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Juan C. Castilla and José Antonio Pérez de Paz

Space protection: EU's dilemmas about an autonomous missile shield

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Abstract:

The need for autonomous missile defence in the EU in the face of growing ballistic and cruise missile threats is analysed, highlighting Europe's current dependence on the US and NATO, mainly due to the lack of its own satellite-based early-warning system. In this context, Germany is promoting the European Sky Shield Initiative (ESSI), a missile shield relient on US and Israeli systems, sparking tensions with France, which advocates for autonomy and brings its nuclear deterrent into the strategic discussion.

The article details the capabilities needed for a missile defence shield, highlighting the importance of satellite-based early detection. While the US has advanced systems such as SBIRS, which will be enhanced by Next-Generation OPIR, the EU lacks a similar capability and faces financial and technological difficulties in developing a system of its own. Europe's TWISTER and ODIN's EYE II, HYDEF and HYDIS projects, still at an early stage, aim to create an early-warning satellite system and new interceptors, although they are not expected to be operational in the short term.

Financing these developments is a major challenge, with options such as joint debt issuance being considered. The EU must decide how to strengthen its defence and space industries, reduce its dependence on certain allies, and operate within constrained budgetary resources, with space-based early-warning capabilities being essential to achieving strategic autonomy in the defence sphere.

Keywords:

Shield, missiles, satellites, early-warning, PESCO, EDF, EDIS, ESSI, TWISTER, ODIN EYE II, SBIRS, OPIR.

Space protection: EU's dilemmas about an autonomous missile shield

Resumen:

Se analiza la necesidad de una defensa antimisiles autónoma en la UE frente a amenazas crecientes de misiles balísticos y de crucero, destacando la actual dependencia europea de Estados Unidos y la OTAN debido, principalmente, a la falta de un sistema propio de alerta temprana satelital. En este contexto, Alemania promueve la European Sky Shield Initiative (ESSI), un escudo antimisiles apoyado en sistemas estadounidenses e israelíes, generando tensiones con Francia, que aboga por la autonomía y que incluye en la discusión estratégica asociada su factor de disuasión nuclear.

El artículo detalla las capacidades necesarias para un escudo antimisiles, resaltando la importancia de la detección temprana por satélite. Mientras EE. UU. dispone de sistemas avanzados como el SBIRS, que será mejorado por el Next-Generation OPIR, la UE carece de una capacidad similar y enfrenta dificultades financieras y tecnológicas para desarrollar un sistema propio. Los proyectos europeos TWISTER y ODIN's EYE II, HYDEF y HYDIS, aún en fase inicial, buscan crear un sistema de satélites de alerta temprana y nuevos interceptadores, aunque no se espera que estén operativos a corto plazo.

La financiación de estos desarrollos es un reto importante, apuntándose a opciones como la emisión de deuda conjunta. La UE debe decidir cómo fortalecer su industria de defensa y espacial, limitando su dependencia de ciertos aliados y con recursos presupuestarios restringidos, siendo la capacidad de alerta temprana espacial fundamental para lograr una autonomía estratégica en el ámbito de la defensa.

Palabras clave:

Escudo, misiles, satélites, alerta temprana, PESCO, EDF, EDIS, ESSI, TWISTER, ODIN EYE II, SBIRS, OPIR.

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Introduction

The major powers (US, China, Russia, India, the EU?) are engaged in a renewed space race with geopolitical implications. They seek technological supremacy in space, a new domain for military operations, deterrence and defence. While sovereignty extends to a nation's airspace, outer space beyond the exosphere lies outside state control; moreveor it lacks an agreed framework of international law. In this new space, both state and private satellites operate, providing essential services, including some for security and defence.

The US, Russia, China and India have tested the destruction of satellites with ballistic missiles[1]. The impact of a Russian anti-satellite (ASAT) missile is a more attributable threat than an accidental impact of *debris* against current (Galileo or Copernicus) or future (IRIS2- *Infractructure for Resilience, Interconnectivity and Security by Satellite*) EU satellites. Ballistic missiles could also directly target EU citizens in their cities.

Today, NATO's ballistic missile defence (BMD) is no longer limited to attacks from Iran; Russia is a declared threat. In Europe, there is a need to improve air defence systems and interceptors within a missile shield.

Do the Member States or the EU have an effective shield? Is it autonomous? When could they achieve such a capability? This paper explains why the EU can count on a shield as long as the US and NATO continue providing it, at least over the next decade. The EU will reimain operationally dependent on the US and NATO until at least 2035.

The *European Sky Shield Initiative* (ESSI), proposed by the German chancellor, assumes reliance on the US satellite segment and has caused political tensions with France due to the benefits it brings for US and Israeli industries. In the future NATO, the US should continue supporting the EU with intelligence, surveillance and satellite capabilities for missile defence[2]. For EU countries to develop autonomous capabilities, they would need to address the challenge of significant funding.

[1] TODD, David (2022). "One year after Russian ASAT Test". https://www.slingshot.space/news/one-year-after-russian-asat-test

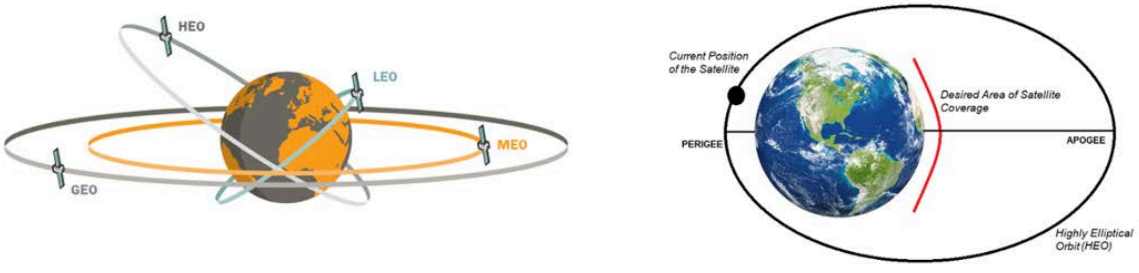
[2] CASTILLA, Juan C. "Bomba de relojería: Ucrania en la UE, pero no en la OTAN". IEEE Analysis Paper 55/2024. https://www.ieee.es/Galerias/fichero/docs_analisis/2024/DIEEEA55_2024_JUACAS_Ucrania.pdf

What is a missile defence shield?

