Strategy Notebook 235-B

Geopolitics of Space

Instituto Español de Estudios Estratégicos

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MINISTERIO DE DEFENSA

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List of Acronyms

3SAS: Strategic Space Situational Awareness System (NATO)
A2/AD: Anti-access/area-denial
ABM: Anti-ballistic missile
ACO: Allied Command Operations (NATO)
ACT: Allied Command Transformation (NATO)
AEE: Spanish Space Agency (Spain)
AI: Artificial Intelligence
APSS: Alliance Persistent Surveillance from Space (NATO)
ASAT: Anti-satellite weapons
AXE: Allied Exchange Environment (NATO)
BOOTES: Burst Observer and Optical Transient Exploring System
C2: Command and Control
C4: Command, Control, Communications and Computers
CAS: Commercial Authentication Service
CDTI: Centre for the Development of Industrial Technology (Spain)
CESAEROB: Centre for Aerospace Observation Systems (Spain)
CESEDEN: Centre for National Defence Studies (Spain)

CESTIC: Centre for Information and Communications Systems and Technologies (Spain)

CFSP: Common Foreign and Security Policy (EU)

CFSpCC: Combined Force Space Component Command of NATO

CGA: Competent GOVSATCOM Authority (EU)

CIFAS: Armed Forces Intelligence Centre (Spain)

CM25: Council meeting 2025 (ESA)

CNES: *Centre national d´éstudes spatiales* (National Centre for Space Studies) (France)

CNSA: National Aerospace Security Council (Spain)

CoHGI: Common Hub for Governmental Imagery *(EU)*

COSPAS-SARSAT: Satellite-Aided Search and Rescue

COVE: Space Surveillance Operations Centre (Spain)

CPA: Competent PRS Authority (EU)

CSAR: Combat Search and Rescue

CSCA: Competent Secure Connectivity Authority (EU)

CSDP: Common Security and Defence Policy (EU)

CSIC: Spanish National Research Council (Spain)

CSIS: Center for Strategic and International Studies (USA)

CSN: National Security Council (Spain)

CSO: Composante Spatiale Optique (Optical Space Component) (France)

CSpO: Combined Space Operations Initiative (Canada)

CWIX: Coalition Warrior Interoperability Exercise (NATO)

DA-ASAT: Direct-Ascent Anti-Satellite Weapons

DEW: Directed Energy Weapon

DG DEFIS: Directorate-General for Defence Industry and Space (EU)

DGAM: Directorate-General for Armament and Materiel (Spain)

DIA: Defence Intelligence Agency (USA)

DIGEID: Directorate-General for Defence Industry Strategy and Innovation (Spain)

DOSA: Defence of Space Assets (EU)

DOSO: Defensive and Offensive Space Operations (NATO)

DRDO: Defence Research and Development Organisation (India)

DSN: Department of National Security (Spain)

DSO: Defensive Space Operations
DSRO: Defence Space Research Organisation (India)
EDA: European Defence Agency (EU)
EDAS: EGNOS Data Access Service
EDF: European Defence Fund (EU)
EDIP: European Defence Industry Programme (EU)
EEAS: European External Action Service (EU)
EGNOS: European Geostationary Navigation Overlay Service (EU)
EIC: European Innovation Council (EU)
ELINT: Electronic Intelligence
EMSA: European Maritime Safety Agency (EU)
ENISA: European Union Agency for Cybersecurity (EU)
EOGS: Earth Observation Governmental Service (EU)
EPRS: European Parliament Research Service (EU)
ERS: European Resilience from Space (ESA)
ERS-EO: European Resilience from Space-Earth Observation (ESA)
ESA: European Space Agency
ESAN: National Aerospace Security Strategy (Spain)
ESMAS: EGNOS Safety of Life Assisted Service for Maritime Users
ESN: National Security Strategy (Spain)
EU SST: EU Space Surveillance and Tracking
EUMS INT: European Union Military Staff Intelligence Directorate
EUMS: EU Military Staff
EUSPA: European Union Agency for the Space Programme (EU)
EU-SSA-N: European Military Space Surveillance Awareness Network (EU)
EUSSSD: Space Strategy for Security and Defence (EU)
EW: Electronic Warfare
EWSS: Emergency Warning Satellite Service
FOCUSEAR: Passive Radio-Frequency Satellite Tracking System (Spain)
FRONTEX: European Border and Coast Guard Agency (EU)
Gbps: Gigabit per second
GEO: Geostationary orbit
GEOINT: Geospatial Intelligence

