The decision to procure IRIS-T SLM not only strengthens national capability but also reflects growing interest in Germany's proposed IRIS-T GBAD solutions for ESSI, reinforcing Slovenia's participation in regional cooperation.

3.3.21. Sweden

Sweden possesses MANPADS and very short-range artillery for border defence, yet the numbers are insufficient; a phased withdrawal of MANPADS is also under consideration. Short- and medium-range systems include RBS-98 and RBS-23. In 2018, Sweden ordered four Patriot batteries from the United States in PAC-3+ configuration. In March 2021, the Swedish Armed Forces re-introduced Launcher Unit 23, developed in the 1990s and completed in the early 2000s, a modified version of Air-Defence System 15, now deployed on Gotland. In November 2021, Sweden received Patriot PAC-3, adding two missile types, three different launchers, a command centre, and integrated reconnaissance and fire-control radars. Sweden also fields I-HAWK (Rb 67) as legacy short-range (SHORAD) system, consistent with NATO range taxonomy.

Under LvS103, Patriot uses the PAC-3 MSE modification, capable against long-range missile and air attacks. In December 2021, first operational capability was declared. The State also settled to purchase 7 medium-ranged IRIS-T SLM air defence system in 2025 June (Defence Industry Europe, 2025b). Among regional countries, Sweden is the only state with a multi-layered air-defence architecture across very short, short, and medium ranges; however, the limited number of systems complicates decision-making on assigning protection tasks to specific critical infrastructure or units.

3.3.22. Switzerland

Switzerland's air-defence history began in the 1960s with the BL-64 Bloodhound missile and has evolved through Rapier, FIM-92 Stinger, Oerlikon GDF towed guns, Oerlikon 35 mm, and the Oerlikon Skyguard fire-control system (guiding Sparrow/Aspide). Launched in 2017, the Air 2030 programme aims to restructure and modernize the Air Force's long-term capabilities, including renewal of air-defence systems and fighter aircraft (International Trade Administration, 2022). The New Ground-Based Air Defence System seeks to replace ageing systems with more effective capabilities for the coming decades.

3.3.23. United Kingdom

The Ministry of Defence identifies Ground-Based Air Defences (GBAD) as a priority in its report Combat Air Strategy: An Ambitious Vision for the Future. Initiatives include the establishment in 2003 of the UK Missile Defence Centre, a government-industry partnership under the MoD's Defence Science and Technology programme; participating firms include BAE Systems, L3Harris ASA, Lockheed Martin U.K., MBDA, QinetiQ, Fluid Gravity Engineering, and Airbus Defence and Space U.K. Work spans six main areas: Scenario Assessment and Wargaming, Sensors and Architecture, Threat Characterization, Threat Mitigation and Lethality, Maritime Missile Defence, and Innovative Technology.

The United Kingdom fields Stormer HVM, Starstreak, and Rapier FSC for very short and short ranges, as well as Enhanced Modular Air Defence Solutions (EMADS) designed with modular architectures. Recently, CAMM and CAMM-ER (MBDA/Thales) entered service, offering flexible land/sea deployment. At medium range, Sky Sabre protects naval systems and fleets. The Type 45 has wide-area capability with Sea Viper, Sampson multi-function radar, and Phalanx as last-ditch defence; other sea-based systems include Phalanx and Sea Wolf. The MoD's Combat Air Strategy and the UK Missile Defence Centre underpin continuing development (Mills, 2025). In early 2022, the United Kingdom officially decommissioned the Rapier system, concluding its nearly fifty-year service life.

3.3.24. Türkiye

Türkiye's air and missile defence has evolved, in the post–Cold War era, from a point-defence–heavy structure to a network-centric, multi-layered architecture. This change could also be seen in the product range of Turkish defence companies. As Turkish defence industry grows, these companies make more appearance in the international arena. Year after year, an increasing number of Turkish companies have been included in the SIPRI Top 100 Defence Companies List, as shown in Table 1. From an industrial perspective, Türkiye's defence-industrial base—both in scale and portfolio breadth, as reflected in SIPRI and Defence News rankings—signals credible capacity for output expansion, sustainment and lifecycle support, and consortium-driven cooperation, albeit within the compliance and eligibility constraints embedded in EU defence-funding instruments (SIPRI, 2025; Defence News, n.d.).