A shield must have detection and interception capabilities (missiles or other directed energy weapons). For detection, early-warning satellites (complemented by communications satellites in the space segment) are used, along with sensors on the ground or on ships. The ground segment typically includes radars and interceptors (ground or naval), including missiles launched by anti-aircraft systems with ballistic missile defence capabilities. Air and space power can also contribute to the shield through in-flight missile interception capabilities or directed energy weapons (such as lasers).

Satellite payload technology must enable accurate, around-the-clock detection (day-night). The space segment of the US shield uses infrared sensors to detect thermal emissions during missile launches, providing early-warning and initial data on the missile's trajectory and future impact point. However, tracking missiles in space is complex, although improvements in synthetic aperture radars on satellites promise enhanced detection capabilities for small objects[3].

The processing of initial data allows trajectory predictions to be made. Additionally, the ground segment can assist in detecting and acquiring the enemy's track for interceptions both within the inner layers of the atmosphere (endoatmospheric) and beyond it (exoatmospheric). The emergence of low-altitude hypersonic cruise missiles (*Hypersonic Cruise Missile* - HCM and *Hyper Velocity Gliding Projectile* HVGP) at low altitudes presents a new challenge for detection and tracking from satellites, as their trajectories can be masked by the Earth's curvature and surface interference[4].



Source: https://www.everythingrf.com/community/what-is-a-highly-elliptically-orbit

[3] MDDA (2024) "Synthetic Aperture Radar (SAR) Technology". https://missiledefenseadvocacy.org/space-defense/sar-technology/

[4] STONE, Christopher (June 2022). "Orbital surveillance: The need for enhanced space-based missile warning and tracking". Mitchell Institute, Vol. 36. https://mitchellaerospacepower.org/orbital-vigilance-the-need-for-enhanced-space-based-missile-warning-and-tracking/

Satellites operate in three layers: *Low Earth Orbit* (LEO) (110/120-2,000 km), *Medium Earth Orbit* (MEO), which extends from the end of LEO to *Geostationary Orbit* (GEO) at 35,786 km. Four satellites in GEO orbit allow for observation of the entire Earth. A MEO satellite at 20,200 km completes its orbit in 12 hours[5] . At lower altitudes, orbits offer less coverage, so multiple satellites in the same orbit are used, as Starlink does. A Highly Elliptical Orbit (HEO) allows for increased coverage over specific areas of the surface.

A missile defence shield's satellite surveillance must sufficiently cover potential enemy launch sites (from land or seas traversed by their navy). A global power requires full satellite coverage, while a country like Israel can focus its reconnaissance capabilities on specific areas. If the EU were to have satellite capabilities for this purpose (or dual-use), it shoud be defined in terms of a particular area of interest; it might not require full global coverage for military reasons, though it likely would for civilian applications.

US: Satellite Detection and Tracking Capabilities

The US has a missile defence shield that includes a satellite segment. In the 1970s, the US implemented the *Defense Support Program* (DSP), which eventually had 23 satellites equipped with infrared sensors[6] . Its successor, the *Space Based Infrared System* (SBIRS), was conceived in 1996, becoming operational in 2013 after more than 15 years of development. This system includes eight satellites: two in high elliptical orbit (HEO) and six geostationary (GEO)[7], launched between 2006 and 2022. It can locate the origin of missile launches, predict trajectories and update impact point estimates using algorithms[8]. The short time between launch and impact[9] requires rapid decisions, aided by computing, on which interceptor to use, whether from space with laser weapons or from the surface.

[5] MORRIS, Austin (2021). "Space terms 2: LEO, MEO, GEO, and HEO" https://www.kallmorris.com/columns/space-terms-2-leo-meo-geo-and-heo

[6] USSF (October 2020). "Defense Support Program Satellites". https://www.spaceforce.mil/About-Us/Fact-Sheets/Article/2197774/defense-support-program-satellites/

[7] BEHLER, Robert F. (December 20, 2019). "FY 2019 Annual Report", Director, Operational Test & Evaluation (DOT&E). pp.203-204.

[8] Missile Defense Advocacy Alliance (September 2022). "Space-Based Infrared System (SBIRS)". https://missiledefenseadvocacy.org/defense-systems/sbirs-geo-1/

[9] HAHN, Anton (February 2023). "European Sky Shield Initiative and its impact on European Ballistic Missile Defence". ISPK Policy Brief No. 12.

In its research and development phase, the program for five satellites cost $4.4 billion in 1996, a figure that rose to $18.3 billion for six satellites in 2012[10]. The funding has experienced significant cost overruns, quadrupling the initial expected cost of $5 billion to $20 billion by 2020[11].

The SBIRS is expected to be improved with the *Next-Generation Overhead Persistent Infrared* (Next-Generation OPIR) programme, which will include four new satellites (two GEO and two HEO) with enhanced cybersecurity[12]. The HEO satellites are intended to increase coverage over the North Pole, from where the flight time of an enemy missile to the US would be shorter. The launch of the first GEO satellite is scheduled for 2025, although delays are anticipated; the first HEO satellite could be lunched in 2028, provided the data processing software version is ready by 2026[13]. The projected cost of Next-Generation OPIR is $14 billion, with the possiblity of future cost overruns[14].

To complement *Next-Generation OPIR*'s HEO and GEO satellites[15], the US will develop new LEO satellites to improve the detection and tracking of missiles, under the *Hypersonic and Ballistic Tracking Space Sensor* (HBTSS) programme[16]. In February 2024, SpaceX[17] launched two HBTSS prototypes for the *U.S. Missile Defense Agency* (MDA)[18].