GLONASS: Russian Global Navigation Satellite System
GMES: Global Monitoring for Environmental Security (EU)
GNSS: Global Navigation Satellite System
GOVSATCOM: Governmental Satellite Communications (EU)
GPS: Global Positioning System
GSC: European GNSS Service Centre (EU)
GSMC: Galileo Security Monitoring Centre (EU)
GSOP: Galileo Service Operator (EU)
GTO: Geostationary transfer orbit
GW: Gigawatt
HAS: High Accuracy Service
HPM: High-Power Microwave
ICBM: Intercontinental ballistic missile
IEEE: Spanish Institute for Strategic Studies (Spain)
INTA: National Institute for Aerospace Technology (Spain)
INTCEN: European Union Intelligence and Situation Centre (EU)
ICO: Initial Operational Capacity
IoT: Internet of things
IRIS²: Infrastructure for Resilience, Interconnectivity and Security by Satellite (EU)
ISAC: Space Information Sharing and Analysis Centre (EU)
ISL: Inter-satellite links
ISR: Intelligence, Surveillance and Reconnaissance
ISS: International Space Station
ITU: International Telecommunication Union
JAPCC: Joint Air Power Competence Centre (NATO)
JAXA: Japan Aerospace Exploration Agency (Japan)
JDP: Joint Doctrine Publication (United Kingdom)
JEMAD: Chief of the Defence Staff (Spain)
JSDF: Japan Self-Defence Forces
LEO: Low Earth orbit
LSN: National Security Act (Spain)
M2M: Machine to machine
MCR: Minimum Capability Requirements (NATO)
MEO: Medium Earth orbit

MESPA: Space Command (MESPA)
METEOSAT: Series of European meteorological satellites
MFF: Multiannual Financial Framework (EU)
MICIU: Ministry of Science, Innovation and Universities (Spain)
MOESPA: Space Operations Command (Spain)
MPCC: Military Planning Capability Centre (EU)
NAC: North Atlantic Council
NCIA: NATO Communications and Information Agency
NDPP: NATO Defence Planning Process
NEO: Near Earth Objects
NOAA: National Oceanic and Atmospheric Administration (USA)
NRO: National Reconnaissance Office (USA)
NSS6G: NATO SATCOM Services 6th Generation (NATO)
OHQ: Operational Headquarters (EU)
OSINT: Open-source intelligence
OSNMA: Open Service Navigation Message Authentication
OSO: Offensive Space Operations (NATO)
P5: the five permanent members of the United Nations Security Council
PERTE: Strategic Project for Economic Recovery and Transformation (Spain)
PESCO: Permanent Structured Cooperation (EU)
PGM: Precision-guided munitions
PNT: Positioning, Navigation and Timing
PR: Personnel recovery
PRS: Public Regulated Service
PVD: Presence, Surveillance and Deterrence
QKD: Quantum Key Distribution
R&D: Research and development
R&D&I: Research, development and innovation
RE-ARM: Rapid European Augmentation Mechanism for Resilience (EU)
RE-ARMED: Evolution of the RE-ARM (EU) fund
RF: Radio-Frequency
RPO: Rendezvous and Proximity Operations

S3TSR: Spanish Space Surveillance and Tracking Surveillance Radar (Spain)

SAFE: Security Action for Europe (EU)

SAGA: Security and cryptographic (ESA)

SAR: Search and Rescue

SatCen: Satellite Centre (EU)

SATCOM: Satellite Communications

SBAS: Satellite Based Augmentation System

ScanSAR: wide-swath scanning mode

SDA: Space Domain Awareness

SDR: Space Data Relay

SECOMSAT: Spanish Satellite Communications System (Spain)

SEOT: Earth Observation System

SFDD-1: Space Force Doctrine Document-1 (USA)

SIAC: Single Intelligence Analysis Capacity (EU)

SIGINT: Signals intelligence

SME: Small and medium enterprise

SOC: Security Operations Centre

SPIDER: Space-based Persistent ISR and Deployable European Resource (EU)

SSA: Space Situational Awareness

SSN: Space Surveillance Network (USA)

SSO: Sun-synchronous orbit

SST: Space Surveillance and Tracking

STARCOM: Space Training and Readiness Command (USA)

STRA: Space Threat Response Architecture (EU)

SWE: Space weather

SWF: Secure World Foundation

THOR: Space Threats Operational Response

UAS: Unmanned Aircraft System

UAV: Unmanned Aerial Vehicle

UCAV: Unmanned Combat Aerial Vehicle

Introduction

Dr. Luis V. Pérez Gil

The conquest of outer space began in the heat of the greatest war humanity has ever waged. The first carrier rockets were developed by the German arms industry towards the end of the Second World War: the famous V2 missiles[1], which, after the Allied victory, fell into American and Soviet hands, although the Soviets already had their own rocket programme underway. Both used those German missiles for their first forays into space, including the taking of the first photograph of the Earth on 24 October 1946. Around that time, a new period of competition between the major powers began, but this time it was indirect, and in many respects covert, in the form of the Cold War, where prestige and gaining influence took precedence over the use of force itself, although they did resort to it when they deemed it necessary, but always against third parties, because nuclear weapons had come to dominate the domain (Freedman, 1983).