Table 1. The SIPRI top 100 arms producing and military services companies in Türkiye, 2024 (SIPRI, 2025).

Company	Rank 2024	Rank 2023	Arms Revenues 2024	Arms Revenues 2023	Change in Arms Revenues (%)	Total Revenues 2024	Arms Revenues %
Aselsan	47	52	3470	2440	42,21%	3660	94,81%
TAI	65	75	2160	1700	27,06%	2700	80,00%
Baykar	73	66	1900	1900	0,00%	2000	95,00%
Roketsan	87	92	1390	1080	28,70%	1390	100,00%
MKE	93	102	1210	900	34,44%	1210	100,00%

In parallel, Turkish defence firms have also strengthened their presence in the Defence News Top 100 List, as presented in Table 2.

Table 2. Defence news top100 defence company in Türkiye (Defence News, n.d.).

Company	Rank 2024	Rank 2023	Total revenue for 2024 (in USD)	Total defence revenue for 2024 (in USD)	Total revenue for 2023 (in USD)	Total defence revenue for 2023 (in USD)
Aselsan	43	42	$3,657,785,000	$3,541,261,567	$3,089,403,352	$2,896,191,483
TAI	47	50	$3,287,106,189	$3,151,029,596	$2,673,762,230	$2,205,738,874
Roketsan	71	71	$1,545,052,590	$1,545,052,590	$1,758,496,410	$1,758,496,410
ASFAT	78	94	$1,281,010,000	$1,276,176,000	$637,035,587	$637,035,587
MKE	80	84	$1,209,280,000	$1,209,280,000	$878,349,000	$878,349,000

This evolution rests on configuring the low altitude (VSHORAD/SHORAD), medium altitude (MRAD), and high altitude/long-range (LRAD/BMD) layers to complement one another; and on progressively strengthening the sensor–C2–data link backbone that binds the layers together with increasingly indigenous components. NATO doctrine describes this approach, within NATINAMDS, as a network of interconnected national and NATO systems, and defines the architecture as the integration of sensors, command and control facilities and weapon systems. Türkiye's current approach is to develop a dual-configuration capability for both national and alliance missions—combining indigenous density at the lower layer, network-architecture maturity at the medium layer, and an autonomous, effective system at the upper layer (Düz & Koçakoğlu, 2025).

3.3.24.1. Low Altitude Systems

A modern lower-tier baseline was established through the Stinger European Co-production Programme. This programme generated both industrial gains and operational capability. The requirement for mobile point defence then crystallized in the pedestal-mounted Stinger concept: tracked and fixed/mobile configurations entered serial production by 2001.

A kind of MANPADS system, SUNGUR programme was launched in 2013 to replace ageing Stinger stocks and meet high-tempo operations at low altitude; entering the inventory in 2022, the system offers superiority over Stinger in altitude/range/guidance parameters and provides flexible integration on land–air–naval platforms. At the low layer, the guided-artillery effect is provided by KORKUT.

In the VSHORAD/SHORAD layer, through the ASELSAN–ROKETSAN production chain and NSPA/NATO integration experience, Türkiye has increased indigenous density; the SUNGUR–Stinger-KÜSS-KORKUT provides a low-cost, high-tempo fire density against UAV/low-observable profiles and saturation attacks, functioning as a buffer that preserves the munitions of upper layers. The lower tier of this layered architecture is supported by the Rapier system, which engages low-altitude threats using Mach 2.5 guided missiles within a defined 8 km range and 5 km altitude ceiling.