[10] CSIS Missile Defense Project (July 26, 2021). "Space-based Infrared System (SBIRS)". Missile Threat, Center for Strategic and International Studies. https://missilethreat.csis.org/defsys/sbirs/

[11] US GAO (September 2021). "Report to Congressional Committees: Missile warning satellites". GAO-21-105249, p. 1.

[12] WOLFE, Franke (November 29, 2021). "Next-Gen OPIR Program Completes System-Level Critical Design Review", Via Satellite. https://www.satellitetoday.com/government-military/2021/11/29/next-gen-opir-program-completes-system-level-critical-design-review/

[13] HADLEY, Greg (June 20, 2024). "New Report: USSF's missile warning satellites in all orbits face challenges". Air&Space Forces Magazine. https://www.airandspaceforces.com/space-force-missile-warning-satellites-challenges/

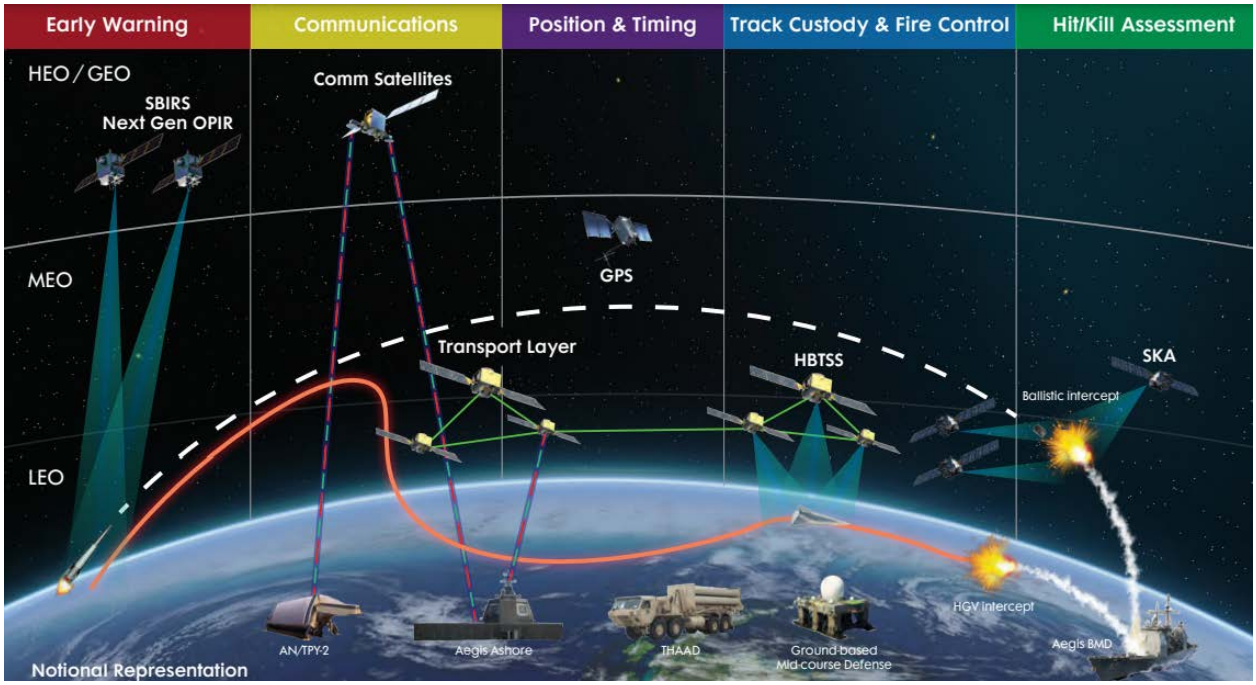
[14] The programme originally envisaged a third GEO satellite, but this has been dropped due to budget reductions. LEE HARPLEY, Unshin (March 11, 2024). "Space Force faces first ever budget cut in 2025, driven in part by fewer launches". Air&Space Forces Magazine. https://www.airandspaceforces.com/space-force-budget-cut-2025-fewer-launches/

[15] Breaking Defense (February 7, 2023). "Overhead Persistent IR is how hypersonic and maneuverable threats will be tracked". https://breakingdefense.com/2024/05/next-gen-opir-2-steps-forward-1-step-back-for-missile-warning-effort/

[16] Northrop Grumman (n.d.). "Hypersonic & Ballistic Tracking Space Sensor." https://cdn.northropgrumman.com/-/media/wp-content/uploads/HBTSS-Data-Sheet.pdf?v=1.0.0.

[17] ERWIN, Sandra (February 14, 2014). "SpaceX launches U.S. missile-defense satellites". https://spacenews.com/spacex-launches-u-s-missile-defense-satellites/

[18] HARPER, John (February 14, 2024). "New SDA, MDA missile-tracking satellites launched into space" Defencescoop. https://defensescoop.com/2024/02/14/sda-mda-missile-tracking-satellites-hbtss/



Source: https://cdn.northropgrumman.com/-/media/wp-content/uploads/HBTSS-Data-Sheet.pdf?v=1.0.0

The operability of a satellite-based early-warning system using infrared detection requires an intelligence system that updates missile infrared signature libraries; otherwise, false alarms and incorrect decisions regarding interceptors may occur.

Israel: Satellite capabilities for its shield?

Israel currently operates approximately ten LEO and two GEO satellites. Although these satellites are said to complement its shield, it is unclear how they do so: whether only through imagery or by integrating early-warning information based on infrared detection[19]. Israel's autonomous space capability involves the ability to launch satellites and produce their payloads, which requires a high technological level and strong political determination to provide the investment. It does not seem to have a space segment in its shield, despite Israel increasing its presence in space with LEO satellites (OFEK series) for electro-optical observation[20].