In this way, the first decade of the Cold War culminated on 4 October 1957 with the Soviets' launch of the first space satellite

[1] Nowadays, they can be seen, amongst other places, at the Musée de l'Armée in Paris, the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik in Munich, and the Militärhistorisches Museum der Bundeswehr in Dresden.

into orbit, Sputnik, a device that was certainly harmless from a military point of view, but which raised a number of key issues (Dickson, 2007). The first was the development of technical and technological capabilities by the Soviets, which enabled them to stay ahead of their Western competitor. The second was the strategic impact of this event on the United States, as they suddenly found themselves facing an opponent's device flying over their airspace with impunity, albeit from outer space. And the third, and ultimately the most important, was a consequence of the previous one: Does the satellite carry weapons? Does it have the capacity to launch nuclear weapons? Although today we know the answer, at the time it caused real consternation and also called for an immediate response.

It was precisely at that moment when a new dimension of combat emerged: outer space. Although it would not become established as such until many decades later, due to continuous technological advances of a dual nature, in other words, both civilian and military.

Thus, during the Cold War, the 'conquest of space' became a genuine military space race, in which launch vehicles (missiles), guidance systems and the crews of the first spacecraft always originated in the military field. In turn, the main aims and objectives centred on strengthening the respective capabilities in the event of a conflict, ranging from early-warning systems against ballistic missiles to reconnaissance, surveillance, command, and control. However, programmes were also activated at that time with the potential to destroy both ground-based and space-based capabilities, the development of which continues to this day. Weapons were even tested in space.

It was a race with just two competitors, vying for first place with successes on both sides, but also with catastrophic failures, resulting in casualties on both blocs. However, military advantage and prestige are a constant feature of the struggle between great powers, which by that time had become superpowers thanks to nuclear weapons (Morgenthau, 1948).

During the Cold War, the US nuclear test carried out in space on 8 July 1962 (Operation Starfish Prime) demonstrated that nuclear weapons could cause indiscriminate damage not only to ground-based electronic systems but also to satellites in orbit and other spacecraft (National Security Archives, 1962). It was precisely at that moment that negotiations began, which led to the signing, on 27 January 1967, of the Outer Space Treaty, which prohibited the presence of weapons of mass destruction in space, but not other types of armaments or combat systems. The emergence of a nascent body of space law comprising treaties, declarations and principles based on the peaceful use of space (*cf.* González Ferreiro, 2021) has made it possible to move towards creating a consensus on the existence of a general prohibition on the presence of weapons in space through repeated practice, although this has not yet been established as a rule of international law.

It was not until almost the end of the Cold War that the major powers decided to cooperate in space, promoting scientific and technological projects of a distinctly civilian nature. These were the golden years of space cooperation, of the Russian Mir space station, of the creation of the International Space Station and of so many other successful projects in which the main Western space agencies (NASA, ESA, JAXA) cooperated alongside the Roscosmos.

After the end of the Cold War, the onset of globalisation led to an expansion of the world economy and communications, not only in advanced societies, but as an unstoppable process that spread to every corner of the planet. The global arena, with all economies interconnected, fostered the development of new communication systems for all kinds of transactions, exchanges and the transport of goods and services (Blasco, 2020a). At the same time, civil societies began an accelerated process of global interconnection through the use of the Internet, which has extended to instant messaging systems and social media used daily by billions of people, ranging from business to the simplest activities of daily life, leisure and social relationships. Consequently, the demands for efficient communications and the mass transmission of data has become unstoppable. In this context, space plays a key role, precisely because of its issues of immediacy, but also as a result of the reduction in costs.

As a result, satellites have become absolutely indispensable to the functioning of contemporary societies, even more so in those that have reached the stage of information societies, also known as advanced or postmodern societies (Castells, 1996). At the same time, the risks of this dependence have increased significantly. However, measures to guarantee its functioning have not kept pace, and the vulnerability gap in the event of a crisis or conflict is growing ever wider. In this regard, an international verification regime has not been established either, despite the fact that the Outer Space Treaty, dated 27 January 1967, itself considers the possibility of carrying out inspection activities on the Moon and other celestial bodies, but not on satellites and spacecraft. In other words, every power with a presence has acted in accordance with its national interests (Waltz, 2000; Brzezinski, 2007) and has been constrained only by the need to coordinate the spectrum and orbital positions in which its space means operate (Dolman, 2002).

Over the last two decades, the globalised international system has moved from an era of cooperation to a new period of strategic competition between major powers, which in turn are the major space powers. New conflicts have arisen in which they are directly or indirectly involved (proxy wars) and where they employ all their capabilities to fight or to support their allies, including their space-based resources.

This reality underscores the validity of the maxim formulated by George Friedman in 2010, when he stated that the next world war would begin in the outer space. Not so much because he predicted a war fought predominantly in space—which he did—, but because he considered that the first act of war would consist of eliminating most of the adversary’s space systems through primarily kinetic attacks, involving their physical destruction (Friedman, 2010). The aim of such a first strike would be not only to target intelligence, surveillance and reconnaissance (ISR) capabilities, but also the command, control, communications and computing (C4) systems and global positioning satellite (GPS) systems required for the functioning of vehicles, ships, aircraft and guided munitions, thereby rendering the fundamental capabilities of multi-domain warfare ineffective.