3.3.24.2. Medium Altitude Systems

The HİSAR Project constitutes Türkiye's low- and medium-altitude backbone. HİSAR-A - is oriented to armoured–mechanized unit protection in low altitudes and HİSAR-O to strategic site/area defence in medium altitudes. HİSAR-A+ components had been delivered by July 2021, and HİSAR-O+ was fully delivered in 2022. The HİSAR layer absorbs the saturation load of the lower layer, giving the upper layer breathing room in terms of munition–tempo; it also enables expansion of the Defended Asset List (DAL). At the medium-altitude layer, the Turkish inventory is supported by the MIM-23 Hawk system, which has been operational since 2005. While the platform offers a theoretical maximum range of 50 km, its tactically effective engagement radius is established at 20 km.

3.3.24.3. High Altitude Systems

Long-range requirements have increasingly been met indigenously. SAMP/T talks continued intermittently after 2016 but infers that the requirement would be covered domestically in the near term via a phased SİPER programme. SİPER is a product of strategic partnership between ASELSAN–ROKETSAN–TÜBİTAK SAGE. In October 2024, it was officially announced that SİPER Block-1 entered the inventory, and July 2025 updates reported successful serial-production acceptance tests for Ürün-1, indicating transition toward early fielding at scale.

Naval variants and maritime IAMD: In addition to the land-based HİSAR and SİPER families, the national roadmap includes shipborne configurations (commonly referred to in open sources as HİSAR-D and SİPER-D) intended to provide layered air defence for naval task groups and critical maritime approaches. Although these variants are in advanced testing and acceptance phases rather than full fleet-wide service, their inclusion is analytically relevant because ESSI/NATINAMDS interoperability depends on consistent sensor-to-shooter networking across domains. In the manuscript, these naval variants are therefore treated as forthcoming capabilities, with a brief discussion of expected engagement roles and their contribution to cooperative engagement concepts at sea, including interface considerations with naval combat-management systems and NATO-standard data links/IFF.

Beyond these conventional assets, the most significant yet controversial component of Türkiye's long-range capabilities is the Russian-made S-400 Triumf system. Due to technical interoperability constraints with NATO's integrated air defence architecture the S-400 remains largely in a state of limited operational readiness rather than being fully active within the national network.

3.3.24.4. The Integration Structure and Steel Dome

Steel Dome as an integration umbrella to protect bases and critical infrastructure against the full threat set (including rocket/artillery/mortar, cruise missiles, and UAVs). The concept is evolutionary and vendor-agnostic, envisaging the progressive absorption of national radar, counter-UAS, and effector families (from very-short to long range) under a common C2 and data-link architecture. Politically and institutionally, late-2024/2025 announcements elevated

Steel Dome as a core line of effort; in 2025, public events highlighted delivery packages and scale, while parallel industrial capacity investments were announced to more than double throughput for command-and-control and air-defence lines—measures directly relevant to serialization, stock depth and sustainment. To operationalize this integration logic, Table 3 consolidates Türkiye's layered GBAD/IAMD capability map, some example products and highlights ESSI-relevant interface implications (sensors, C2, datalinks/IFF, and interceptor families), providing the bridge between the capability description and the cooperation argument developed in the subsequent sections.

Table 3. Türkiye's layered GBAD/IAMD capability map and ESSI-relevant interfaces.

Layer (Range Tier)	Representative National Systems (Examples)	ESSI/NATINAMDS Interface Implications
VSHORAD/ SHORAD	SUNGUR; Stinger co-production legacy; KORKUT (gun-based)	High-tempo, low-cost layer for UAS/low-altitude threats; requires cueing from shared air picture and deconfliction with higher-tier engagements
MRAD	HİSAR-A/HİSAR-O family (including A+ / O+ variants)	Area/point defence for critical sites and manoeuvre forces; integration hinges on data-link interoperability, IFF, and engagement-management alignment
LRAD / Upper Tier	SİPER Block-1 (growth blocks projected); associated radars/C2	Upper-layer contribution and magazine-depth potential; interfaces must be standards-compliant to plug into NATINAMDS engagement coordination
Maritime Layer (Forthcoming)	Navalised variants of HİSAR and SİPER ("HİSAR-D / SİPER-D" in open sources); ESSM on naval platforms	Extends layered defence to maritime approaches; requires naval C2-to-NATINAMDS data exchange, common IFF, and cooperative engagement deconfliction