It is presumed that Israel continues to receive satellite information from the US in the face of events such as the missile and drone attacks launched by Iran on April 14 and

[19] NAGEL, Jacob (March 6, 2023). "Israel Super Capabilities in Space. Foundations for Defense of Democracies. https://www.fdd.org/analysis/2023/03/16/israel-super-capabilities-in-space/

[20] ESHEL, Tamir (June 6, 2022). "Israel becomes a spy-sat superpower", Defense Update. https://defense-update.com/20220606_ofek16-spysat.html

October 1, 2024. Additionally, Israel has ground-based radars capable of detecting airborne threats at distances and altitudes that allow its interceptors to neutralise them at intermediate or late phases of their trajectory.

The Israeli Arrow 3 system is the result of collaboration between the Israeli Ministry of Defence and the US Missile Defence Agency, developed by Israel Aerospace Industries (IAI) and Boeing. It entered service in 2017 and was declared operational in 2023[21]. This system can detect and intercept exoatmospheric missiles, expanding the capabilities of its predecessor, Arrow 2, which could only intercept within the atmosphere. On October 31, 2023, the Arrow 2 intercepted an Iranian ballistic missile, marking its first real use; on 9 November, the Arrow 3 neutralised another launched by the Houthis from Yemen[22].

The Israeli shield's early detection capabilities are based on the indigenous EL/M-2080 *Green Pine* ground-based radar, which can detect and track threats up to 500 kilometres away, including hypersonic missiles[23]. The Green Pine is integrated with the Arrow 2 and 3 interceptors, the latter of which can act as a LEO anti-satellite weapon[24] . The *Iron Dome* uses PATRIOT batteries, and the shield incorporates other systems such as *David's Sling* which has the interceptor known as Stunner. Many components of these systems are of American origin. Moreover, the US has recently strengthened Israel's missile defence capabilities with the deployment of the ground-based THAAD system[25] and ship-based missile capabilities.

[21] GREENBERG, Tzally (November 10, 2023). "Israel announces first Arrow-3 operational intercept", C4ISRNET. https://www.c4isrnet.com/battlefield-tech/space/2023/11/10/israel-announces-first-arrow-3-operational-intercept/

[22] Center for Strategic & International Studies (n.d.). "Israel's missile defense engagements since October 7". https://www.csis.org/analysis/israels-missile-defense-engagements-october-7th

[23] MAJUMDAR, Prajesh (December 23, 2023). "Precision in protection: a closer look at Israel's "Arrow" anti-ballistic missile system", Medium. https://medium.com/@AirPra/precision-in-protection-a-closer-look-at-israels-arrow-anti-ballistic-missile-system-4563e0d562b0.

[24] OPALL-ROME, Barbara (November 9, 2009). "Israeli experts: Arrow-3 could be adapted for anti-satellite role". Space News. https://spacenews.com/israeli-experts-arrow-3-could-be-adapted-anti-satellite%E2%80%82role/

[25] BBC (October 2024) "What are Israel's Iron Dome, David's Sling, Arrow and Thaad missile defences?" https://www.bbc.com/news/world-middle-east-20385306

Defence in Europe and missile defence shield capabilities.

In NATO, air and missile defence is conceived in an integrated manner (NATO IAMD) and implemented through the *NATO Integrated Air and Missile Defence System* (NATINAMDS), a network of Alliance and national systems including sensors, command and control assets, and weapons systems[26], aimed at neutralising ballistic and cruise missiles, among other threats. The US contributes with information from its early-warning satellites to the system, while ground-based and naval platform-based sensors are available in several countries. Allies contribute different anti-aircraft systems, including some with ballistic missile defence capabilities, which are integrated under a unified command and control.

The NATINAMDS conducts a permanent multilayered ballistic missile defence (BMD) mission. From the outermost to the lowest layer, it includes systems such as AEGIS, THAAD, PATRIOT and SAMP-T. The North American AEGIS[27] operates on US Arleigh Burke class ships, and others from Canada and Spain (with limitations). It integrates an AN/SPY-1D radar sensor (Phase Array*)*, capable of detecting targets at approximately 185 kilometres[28]. The US AEGIS systems were initially installed on naval platforms, such as those on the four ships in Rota, Spain, and operate with SM2, SM3 and SM6 missiles. The SM2 and SM6 are endo-atmospheric interceptors, while the SM3 are exo-atmospheric[29] . There are also AEGIS *Ashore* systems in Romania and Poland, operational since 2016 and 2024, respectively.

The ground-based *Terminal High Altitude Area Defence* (THAAD) system[30], equipped with the AN/TPY2 radar, is capable of detecting intermediate-range ballistic missiles outside the atmosphere and intercepting them in their terminal or initial phase, within the atmosphere or beyond[31].

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[26] NATO (August 8, 2024). "NATO Integrated Air and Missile Defence". https://www.nato.int/cps/en/natohq/topics_8206.htm

[27] Lockheed Martin (n.d.). "Aegis: The Shield (and the Spear) of the Fleet". https://www.lockheedmartin.com/en-us/products/aegis-combat-system.html

[28] United States Navy (September 20, 2021). "AEGIS Weapon System. https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166739/

[29] CSIS Missile Defense Project (March 9, 2023). "Standard Missile-3 (SM-3)". Missile Threat, Center for Strategic and International Studies. https://missilethreat.csis.org/defsys/sbirs/

[30] FEICKERT, Andrew (April 25, 2024). "The Terminal High Altitude Area Defense (THAAD) System". Congressional Research Service. https://crsreports.congress.gov/product/pdf/IF/IF12645/2

[31] HAHN, Anton, *Op. Cit.* p.9

A THAAD deployment near the Russia's borders, combined AEGIS' exoatmoshperic missile capability, would enable the interception of intermediate-range ballistic missiles aimed at allied territories in the Baltic or Black Sea, providing an advanced defence, which Germany could also leverage in response to Russian capabilities in Kaliningrad. This deployment could be complemented by lower-altitude systems, such as the US PATRIOT batteries, used by several allies, or the French SAMP/Ts, which Italy also possesses, capable of neutralising short- and medium-range ballistic missiles within the atmosphere. The Alliance's multilayered defence is further reinforced with lower-capacity air defence systems, such as the Norwegian NASAMS, the German IRIS-T and the British BMC4I Sky Sabre (or Land Ceptor)[32].