The most recent war conflicts (the Nagorno-Karabakh War, the war in Ukraine, the wars in the Middle East, and the US intervention in Venezuela) have made it clear that it is no longer possible to wage war without the use of space. All the major powers have ongoing military space programmes covering the areas mentioned, also including anti-satellite (ASAT) capabilities, but for the time being, no one enjoys a decisive technological advantage that would allow them to gain the upper hand over the rest (Pérez Gil, 2020). This state of affairs raises important questions.

The first concerns the militarisation of space, which, as it has been seen, lies at the root of the very race to conquer it. All systems in orbit contribute to multiplying combat capabilities (Cano García, 2000), but one or more powers might also decide to put weapons systems in orbit, thereby entering the stage of space 'weaponization'. Over the last decade at least, advances have been made in this area, and its implementation appears to be drawing ever closer in an ever-escalating strategic environment (Pérez Gil, 2020). Consequently, should this take place, it would undermine the fundamental consensus that has hitherto governed the absence of weapons in space. At this point, and with the prospect of the loss of all the arms control treaties agreed at the end of the Cold War (Pérez Gil, 2019; 2025), the denunciation and subsequent withdrawal from the Outer Space Treaty cannot be ruled out, as it is considered to have become obsolete and no longer serves the interests of the major space powers.

It is estimated that currently one hundred and ninety countries and private companies have 48,600 objects of all kinds in space. Furthermore, 90% of these are in low orbit (LEO), of which approximately half are obsolete, posing problems regarding the clean-up and reuse of these orbits[2]. Their vulnerability is extraordinary because they can be affected by high-powered lasers and microwave weapons located both on the ground and in space—systems in which rapid advances are being made—, as well as by cyberattacks, without the need to physically destroy them. And, as mentioned before, in the event of an open conflict between major powers, one or more high-powered nuclear detonations would be sufficient to render most of these satellites inoperable due to the impact of the electromagnetic pulse and radiation, a situation that would represent a genuine catastrophe for global communications infrastructure (Porteous, 2025).

The second issue is that, as a result of this strategic competitive landscape, there are no incentives to reach fundamental agreements on the regulation of space use. More specifically, the declaration of space as a common good or shared space of humanity is rejected (as is recognised in the case of international waters or, temporarily, with regard to the territory of Antarctica), and energy and mining projects are already being proposed. However, these are still in the early stages as the necessary technologies to carry them out are not yet available (Blasco, 2020b), but it is only a matter of time. What is indeed certain is that the powers leading these activities (first movers) will dictate the rules that will apply to them in the future.

[2] The US aerospace company SpaceX has become the undisputed global leader in satellite launches thanks to its reusable rockets.

The third is that, due to the widespread adoption and reduction in costs of space technologies, an increasing number of countries and private companies are joining a new space race (Hainaut, 2023), also known as the 'democratisation of space.' Mastering space has a multiplier effect on their economies, enabling them to gain autonomy in communications, image acquisition and the fight against natural disasters, whilst increasing their own military capabilities; however, it also creates new risks and threats (Altaf, 2025).

The fourth is the recognition that, after seventy years of the space race, there is still no common or international authority over space. During that time, the major powers have been unable to reach an agreement on this point, either by establishing their own body or by turning to the United Nations' own system to achieve this, on the principle that no one wishes to be tied to agreements that might limit the development of novel capabilities.

Equally, it seems clear that very few countries would agree to a regime of inspections of their space systems or capabilities (Coria, 2026). For example, until 1992, the US National Reconnaissance Office (the famous NRO) functioned as a secret agency to prevent any type of interference or investigation into its capabilities (Porteous, 2025). Currently, such initiatives would be even less acceptable, given that a group of emerging powers have active space programmes and are striving to gain recognition of their own status and, therefore, of their capacity to participate in the creation of international regimes. India and Brazil are the most notable examples, although not the only ones.

Consequently, as long as no international authority emerges, that role falls to the UN Security Council in all matters relating to the maintenance of international peace and security, and only the Council itself has the authority to make such a declaration. It should be made clear from the outset that this body is composed of the five victorious powers of the Second World War (P5), which also possess more than 95% of all existing nuclear weapons and which, with their right of veto, are the main shapers of international law; in short, they constitute the world's board of directors. The remaining bodies act only when the Council itself permits them to do so, either by action or by omission[3].

[3] A case in point is General Assembly Resolution 1884, dated October 1963, which predates the adoption of the Outer Space Treaty and was adopted following a diplo-

Consequently, it will be those major powers (and not the rest) that will lay down the basic rules for the exploitation and allocation of space, where applicable. But none of this is set in stone; it can change. And that change may respond to two different approaches. The first is that of cooperation, which prevailed in the 1990s and continued into the first decade of this century. The major powers may decide to establish an explicit regime, setting out a set of norms, rules and decision-making procedures to enable the peaceful exploitation of space. However, they may also agree on a division of areas or even a specialisation based on capabilities, which would then be shared within a sort of implicit regime, one that is less stable and subject to recurring tensions (Bateman, 2023).