3.3.25. Political–Economical -Conjuncture and Türkiye's Critical Role

3.3.25.1. Joint Procurement, Consortia, and Standardization Pressure

Rapid thickening of Europe's layered air and missile defence depends on the functionality of joint-procurement and consortium-based acquisition architectures. These architectures are designed not only to reduce unit costs, but also to create congruent solutions in logistics/sustainment and training–TTPs (tactics, techniques and procedures) (Reuters, 2024; armasuisse, 2025). NATO defines NATO Integrated Air and Missile Defence (IAMD) as implemented through NATINAMDS, a network of interconnected national and NATO systems comprised of sensors, command and control assets, and weapons systems; a key prerequisite for such integration is interoperability (procedural, technical and human), which in practice drives common interfaces and standardization pressure.

In the ESSI context, cooperative procurement frameworks and follow-on procurements (IRIS-T SLM; Patriot) operationalize these goals by privileging standard configurations and bundling sustainment/training elements alongside integration needs (Armasuisse, 2025; Bundesministerium der Verteidigung, 2024). The letter of intent signed in 2022 made this impetus explicit, and participation expanded in subsequent accession waves. In field implementation, prime–subcontractor consortia are expected to span project management, joint engineering, integration, and certification; within such a framework, Türkiye's ongoing layered GBAD programs (HİSAR/SİPER) and their emphasis on command-control compatibility, IFF, recognized air picture generation, and data-link-enabled interoperability are relevant to the technical connectability of very short–short–medium–long-range layers (Roketsan, n.d.; ASELSAN, n.d.-a; ASELSAN, 2021).

3.3.25.2. Financial Instruments: EDF, PESCO, ASAP, and SAFE

The European Defence Fund (EDF) aims to increase the competitiveness of the industrial base and the production of interoperable defence technologies within the Union by funding collaborative defence research and development and capability development projects. PESCO projects (IMLAMD/TWISTER) invest in the BMC4I/C2 pillar of IAMD and a multi-layered approach to counter new threats including hypersonic. Together with CARD and the EDF, PESCO constitutes one of the three mutually reinforcing pillars of EU defence cooperation, providing binding commitments and governance for collaborative capability projects (including PESCO projects such as IMLAMD).

ASAP (Act in Support of Ammunition Production), which entered into force in 2023, sought to accelerate capacity expansion to remove bottleneck effects in the ammunition/missile chain; Commission documents note the programme's focus on propellants, explosives, casings, and test lines and indicate ≥€500 million in EU budget with scaling to ≥€1.5 billion total volume. SAFE (Security Action for Europe), adopted by the Council in 2025, is a new funding arm focused on joint procurement; according to the Council communication, €150 billion of leverage is envisaged for joint procurement, and the regulation stipulates that SAFE provides financial support to Member States for urgent and major public investments.

Although Türkiye is not an EU Member State and therefore lacks direct access to EU defence-financing instruments such as EDF grants and SAFE loan facilities, limited indirect pathways may nevertheless emerge through consortium-based cooperation—most plausibly via technology partnerships, joint R&D, and engineering work structured around EU-based prime contractors and supply chains. Under the current SAFE architecture, while only Member States may benefit from SAFE loans, common procurement participation may extend to EU acceding states, candidate states, and potential candidate states; however, this participation does not, by itself, translate into eligibility for the underlying funding. In parallel, access to EDF support is conditioned on strict eligibility and establishment requirements: EDF-funded actions generally require a consortium (typically at least three eligible Member States and/or associated countries), and both beneficiaries and subcontractors must be established within the EU and have their executive management structure located there, which materially constrains Türkiye's ability to receive EDF/SAFE resources directly and effectively channels cooperation—if any—into EU-established entities and compliant consortium structures.