It is not published that any EU Member State or the UK has a satellite capability for infrared detection for early-warning against ballistic or cruise missiles. French experience in the development of CSO (*Composante Spatiale Optique*) satellites[33] , within the MUSIS (*Multinational Space-based Imaging System*) programme, alongside the know-how of Thales Alenia Space[34], could enable France to access this capability. Its CSO satellites are in their third generation, and this early-warning capability is relevant for a country with its own nuclear deterrance.

Some EU states have anti-aircraft systems produced in Europe, and there are projects to develop more advanced interceptor systems, as well as conceptual initiatives to create an early warning capability from space; this could lead to a European project of common interest for the new European Defence Industrial Strategy (EDIS) of 2024. However, Europe currently depends heavily on NATO, which ensures a persistent US presence both on the ground and in space.

In Europe, within the EU or NATO, there is a variety of low and medium altitudes air defence systems, reflecting the fragmented nature of the European defence industry. This fragmentation poses interoperability problems, although once plugged into NATINAMDS theses systems can function in an integrated way. Additionally, Europe does not

[32] AURAN Jean (2023) "European ground-based air defence programmes" European Security & Defence, https://euro-sd.com/2023/07/articles/32874/european-ground-based-air-defence-programmes/
[33] Centre National d'etudes Spatiales (n.d.). "CSO / MUSIS Optical military reconnaissance satellites". https://cnes.fr/en/projects/cso
[34] Thales Alenia Space (n.d.). "Space to secure & defend". https://www.thalesaleniaspace.com/en/what-we-do/secure-defend

manufacture systems capable of intercepting ballistic missiles beyond the atmosphere, which is a signigicant gap in its defence industry's competitiveness.

European NATO allies lack sufficient air defence systems to address current risks and threats, with a marked shortage in defence capabilities against missiles. These shortfalls are identified as priorities in the NATO Defence Planning Process (NDPP) and in the Capability Development Plan (CDP) led by the European Defence Agency (EDA) in the EU. While there are projects under the Permanent Structured Cooperation (PESCO) and the European Defence Fund (EDF) that seek to address these needs, no concrete timelines exist for transitioning these projects into acquisition programs.

Germany has acknowledged the pressing need to enhance its defences and lead a European effort to address some of the shortcomings mentioned above[35]; hence the *European Sky Shield Initiative* (ESSI)[36] as part of NATO's integrated defence[37]. Chancellor Scholz has championed ESSI as the most efficient mechanism for joint European defence. European leaders' speeches are sometimes ambiguous in their references to Europe, without clarifying whether they refer to NATO or the EU.

In October 2023, ten primarily Eastern European states signed a memorandum of understanding to join ESSI; currently, 22 countries (20 NATO countries plus Switzerland and Austria) support the initiative. Proposed systems include Arrow 3 (US/Israel), PATRIOT (mainly US) and IRIS-T (German), but not SAMP/T (Franco-Italian)[38]. This proposal is controversial, as it could increase European dependence on foreign industries, especially from the US. While the German proposal benefits its own industry, it mainly favours US industry, which produces systems for which there are (yet) no European alternatives for exoatmospheric interceptors.

[35] ARNOLD Steven & ARNOLD Torben (February 2, 2023). "Germany's fragile leadership role in European air defence". Stiftung Wissenschaft und Politik. SWP Comment 2023/C 06, https://www.swp-berlin.org/10.18449/2023C06/
[36] MONAGHAN, Sean & CHRISTIANSON, John (May, 2023). "Making the most of the European Sky Shield Initiative". Center for Strategic & International Studies. p. 9.
[37] NATO (October 11, 2023). "10 NATO Allies take further step to boost European air and missile defence capabilities". https://www.nato.int/cps/en/natohq/news_219119.htm
[38] DESMARAIS, Anna (July 28, 2024). "How Sky Shield, Europe's proposed Iron Dome, would work and why it's becoming controversial". Euronews. https://www.euronews.com/next/2024/07/28/how-sky-shield-europes-proposed-iron-dome-would-work-and-why-its-becoming-controversial

In his April 2024 speech at the Sorbonne[39], President Macron stated that Europe is ill-equipped to meet current risks. During his visit to Germany[40] in May 2024, he stressed the need for "credible and robust responses", especially in missile defence, advocating greater European autonomy. Asked why France had not joined the ESSI and how he saw possible funding for the initiative, he replied: "The situation of capabilities in France is completely different from Germany's, as we have nuclear weapons that allow us to act as a deterrent". Investment in defensive weapons is often more costly than in offensive ones; however, in European democracies, the former is generally easier to justify to voters.

Some warn that nuclear deterrence remains effective in countering Russian threats, arguing that the proliferation of anti-missile systems might prompt Russia to bolster its offensive capabilities, weakening NATO's deterrence balance[41]. The intertwined interests of organizations, nations, and defence firms[42] often shape these debates, necessating critical scrutiny of underlying motives.

While EU countries face shortages in interceptors, there is a clear absence of early-warning satellites capabilites. NATO's defence planning does not assign such objectives to any specific ally, as the technical and economic challenges would be unreasonable for a single European country. However, a capability could be proposed in the EU to be acquired collaboratively, with common funding and available for the Common Security and Defence Policy, under a co-ownership[43] model between Member States and EU Institutions, exemplifying EU-NATO complementarity.