On the other hand, the struggle for power and influence may escalate into conflict. So, one or more major powers will prevail in a decisive confrontation, as happened in the Second World War. The winner (*hegemon*) or winners (depending on whether the system is bilateral or multilateral) will then establish a new international order intended to remain in place for a long period of time. That order will also apply in outer space (Friedman, 2010).

These ideas and theoretical reflections, in light of the changes happening in the current international system, are what underpin and justify the *Geopolitics of Space* monography being presented at the moment. The recognition of space as one of the six domains of combat (land, sea, air, space, cyberspace and the cognitive domain) in recent conflicts led to the creation of a working group within the Spanish Institute for Strategic Studies (IEEE), which, as part of the annual research plan of the Centre for National Defence Studies (CESEDEN), would address the issues raised. It is true that the work was based on a previous strategy paper on space (Spanish Institute for Strategic Studies, 2021), and while that paper focused on an analysis grounded in cooperation and the peaceful use of space, the aim here is to advance the study of space as a domain of combat, a reality that has become inescapable.

To this end, Spanish experts from the business, government and space industry were convened under the presidency of Pedro Duque, who can be considered the most respected Spaniard in this field, not only because he had the opportunity to fly on two space missions, both on a US space shuttle (October to

matic agreement between the Soviets and the Americans.

November 1998) and on a Russian spacecraft (October 2003), but also because he has continued to work in a sector he knows inside out and, since December 2023, has presided over one of Spain's leading space companies, Hispasat.

Duque writes the first chapter of the strategy paper, where he discusses the use of space, the technological barriers of this extremely complex environment, and its ever-increasing economic value for developed societies. As he notes at the beginning of his chapter, placing devices in space, in orbit around the Earth or further afield, offers enormous advantages and makes it possible to devise solutions to needs that, in many cases, are entirely different from and superior to those possible on Earth. And this has to do with the innate capacity of the human being to progress, to go further, to create and to make life more comfortable in an increasingly sustainable environment, where development and growth go hand in hand. In space, there is a relatively invulnerable territory where telecommunications have developed at an extraordinary speed, improving human activities in virtually every field; where the capacity for permanent observation has been achieved, regardless of climatic or weather conditions; and where progress is being made in the search for new sources of energy and resources.

But it is not just that. Space is the best vantage point for observing the universe. Beyond the atmosphere, these devices have a virtually infinite field of view, as is regularly demonstrated by the images provided by large space-based telescopes, such as the Hubble or the James Webb, to cite the best-known examples. And these advancements are being made by overcoming technological barriers that are primarily related to an environment hostile to goods, equipment and human beings, although it must be acknowledged that we are still in the early stages of our civilisation's use of space and energy according to the Kardashev scale (1964). But challenges are there to be overcome, and this is where Duque highlights the value of space as a driving force behind the global economy, based on overwhelming global connectivity.

Whereas until very recently the talk was of space constellations comprising thousands of satellites[4], plans are now being made

[4] At the time of drafting this introduction, in February 2026, SpaceX's Starlink Internet access constellation had 11,130 operational satellites in LEO orbit.

for hundreds of thousands[5] or even a million satellites, in this case to be used for data storage and transmission, cutting costs and reducing the environmental impact of ground-based storage centres[6]. Similarly, progress seems unstoppable in the field of using new energy sources in space. But it is also necessary to preserve and protect all these developments, because the future of contemporary societies is inextricably linked to the successful development of space activities. This is where the concepts of security, space superiority and resilience, which are analysed in the following chapters, come into play.

Ana Molina, the newly appointed CEO of Hisdesat, introduces the second chapter, which focuses on current and potential European programmes, based on the fundamental premise that Europe is facing a pivotal moment in the field of space. Faced with a scenario of increasing militarisation, the development of mega-constellations, dependence on third parties for essential services, and technological competition between major powers, several Member States have taken the initiative to accelerate European strategic autonomy and assert their leadership. Capabilities have been developed in three parallel and complementary areas: the European Space Agency (ESA), the European Space Programme led by the European Commission, and the programmes developed independently by each Member State, which are pooled according to their own interests and needs, sharing capabilities and gaining returns.

It thus provides a comprehensive overview of successful programmes such as Copernicus, Galileo and the European Geostationary Navigation Overlay Service (EGNOS), but also of projects that the current international context has helped to accelerate, significantly reducing development times, such as the future multi-orbit secure communications constellation IRIS², a public-private collaboration that uses the response of Member States to the challenges facing the aerospace industry, or the advances being made in access to space.

At the same time, significant efforts are being made in ISR capabilities, as well as in disruptive technologies such as key distribution

[5] In December 2025, the Chinese Government submitted plans to the International Telecommunication Union (ITU) to establish two space constellations comprising 200,000 satellites.

[6] In January 2026, SpaceX submitted plans to the US Federal Communications Commission to launch a constellation of one million mini-satellites into LEO, designed to function as an orbital data centre.

or quantum gravimetry, which aim to meet European ambitions in the space domain. Through the proposed EU Space Act, the aim is to advance towards establishing a harmonised legal framework based on three key pillars: the security, resilience and sustainability of space assets. It is expected to come into force in 2030 and will apply to both EU operators and those from third-party countries providing services within European territory, excluding assets used for security and defence purposes.