3.3.25.3. The Strategic Autonomy–U.S. Dependence Tension

Europe's defence ecosystem is shaped by a structural tension between strategic autonomy objectives and persistent dependence on U.S.-sourced systems and sustainment. In the early ESSI framing, the prominence of a Patriot–IRIS-T SLM–Arrow-3 procurement logic (short/medium/upper layer) fuelled perceptions in some capitals that the Franco–Italian MAMBA/SAMP-T line and other European-first solutions were being side-lined, thereby deepening political contestation over industrial sovereignty and long-term supply-chain dependence (Gotkowska & Maślanka, 2023; Bundesministerium der Verteidigung, 2023). This dossier has consequently been debated in European public discourse through "France's distance to Sky Shield" and intra-European priority differences, with Paris repeatedly highlighting the strategic risk of path-dependence on non-European technologies (France 24, 2023; Gotkowska & Maślanka, 2023).

Institutionally, the EU's response has been to expand intra-European production capacity and to incentivize standardization effects through joint procurement and collaborative capability programmes. In this direction, the ReArm Europe Plan/Readiness 2030 is presented as a financial-leverage architecture designed to mobilize up to approximately €800 billion for defence-related investments, while SAFE is structured as a €150 billion loan instrument that privileges common procurement to generate economies of scale and interoperability and to reduce fragmentation. Complementarily, the European Defence Fund (EDF) is framed as the EU's budgetary instrument for collaborative R&D and interoperable capability development, and PESCO provides the treaty-based project framework for participating Member States to jointly plan and invest in capability projects—together constituting a policy bundle that operationalises the autonomy–dependence debate into industrial and procurement governance.

3.3.25.4. Türkiye's Critical Role: Contributions and Constraints

The sustainable success of ESSI rests on three pillars: integration (common C2/IFF/data links; standardized configurations), financial sustainability (ASAP/SAFE/EDF levers), and political cohesion (inter-member priority synchronization). Under these conditions, ESSI can become not only a technical shield but also a symbol of European deterrence and unity.

Situated on the Black Sea–Caucasus–Levant axis, Türkiye, as a frontline state, adds eastern and southern early-warning depth to the common ESSI/NATINAMDS picture; the geostrategic projection contributes to layered protection of high-value targets (energy, ports, air bases, logistics nodes). This contribution can occasionally be bounded by factors such as political frictions, export controls, and mission-configuration separation; yet negotiation capacity and flexible interfaces render these bounds manageable.

The HİSAR-A/O and SİPER lines, with design principles that prioritize inter-layer connectivity via C2/IFF/data links, serve the goals of multi-layer protection and area defence. The HİSAR-A/O and SİPER lines, with design principles that prioritize inter-layer connectivity via C2/IFF/data links, serve the goals of multi-layered defence and regional area defence. This line bears technical contribution potential to ESSI's upper-tier requirements through (i) scalable interceptor production, (ii) standardized C2/data-link/IFF interface packages, and (iii) joint test–evaluation and certification pipelines. SİPER Block-1 has a confirmed range of 100+ km; with growth blocks, the roadmap extends to 180 km scale. Steel Dome is foregrounded as an integration move that brings radar–C2–effector clusters together under a vendor-agnostic logic. This line bears technical contribution potential to the upper-layer requirements within ESSI—new production, new interfaces, and joint test–certification.

NATINAMDS doctrine elevates common tactical picture and common engagement management to the level of a legal–technical requisite. (a network of interconnected national and NATO systems; sensors, command and control facilities and weapon systems.) In this context, as repeatedly underlined by NATO leadership, the S-400's non-integration into NATINAMDS has produced a dual-configuration model for national vs alliance missions in Türkiye; it has increased the priority of indigenous solutions (HİSAR/SİPER) and the Steel Dome integration. ESSI's technical effectiveness depends on the extent to which systems of different provenance can be brought to full-compliance with the alliance network.