If certain PESCO and EDF projects for a missile defence shield were to be consolidated as collaborative programmes, they could enhance the technological base of the associated industry. The European Commission considers the area of "space and defence capabilities" as a priority for its "open strategic autonomy", seeking to secure

[39] MACRON, Enmanuel (2024) "Europe Speech". https://www.elysee.fr/front/pdf/elysee-module-22625-en.pdf

[40] Die Bundesregierung (May 28, 2024). "Pressekonferenz von Bundeskanzler Scholz und Präsident Macron zum 24. Deutsch-Französischen Ministerrat". https://www.bundesregierung.de/breg-de/aktuelles/pressekonferenz-von-bundeskanzler-scholz-und-praesident-macron-zum-24-deutsch-franzoesischen-ministerrat-am-28-mai-2024-komplett--2288912

[41] GOTKOWSKA, Justyna & MASLANKA Łukasz (June 22, 2023). "France against Germany's European Sky Shield Initiative". Center for Eastern Studies. https://www.osw.waw.pl/en/publikacje/analyses/2023-06-22/france-against-germanys-european-sky-shield-initiative

[42] CASTILLA, Juan C. (April 2024) "From public defence policy to defence planning. About enhancing the EU processes and complementarity with NATO". UNED doctoral thesis. https://hdl.handle.net/20.500.14468/22970

[43] CASTILLA, Juan C. (April, 2024) *Op. Cit*. pp.175; 192

access to space and recognizing the need to protect space infrastructure against evolving threats[44] .

In this sense, the *Timely Warning and Interception with Space-based Theater Surveillance* (TWISTER) project[45], involving France, Germany, Italy, Finland, the Netherlands and Spain, was accepted into PESCO in 2019. This project envisions a detection and tracking space segment as well as a ground segment with an endo-atmospheric interceptor against intermediate-range, hypersonic and glide-launched hyper-velocity missiles. The space segment aims to develop a European system akin to the US SBIRS, although it remains in the conceptual stage and the types of satellites that would be part of it have not yet been defined.

These programmes align with the Union's needs as reflected in its Strategic Compass[46] and with NATO as a possible contribution to NATINAMDS[47]. The Commission underlines TWISTER's role in equipping the EU with early-warning capabilities and complements other EDF-funded initiatives to foster collaborative research and development.

In 2022, the *Multinational Development Initiative for a Space-based missile early-warning architecture* II (ODIN's EYE II) project was approved with EDF funding. Currently in the conceptual design phase, it is set to run until 2025, at a cost of 96 million euros, almost entirely funded by the Commission[48] . Since 2022, the focus has been on defining the development of the programme and its simulator[49], involving a consortium of 43 companies from 14 Member States, led by Germany's OHB System AG[50]. The

[44] European Commission (September 8, 2021). "2021 Strategic Foresight Report. The EU's capacity and freedom to act". COM (2021)750 final. p.21.
[45] Permanent Structured Cooperation (n.d.). "Timely Warning and Interception with Space-based Theater Surveillance". https://www.pesco.europa.eu/project/timely-warning-and-interception-with-space-based-theater-surveillance-twister/
[46] FIOTT, Daniel (November, 2022). "The Strategic Compass and EU space-based capabilities". Directorate-General for external policies: Policy Department for External Relations, PE 702.569. p. 26.
[47] SpaceWatch.Global (November 18, 2019). "European Military Space: EU pursuing space-based early warning, PNT, And SSA Projects Under PESCO Initiative". https://spacewatch.global/2019/11/european-military-space-eu-pursuing-space-based-early-warning-pnt-and-ssa-projects-under-pesco-initiative/
[48] European Commission (2022). "ODIN'S EYE II: Multinational Development Initiative for a Space-based missile early-warning architecture II". https://defence-industry-space.ec.europa.eu/document/download/3d80aee3-404c-4207-b8fa-5df7310668e1_en?filename=ODINS%27EYE%20II-Factsheet_EDF22.pdf
[49] PARSONSON, Andrew (December 27, 2023). "OHB get go-head to commence €90M ODIN'S EYE II Project". European Spaceflight. https://europeanspaceflight.com/ohb-get-go-head-to-commence-e90m-odins-eye-ii-project/
[50] Among the Spanish companies involved are Deimos, GMV, Indra and SENER.

architecture is expected to integrate into NATINAMDS[51]. After this initial stage, the programme is expected to move towards collaborative procurement, although European early-warning satellites are not expected to be operational within a decade.

In the realm of endo-atmospheric interceptors, two EDF initiatives stand out: the Hypersonic Defence European Interceptor (HYDEF) and the Hypersonic Defence Interceptor Study (HYDIS). It is questionable whether this is just another case of fragmentation of initiatives or whether the research competition between technology leaders in Germany and France will be fruitful.

HYDEF, which involves Belgium, Germany, Spain, Norway and Poland, was selected by EDF in 2021 to receive nearly €100 million (total cost estimated at €110 million)[52] to develop a hypersonic missile interceptor. In 2023, coordination of the project shifted to the Spanish consortium Sistema de Misiles de España (SMS: SENER, GMV, Escribano and Instalaza). Germany's Diehl Defence is providing the technical expertise, while the Spanish consortium expects to complete the design by 2025, targeting production for 2035[53]. Whether this evolves into a formal procurement programme remains to be seen[54].