In the third chapter, José María Cifuentes Rivera, who works in the Concept Development and Experimentation Division of the NATO Centre of Excellence for Space, introduces the approach to military operations adopted by the countries and alliances that make up the Western Bloc. He begins with fundamental issues such as the recognition of the importance of space for security and defence, its multiplier effect on military operations in other operational domains (land, sea, air or cyberspace), as well as the need to guarantee and protect one's own assets in the face of the unstoppable presence of Russia and China, but also from other regional powers and non-state actors that pose new risks and threats to the peaceful exploitation of space. To respond successfully to this competitive environment, it is necessary to promote compatibility and interoperability between national capabilities, as these are essential for providing support to military operations as part of a strategy of deterrence and resilience.

Cifuentes Rivera writes about NATO's advances in the space domain, which implicitly recognise the possibility that space may become a battlefield in the not-too-distant future, as theorised by authors such as Friedman (2010) and Johnson-Freese (2017). He examines the principles of NATO's Global Space Policy, present and future allied capabilities, and their employment as part of an integrated deterrence strategy based primarily on defensive operations, but which also considers offensive actions within the plan, execute and evaluate doctrine, including the possibility of triggering Article 5 of the Washington Treaty in response to an attack in space.

He then studies the United States capabilities from a position of space leadership, its June 2020 space defence strategy, and its comprehensive approach that combines military assets and civilian means, which it also actively funds and promotes. The stated objective is to achieve strategic space superiority over other powers, taking into account that, under US doctrine, space is considered a new domain of combat. To achieve this, they are also committed to arms initiatives such as the Golden Dome, launched by President Donald Trump as a revival of President Ronald Reagan's Strategic Defence Initiative, dated March 1983. However, it must be taken into account that these projects, which call for the deployment of kinetic interceptors in space, although they remain a prohibitively complicated possibility in economic and technological terms, undermine the foundations of the strategy of mutually assured destruction, which has guaranteed peace between major powers since the days of the Cold War (Podvig, 2025). Cifuentes Rivera also examines the capabilities of other Western space powers, such as the United Kingdom, Canada, Australia and Japan, and their contribution to deterrence and collective defence.

Meanwhile, José M. Martínez Cortés, a scholar at the Centre for International Security at the Francisco de Vitoria University in Madrid, continues in chapter four with an analysis of the strategic competition and control of space, in which he examines in detail the space strategies, policies and capabilities of major emerging powers such as China, Russia and India, placing particular emphasis on specific capabilities for offensive space control. All of them are benefiting from greater access to space technologies and the reduction in cost of satellite systems, and are seeking to equip themselves with the means to oppose and counter the military capabilities of potential adversaries in the event of a crisis or conflict.

Martínez Cortés begins his presentation with an analysis of space control capabilities, detailing the means and resources required to act upon and against a potential adversary's in-orbit systems. He then addresses the developments, doctrines and capabilities of China, Russia and also India in their sustained efforts to compete with the West, especially in the case of the first two, and to equip themselves with the necessary means to gain power and influence in the space domain as well. He also highlights some of the advanced programmes developed in the utmost secrecy, such as various types of lasers, high-power microwave weapons and satellite interceptors, and their potential offensive employment in future conflicts. He even raises the prospect of the employment of nuclear weapons in space, as it has been mentioned before. The ultimate shared objective of these powers is to change the rules of an international order that does not serve their interests, and which could lead to a decisive clash with the West.

Juan Manuel Chomón Pérez, who is a member of the EU Military Staff, dedicates the fifth chapter to one of the key themes that justify the production of this paper, namely European strategic autonomy in space. The EU is a leading player in space thanks to flagship programmes such as Galileo, Copernicus, EGNOS and GOVSATCOM, some of which are not known to the general public, and which have been developed in close cooperation with the ESA. Huge investments have also been made to develop initiatives such as IRIS², the Earth Observation Governmental Service (EOGS) and the so-called European Space Shield, an initiative aimed at equipping Member States with the necessary space capabilities to strengthen the resilience and protection of space infrastructures towards a fully dual-use space architecture. There is therefore a common goal among the EU, the ESA and the Member States to share capabilities and advance towards an integration model that will enable them to compete with the major powers in the space domain.

However, there are structural gaps that prevent progress from being made with the necessary speed, such as technological, investment and operational gaps, which stem precisely from this institutional fragmentation and the difficulties in coordinating national policies under a common command. The first gap lies in the dependence on external suppliers for critical technologies. The second in the fragmentation of the European market, the dispersion of financial resources and the redundancy in programme development. Within the EU alone, funds are allocated to the European Defence Fund (EDF), Permanent Structured Cooperation (PESCO), the SAFE programme and the RE-ARM initiative, to which funding must be added for the ESA activities and national space programmes themselves. The third is reflected in the absence of a sufficiently robust common framework to enable the integration of the use of all space capabilities into missions and operations under the Common Security and Defence Policy (CSDP).