4. Discussion

This study confirms the literature's core proposition that layered air and missile defence yields deterrence value only when sensors, command-and-control, data links, and effectors are designed and employed as an integrated operational fabric, rather than as parallel national inventories (Düz & Koçakoğlu, 2025). In this frame, ESSI is best understood as a capability accelerator that translates NATO's operational requirements into EU-enabled procurement and industrial scaling: NATINAMDS provides the doctrinal backbone (procedures, engagement authorities, and the common tactical picture), while ESSI compresses acquisition timelines and standardizes interfaces across national force-development lines (AIRCOM, 2023). The strategic autonomy–U.S. dependence debate embedded in ESSI membership politics is therefore more accurately treated as a sequencing problem—closing urgent gaps with interoperable off-the-shelf solutions while building European industrial depth over the medium term through coordinated investment (Düz & Koçakoğlu, 2025).

Against this backdrop, Türkiye's role is coherent. Geostrategically, its position on NATO's south-eastern flank expands early-warning reach and helps secure key corridors linking the Black Sea, the Straits, and the Eastern Mediterranean, strengthening NATO's distributed sensor and C2 architecture (NATO, 2024a). Capability-wise, Türkiye's layered GBAD trajectory—dense lower tiers, a maturing MRAD backbone, and SİPER at the upper layer—aligns with NATO's network-centric IAMD logic, especially when paired with the Steel Dome concept's platform-agnostic, C2-first integration approach (ASELSAN, 2021; Düz & Koçakoğlu, 2025).

Europe's integrated air and missile defence (IAMD) debate has matured from a question of which systems to a more demanding question of how systems cohere and endure as a federation over time. Recent analyses converge on three structural bottlenecks: (i) fragmentation risks rooted in heterogeneous acquisitions and political contestation, (ii) the strategic autonomy–dependence tension created by reliance on non-European interceptors and sustainment chains, and (iii) a persistent gap between declared ambition and deployable, sustainable volume (Monaghan & Christianson, 2023; Wachs, 2023; International Institute for Strategic Studies [IISS], 2025). Building on this baseline, the present study assesses the European Sky Shield Initiative (ESSI) as a capability-acceleration and standardization pathway for Europe's ground-based air and missile defence, and evaluates Türkiye's potential role within an integrated, NATO-aligned air and missile defence ecosystem.

A key contribution of the article is methodological and implementation-oriented: it couples an ESSI participation–capability overview with a Türkiye-focused layered map and interface analysis, thereby translating policy-level debate into concrete integration variables. While the literature appropriately foregrounds strategic and governance dilemmas, the argument here is that integration is ultimately decided at the interface level—specifically, where sensor–command-and-control (C2) coupling, data-link/IFF harmonization, and certification–testing pathways convert procurement into interoperable readiness (Monaghan & Christianson, 2023; IISS, 2025). In this sense, the study does not merely restate the fragmentation/autonomy/volume triad; it specifies where standardization pressure becomes binding and how it can be operationalized through measurable work packages.

From an operational standpoint, the discussion aligns with NATO IAMD logic that stresses fused situational awareness, track quality, and engagement coordination as core determinants of effectiveness. Accordingly, ESSI's added value is better measured not only by "what was bought" but by what was integrated, exercised, and sustained—a distinction that is increasingly salient under contemporary saturation conditions dominated by mixed salvos of missiles, drones, and electronic warfare (Wachs, 2023). The Ukraine war has reinforced this operational logic by demonstrating that deterrence by denial is not achieved through gradual, piecemeal modernization. Credible protection requires a layered-in-depth design from the outset, where lower-tier (VSHORAD/SHORAD/MRAD) and upper-tier (LRAD/BMD) elements are conceived as a single fabric—sensors, C2, data links, identification, and engagement coordination—rather than as separately optimized procurements. Interoperability is therefore a hard requirement, not a preference: capabilities that cannot connect to the NATO backbone on day one tend to generate friction, duplication, and blind spots that are costly to rectify under crisis pressure (IISS, 2025; Muravska, 2023).