Meanwhile, HYDIS involves a consortium of 19 companies from 14 Member States, led by MBDA[55] . This project focuses on a conceptual study for an endo-atmospheric interceptor[56] over three years. The EDF will fund €80 million of the €114 million estimated

[51] WEIGHTMAN, Louise (December 29, 2023). "OHB secures European Defense Fund's EUR 90 million for ODIN's EYE II Project". SpaceWatch.Global. https://spacewatch.global/2023/12/ohb-secures-european-defense-funds-eur-90-million-for-odins-eye-ii-project/

[52] European Commission (2021). "EU HYDEF: European Hypersonic Defence Interceptor". https://defence-industry-space.ec.europa.eu/system/files/2022-07/Factsheet_EDF21_EU%20HYDEF.pdf

[53] BARRIE, Douglas & GIEGERICH, Bastian & LAWRENSON, Tim (August 26, 2022). "European missile defence - unstructured cooperation? The International Institute for Strategic Studies. https://www.iiss.org/online-analysis/military-balance/2022/08/european-missile-defence-unstructured-cooperation/

[54] In August 2024, the programme passed the Mission Definition Review, completing the Pre-Feasibility Phase and initiating the Feasibility Phase. See DE SANTOS, Ángel Luis (30 August, 2024). "El futuro programa europeo para interceptar misiles hipersónicos rusos o chinos, con gran presencia española, da un importante paso adelante". *La Razón.* https://www.larazon.es/espana/defensa/futuro-programa-europeo-interceptar-misiles-hipersonicos-rusos-chinos-gran-presencia-espanola-importante-paso-adelante_2024083066d209ed797ae10001e0d559.html

[55] MBDA (August 2, 2023). "Hydis consortium project for hypersonic defence interceptor proposed for funding by the European Commission". https://www.mbda-systems.com/press-releases/hydis²-consortium-project-for-hypersonic-defence-interceptor-proposed-for-funding-by-the-european-commission/

[56] European Commission (2024). "HYDIS: Hypersonic Defence Interceptor Study". https://defence-industry-space.ec.europa.eu/document/download/662f7204-c551-41ba-a1a0-680d7dc65c6e_en?filename=EDF-2023-DA-DS-AIRDEF-EATMI_HYDIS².pdf

for the study's development. Like HYDEF, the European Commission has tasked OCCAR with coordination and indirect oversight[57].

In short, as with ODIN'S EYE II (warning space segment), the ground-based segment of endoatmospheric interceptors designed to neutralise ballistic or hypersonic missiles will not be available in the short term (within the next six years according to NATO planning). Furthermore, there are no plans for exoatmospheric interceptors similar to THAAD or Arrow 3 missiles.

Should the concepts for both segments —space-based and ground-based— be ready by 2025 or 2026 for transition into procurement programmes, the challenge of a significant investment would remain, as it could amount to tens of billions of euros (remember the costs of the US satellite programmes), in a context of debt adjustments and budget deficits in several European countries[58].

Considerations on the future financing of the EU shield

Defense cuts because peace dividends and after the 2008 crisis created a deficit in European defence industry investment, which remains unresolved[59]. The funds so far provided by EU initiatives (EDF, CASSINI[60], EDIRPA, EDIP) are insufficient to cover the cost of a space-based early-warning satellite programme. For the possible implementation of the European Defence Industry Strategy (EDIS), the EU and Member States must agree on key aspects such as financing; one option is the issuance of joint debt, although the frugal countries seem reluctant.

The Draghi report emphasizes that public spending is insufficient to sustain a competitive industry[61], noting that the US invests 14 times more in defence R&D and innovation than Europe[62]. The progress of the EU's 2023 Space Strategy for Security and

[57] European Commission (December 11, 2023). EDF 2023 project "Hypersonic Defence Interceptor Study" (HYDIS²) entrusted to OCCAR. https://defence-industry-space.ec.europa.eu/edf-2023-project-hypersonic-defence-interceptor-study-hydis2-entrusted-occar-2023-12-11_en

[58] CASTILLA, Juan C. (September 25, 2024). "El Folk Europeo y la inversión en industria de defensa; criterios de convergencia". CESEDEN. https://www.defensa.gob.es/ceseden/-/el-folk-europeo-y-la-inversi%C3%B3n-en-industria-de-defensa-criterios-de-convergencia

[59] EDA (2023)." For the long haul. Sustaining EU ambitions in defence: Can investors still come to the aid of the defence industry?". European Defence Matters. nº26. pp. 26-29.

[60] CASSINI (n.d.). "Space Entrepeneurship Initiative. https://www.cassini.eu/cassini-initiative

[61] European Commission (September, 2024). "The future of European competitiveness. Part B: In depth analysis and recommendations". Section 1, Chapter 7. p.160.

[62] *Ibid*, pp. 165-167.

Defence[63], which seeks to create synergies between the space and defence sectors, is acknowledged; however, neither this strategy nor the report mentions a European missile defence shield.

The cited strategy does refer to the future evolution of Copernicus (Earth observation programme) and that military requirements will be considered with a horizon up to 2035 (primarily referring to space-based defence services). The space strategy includes the objective to: "enhance the use of space for security and defence purposes by better integrating the space dimension into the planning and conduct of Common Security and Defence Policy (CSDP) missions and operations; by strengthening the EU Satellite Centre (Satcen)".

To address these financing needs, imaginative formulas are being sought without altering the Lisbon Treaty, aiming for synergies between the European Investment Bank (EIB), the European Space Agency (ESA) - an organisation outside the Union - the European Defence Agency (EDA) and the Commission through the Directorate-General for Defence Industry and Space (DG DEFIS).

In January 2024, ESA, DG DEFIS and the EIB signed an agreement to bolster the European space sector by offering financial support and advice to companies[64]. In October, the EIB and EDA updated their 2018 memorandum of understanding to identify the financial needs of the Union's defence industry[65] and strengthen instruments such as the Cooperative Financial Mechanism[66], which finances defence projects through EIB loans and state-to-state support. This agreement follows the line of the EIB, which last year increased its security and defence fund to €8 billion.[67]

[63] European Council (November 14, 2023). "Space: Council adopts Conclusions on the EU Space Strategy for Security and Defence". https://www.consilium.europa.eu/es/press/press-releases/2023/11/14/space-council-approves-conclusions-on-the-eu-space-strategy-for-security-and-defence/

[64] European Commission (January 24, 2024). "DEFIS-EIB-ESA partner to strengthen the European space sector". https://defence-industry-space.ec.europa.eu/defis-eib-esa-partner-strengthen-european-space-sector-2024-01-24_en

[65] EDA (October 3, 2024). "EDA and EIB deepen partnership in support of financing for defence". https://eda.europa.eu/news-and-events/news/2024/10/03/eda-and-eib-deepen-partnership-in-support-of-financing-for-defence

[66] EDA (September 26, 2019). "Cooperative Financial Mechanism (CFM) ready for signing". https://eda.europa.eu/news-and-events/news/2019/09/26/cooperative-financial-mechanism-(cfm)-ready-for-signing.