Consequently, despite the advances made, European space autonomy remains limited and further work is needed in the political, institutional and financial fields to achieve the long-sought strategic independence in an increasingly complex and unstable international system. With this in mind, Chomón Pérez outlines a series of perspectives for 2035 that range from the fragmentation of efforts and capabilities, and dependence on the US and NATO, to strategic autonomy, an optimistic scenario in which the EU would not only succeed in fully exploiting all of its space capabilities, some of which are still under development, but would also consolidate a space defence system integrated with that of its Member States and possessing a high level of autonomy.

Juan Carlos Sánchez Delgado, Director of Security and Planning at the Spanish Space Agency (AEE), and Juan Antonio de la Torre Valentín, Deputy Director-General for Communications and Infrastructure within the National Security System of the Department of National Security (DSN), have jointly authored chapter 6, which is dedicated to the National Aerospace Security Strategy (ESAN). After a brief overview of the background, they focus on the analysis of the most recent ESAN, approved on 14 July 2025, which introduces the concept of 'domain' into official Spanish documents; redefines the approach to security in the air and space domains, and highlights their significance within the Spanish National Security System.

The document defines national interests in this environment and establishes three main objectives: protecting Spain's position in the aerospace field, enhancing security and defence capabilities, and promoting a safer and more sustainable environment. It advocates for European resilience and cooperation as key factors in minimising risks and threats in space. Furthermore, it anticipates the need for its own national space strategy that integrates security, defence and governance as a guarantee for maintaining sovereignty and competitiveness in a contested international context.

They also carry out a comparative study of the respective space strategies of France and Germany as Spain's closest allies and propose moving towards separate Spanish strategies for space security and space policy, integrating security, defence and sustainability through a comprehensive state-led approach. It is precisely this evolution of the strategic environment that makes it absolutely necessary to strengthen capabilities for anticipation, early warning, resilience and a comprehensive response to threats in space, as well as to prepare and approve the necessary doctrinal and legal frameworks to effectively address new hybrid and more technologically complex scenarios.

Cecilia Hernández Rodríguez, Director of Programmes and Industry at the AEE, closes the paper with chapter seven, which examines the present and potential capabilities of the Spanish industry to make decisive contributions to European security and defence. On the one hand, she analyses the evolution of the European space industry, which has moved from a predominantly civilian model to a dual-use approach following the Space Strategy for Europe, of October 2016. Its implementation accelerated the discussion on the need for specific operational structures for the space domain, fostered inter-institutional dialogue led by the European Commission and the European External Action Service (EEAS), and placed the main space programmes at the heart of the discourse on strategic autonomy.

Furthermore, initiatives aimed at improving border control, maritime surveillance and secure government communications (GOVSATCOM and EU SST, among others) were launched. This change in approach was first set out in the Strategic Compass of March 2022, which recognises space as a strategic domain, and subsequently in the EU Space Strategy for Security and Defence of March 2023, which definitively established the convergence between space capabilities and defence objectives. During this period, progress was also made in the cooperation with the ESA and at the ministerial summit in Bremen in November 2025, where Member States agreed to a significant increase in their financial contributions, including Spain, which has now risen to a prominent fourth place.

These efforts should be maintained in the EU's next Multiannual Financial Framework from 2028 onwards. These present opportunities for each country's space industries, which receive returns proportional to their contributions, and which must be harnessed to overcome the gaps detected, especially in the areas of advanced electronic components, access to geostationary orbits, and the vulnerability of the supply chain for critical materials, including rare earths, which are essential for electric propulsion systems.

In this scenario, Spain emerges as a key player thanks to a dual institutional architecture that integrates the civil and military fields. Firstly, with the creation of the AEE in April 2023, which has a mandate to act in four key areas: the coordination of defence space programmes, representation in European bodies and forums, the promotion of the space industry ecosystem, and the development of sovereign capabilities in critical segments.

Secondly, within the operational structure of the Ministry of Defence, both within the Defence Staff, with the establishment of the Space Operations Command (MOESPA), and within the Air

Force, which in June 2022 was also renamed the Space Force, with the new Space Command (MESPA), which assumes responsibility for the preparation and operational direction of its space forces. Thus, the emphasis is placed on space operations within the new doctrine of multi-domain warfare.

Thirdly, within the bodies and agencies attached to the Secretary of State for Defence, particularly in the fields of technology and communications, in order to provide a detailed account of the technical and operational capabilities specific to the space domain: secure communications, Earth observation and geospatial intelligence, rapid response and remote access capabilities, satellite navigation, as well as operations of the EU Satellite Centre (SatCen) and the Security Monitoring Centre.

It concludes with the analysis of areas of potential contribution to the European space architecture, including the New Space ecosystem and its rapid response capabilities. As the author points out, Spain's consolidation as a key European space player requires not only appropriate strategic decisions but also sustained political willingness and the capacity to mobilise the necessary resources in a context of intense budgetary competition with other defence priorities. These are challenges that must be addressed within the framework of their design as state policies.