A second operational principle follows directly: sustainment is strategy. Stockpiles, industrial surge capacity, maintenance pipelines, trained crews, and validated C2 federation before crisis onset are decisive variables in long-duration, high-tempo scenarios. This emphasis is consistent with strategic assessments warning that without predictable serial production, sustainment planning, and work-share arrangements, layered GBAD remains vulnerable to single-point supply constraints and political gating of support chains (IISS, 2025). The policy instruments referenced in the manuscript—SAFE/EDF/PESCO—support the claim that Europe is simultaneously seeking to accelerate procurement and thicken industrial capacity; however, these instruments only translate into operational credibility when anchored to interoperability interfaces and testing regimes that keep national systems mutually usable across capitals (Muravska, 2023). Joint procurement, shared spares, and common certification are not administrative conveniences; they are mechanisms of endurance.

Within this frame, ESSI is best understood as a cooperation instrument that translates shared threat perception into shared procurement and common interfaces. It complements NATO's integrated architecture by accelerating fielding and standardization, while NATO provides the doctrinal and technical anchor—common procedures, a shared tactical picture, and the legal–technical discipline required for sustained mutual usability across national inventories (Muravska, 2023). Where politics pulls in different directions—most notably in the autonomy–dependence debate—sequencing becomes a practical governance solution: close urgent gaps with available options now, while scaling European industrial depth over the medium term, rather than deferring operational readiness in pursuit of an ideal end-state that remains contested (Monaghan & Christianson, 2023; IISS, 2025).

Türkiye's potential contribution to this ecosystem emerges at the intersection of geographic exposure, alliance embeddedness, and an increasingly diversified sensor–effector portfolio. While ESSI is primarily an EU/European initiative, its operational logic is NATO-facing; therefore, Türkiye's role is more accurately conceptualized not as a political add-on but as a potential integration and industrial partner in the broader NATINAMDS-compatible ecosystem—provided that interface governance and standardization requirements are explicitly embedded in cooperative frameworks (Düz & Koçakoğlu, 2025). Here, the study's interface-centred approach matters: Table 3 functions as the paper's "translation device" between policy-level discussion and implementable integration variables. By mapping Türkiye's layered GBAD/IAMD capabilities and indicating ESSI-relevant interfaces (radars and sensors, C2 nodes, datalinks/IFF, and interceptor families), Table 3 makes explicit where interoperability work packages, joint testing, and certification pathways would be required. This linkage is designed to answer the editorial concern regarding the manuscript's original contribution: the novelty lies in specifying the integration agenda in operationalizable terms rather than treating cooperation as an abstract political aspiration.

Substantively, Türkiye's role can be articulated along three measurable axes. First, along the capability and sustainment axis, a layered posture spanning lower, medium, and upper tiers can be scaled in production and sustained through mature subcomponents and industrial processes that underpin magazine depth and repairability under high-tempo conditions (IISS, 2025; Düz & Koçakoğlu, 2025). Second, along the integration axis, sensor–C2–data-link fusion designed for immediate interoperability with Alliance architectures can support a coherent common operating picture, reliable cross-border identification and handoff, and institutionalized testing/certification/training pipelines; when paired with joint stockpiles and harmonized maintenance regimes, this reduces friction costs and shortens time-to-effect (Monaghan & Christianson, 2023; Muravska, 2023). Third, along the geographic axis, Türkiye's position at the junction of the Black Sea, the Straits, the Eastern Mediterranean, and the Levant can extend early-warning depth, protect critical corridors, and provide flexible C2 relay paths on the Alliance's south eastern flank—features that harden the wider theatre against saturated missile and uncrewed-system campaigns and associated electronic-warfare pressures (Wachs, 2023; Düz & Koçakoğlu, 2025).