[67] European Investment Bank (n.d.). "Strengthening Europe's security and defence industry". https://www.eib.org/en/projects/topics/innovation-digital-and-human-capital/sesi/index

In the discussion on financial tools, some propose the issuance of joint European debt to address the high cost of missile defence systems[68]. This mechanism could advance the recommendations of the Draghi Report, which underscores the need to release more EIB loans for the defence industry, establish a single market for the space sector and fund multinational projects[69]. Through these measures and a European Space Fund, the EU could reinforce its space defence capabilities.

Ursula von der Leyen recently tasked Defence and Space Commissioner Andrius Kubilius with leading the proposal for Defence Projects of Common European Interest in coordination with NATO and Member States, and to initiate the design and implementation of a European Air Shield[70]. In his hearing before the European Parliament on November 6, Kubilius stressed the urgent need to establish such a European Air Shield, which will be a priority for the forthcoming White Paper on the Future of European Defence. He stressed the importance of deciding whether to use exclusively European technology or technology from external partners, balancing economic viability with the Union's strategic autonomy. Furthermore, the Commissioner emphasised the need to ensure European autonomy in space access and to develop space defence capabilities, which will require an appropriate legislative framework (future European Space Act) and sustained funding[71].

Conclusions.

Member States' contributions to NATO missile defence in Europe are currently limited to the ground segment, with reduced endoatmospheric interception capabilities and interoperability challenges due to a fragmented and US-dependent industry. There are PESCO and EDF projects in the conceptual phase for developing endoatmospheric interceptors (HYDEF and HYDIS) and a satellite-based early-warning system similar to the US infrared detection capabilities (TWISTER in PESCO and ODIN EYE II in EDF).

[68] WOLFF, Guntram B. (May 29, 2024). "European Union debt to boost European air defence. Bruegel. https://www.bruegel.org/first-glance/european-union-debt-boost-european-air-defence"
[69] European Commission. The future of European competitiveness...". *Op.cit*. pp. 168 & 183.
[70] Ursula von der Leyen (September 17, 2024). "Mission letter to Andrius Kubilius". Brussels. pp. 5-6.
[71] KUBILIUS, Andrius (6 November, 2024). "Confirmation hearing of Andrius Kubilius, Commissioner-designate, Defence and Space". https://multimedia.europarl.europa.eu/es/webstreaming/afet-sede-itre-tran-committee-meeting_20241106-1830-COMMITTEE-CONFIRMATION-HEARING-A

However, these initiatives are unlikely to materialise into operational systems in the short term (6 years) or even in the next decade.

Faced with the threat of ballistic and cruise missiles, Germany seeks to integrate its demand for systems to neutralise them by partially supporting its own industry and relying on US and Israeli solutions, while initially excluding French systems. *European Sky Shield Initiative* (ESSI) is being developed within NATO's integrated defence framework. Germany and France have different visions on how to address these shortfalls, posing political challenges for financing common-interest projects in the EU, a debate often influenced by the interests of their respective defence industries.

Member States are entirely dependent on the US space-based early-warning system, lacking indigenous capabilities. The European Commission acknowledeges the significance of this gap, and its impact on the EU's technological sovereignty, industry, and strategic autonomy if resolved. Financing an early-warning and tracking space segment as part of a missile shield is a candidate for a European Defence Common Interest Project, a task entrusted to the new Commissioner for Defence and Space, Andrius Kubilius. Its implementation could require investments in the tens of billions of euros.

Innovation and integration of space technology into defence, driven by initiatives like CASSINI for SMEs and agreements between the EIB, EDA, ESA and DG DEFIS, essential for technological progress. A possible solution to the funding challenge could be the issuance of joint European debt, as demonstrated during the COVID-19 pandemic. The Commission's support for fostering the industrial defence and space sectors will depend on the willingness of Member States to allocate resources and the negotiations of the upcoming multiannual financial framework (MFF 2028-2034).

The political-strategic debate is complex: while Germany promotes initiatives like ESSI, France prioritises nuclear deterrence, potentially extending this concept to a broader deterrence for the Union[72] . Both approaches entail significant costs and funding implications.

[72] SCHNEIDER, Mark (July 10, 2024). "Macron's European Union Nuclear Deterrence Initiative and Extended Nuclear Deterrence". National Institute Press. Information Series. No. 592; WATKINS, Peter (July 2024). "Insuring against uncertainty. A European nuclear deterrent?" International Centre for Defence and Security. ISSN 2228-2076.

Should French nuclear deterrence ever become integrated into the EU's Common Security and Defence Policy or its defence industrial policies, the development of an EU satellite system for missile warning might gain access to common funding. The possibility of reducing French maintenance costs associated with nuclear deterrence could also be explored, in exchange for knowledge transfer and funding to develop such a system. Both could be classified as European common-interest defence projects worthy of shared financing. Yet, critics may question: will all EU members end up footing the bill for France's nuclear deterrence?

Another subsequent issue concerns the location of the ground infrastructure linked to the satellite segment of the shield: Would the Satellite Centre (Satcen) in Torrejón (Madrid) be an option for data management of an EU missile early-warning system? Would the Germans and the French agree to this? These are merely anticipatory questions that could shape future debates. We will have to remain vigilant; in the meantime, the US will continue to monitor an area that is also European, and where the EU's military presence is very limited.

Juan C. Castilla
PhD in International Security
@jccastillaba

José Antonio Pérez De Paz
Graduate in International Studies and Law