These conclusions should be read in light of limitations typical of open-source policy-technical assessments. Public data on exact interceptor performance, integration maturity, and classified C2 architectures is partial; accordingly, the findings prioritize structural constraints, interface logic, and bounded inferences over definitive performance claims. Nevertheless, the evidence supports a clear strategic inference: ESSI's utility will be decided less by the elegance of its architecture than by disciplined integration and repeatable operationalization—common interfaces, joint testing, and sustained readiness (IISS, 2025; Monaghan & Christianson, 2023). Within these parameters, Türkiye can function not only as a geographic node but as an industrial and integration partner, provided cooperation is structured around standards compliance, shared work packages, and measurable interoperability outputs (Muravska, 2023; Düz & Koçakoğlu, 2025).

5. Conclusion

This study finds that the effectiveness of Europe's air and missile defence rests on the ability to integrate national systems into a coherent operational structure. The ESSI contributes by accelerating procurement and promoting common technical standards, while NATO's NATINAMDS framework provides shared doctrine, command-and-control, and a common operational picture. Persistent challenges such as fragmentation, reliance on non-European systems, and insufficient sustainable capacity cannot be addressed through platform selection alone. Instead, operational credibility depends on interface-level integration, including sensor fusion, command-and-control coordination, data-link compatibility, and structured testing. In this sense, ESSI's value is determined by sustained interoperability and readiness rather than procurement outcomes.

Within this NATO-oriented framework, Türkiye emerges as a complementary actor with tangible operational relevance. Its position on the Alliance's south-eastern flank and its layered air defence development support early warning, regional coverage, and command-and-control continuity. The analysis indicates that Türkiye's contribution is strongest when cooperation is organized around shared standards, joint testing, and interoperable command-and-control arrangements. Despite the limits of open-source data, the findings support a clear conclusion: ESSI's long-term effectiveness depends on disciplined integration, industrial sustainment, and repeatable operational practices. Under these conditions, Türkiye can function as a credible geographic and integration partner in Europe's evolving air and missile defence architecture.

Future research should extend the present interface-focused approach in three complementary directions. First, quantitative force-planning and campaign-sustainment modelling should be developed for layered GBAD under mass-attack conditions. Such modelling would estimate required interceptor consumption rates, resupply timelines, repair cycles, and the sensitivity of readiness to industrial surge capacity, thereby allowing ESSI-related procurement decisions to be tested against endurance requirements rather than nominal inventories (IISS, 2025; Monaghan & Christianson, 2023).

Second, interoperability outcomes should be examined empirically through exercises, test campaigns, and certification pathways. This line of work would focus on measurable integration indicators—track fusion performance, identification robustness, cross-border engagement handoff, and latency/resilience of C2 and data-link architectures—making it possible to evaluate whether procured capability has translated into usable capability at NATO-network standards (Muravska, 2023; IISS, 2025).

Third, industrial resilience should be analysed as an independent determinant of IAMD credibility. Comparative work on supply chains, licensed production, component dependencies, maintenance ecosystems, and workforce pipelines would clarify how quickly layered architectures can be thickened, repaired, and sustained under political friction or supply disruption (IISS, 2025; Wachs, 2023). Taken together, these research avenues would operationalize the manuscript's core claim: that IAMD credibility hinges on the triad of integration, sustainment, and governance discipline, and that cooperation frameworks should be evaluated against those variables rather than headline procurement figures.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors also declare no non-financial competing interests relevant to the subject matter of this manuscript.

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Ethical Statements

This study is based on publicly available data and literature; therefore, it did not involve human participants or animal subjects. Ethical approval was not required for this research.

Data and Code Availability

Data sharing is not applicable to this article as no new datasets were generated or analysed. All information used in this study is derived from publicly available sources cited in the manuscript.

Supplementary Materials

No supplementary materials are associated with this article.

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