This is the general interest of this monography dedicated to the competition for hegemony in space, which is also being presented at a key moment, during a period of transition in the globalised international system, in which not only the dominance of the West is at stake, but also the very future of the EU and Spain as political organisations. Therefore, as some of the authors have proposed, this is an opportunity to make decisions with a long-term perspective, because this conflict can only end either with a cooperative regime that guarantees peace and security, or with a decisive confrontation, which would likely be disastrous in scale, and would open up a new era in international relations, one that is as for the moment unknown, including in the outer space.

To conclude this introduction, I would like to express my gratitude, on behalf of the Spanish Institute for Strategic Studies and on my own behalf, for the invaluable contribution made by the president of the working group, Pedro Duque, and his team, as well as by Major General (Air Force) Juan Carlos Sánchez Delgado and retired Colonel (Army) Juan Pons Alcoy, in the form of lengthy discussions that gave shape and substance to this strategy paper.

I would also like to thank the members of the working group and the authors of the chapters that make up this volume, for their commitment and dedication in reaching the conclusions set out in the text. All that remains is to recommend that you read it carefully and reflect deeply on the ideas put forward, as this is in the interests of our country's security and defence.

Madrid, April 2026.

Chapter one

Utilization of space, technological barriers and economic value for developed societies

Pedro Duque

Abstract

Placing devices in space, in orbit around the Earth or beyond, offers significant advantages and allows us to develop solutions to societal needs that, in many cases, are entirely different and better than those possible on Earth or using aircraft. Significant technological barriers hindered its use in the past, but we live in an era in which these barriers have been overcome with increasing efficiency. This means that, on the one hand, more space-based solutions are becoming convenient and economical, and on the other hand, more countries are developing their own ways to access and utilize space. The massive investments in innovation made by the United States and the Soviet Union to send their astronauts into Earth orbit enabled its use in various forms. Soon, other powers developed their own technologies, and others have since joined them. From the outset, the advantages that space could offer militaries were recognized, and pioneering treaties were signed that slowed the deployment of weaponry in orbit. But technological development has provided multiple ways in which access confers advantages, particularly in the areas of communications and intelligence.

Keywords

Space exploration, Secure communications, Observation, Intelligence, Global positioning systems.

Introduction

The desire to explore has always been a fundamental characteristic of human nature. The prehistoric man's capacity for innovation set him apart from other species and enabled him to explore new regions with different characteristics from those of his ancestral lands. The ability to make fire enabled survival in colder temperatures; the creation of warm clothing helped in the same way; weapons prevented them from falling prey to animals with significant adaptive advantages to the natural environment they explored. Cooking allowed man to consume foods that, naturally, would not form part of their diet; the construction of shelters protected early humans from the outdoors; and boats enabled them to cross bodies of water. All this without having to wait the thousands of generations that other species would need in order to adapt naturally to a new environment (Tattersall, 2012).

And so the coldest and warmest regions, the driest and wettest, the highlands and the valleys all became populated. Within a relatively short time, exploration led to the expansion of the species. And this drive has continued: people have explored the oceans and their depths, caves, high mountain peaks, rainforests and, finally, we have turned our attention to space.

There is no doubt that space holds a fascination for everyone, and that the initial drive to develop technologies to conquer it was a consequence of that fascination. The technological powers saw in the conquest of space an opportunity to demonstrate to the world, in a way that was immediately understood, their capacity for innovation and their scientific and technical pre-eminence (Davenport, 2018). Conquering space was, and to a large extent still is, a way of demonstrating the success of a technological society.

1 Relatively invulnerable

Satellites sent into orbit are completely immune to the events occurring on the Earth's surface or in the atmosphere. Natural disasters can disrupt land-based communications, but not those provided by satellites. For this reason, adequate preparation involving backup satellite systems can be highly effective in providing a rapid and coordinated response to the effects of any major disruption, be it due to natural causes or the consequence of an attack (Friedman, 2010). Just like communications, ground observation will continue as long as the necessary space resources are available to do it.

It is natural to think that the armed forces around the world have major incentives to destroy their adversaries' satellites. China and the United States as well as Russia and India have all already tested weapons systems capable of destroying a satellite in low orbit, and there are growing suspicions that the same offensive capabilities may exist against geostationary satellites. Less aggressive techniques, such as signal interference, including from other satellites, have been in use for a long time and satellite manufacturers are doing their part to counter these threats.

2 Telecommunications: the ideal repeater

Communications have always been the foundation of strong states and empires. Coordination between the various levels of society's leadership made it possible to make the right decisions based on reliable data. The Roman Empire relied on its roads for the transport of troops and goods, but they were also made very smooth so that messengers could travel at high speeds. Furthermore, the maritime transport network was, and continues to be, essential for communication.

Other means of communication were developed to enable the transmission of information without the need for a physical medium. The Great Wall of China was equipped with watchtowers that were within sight of the adjacent towers, so that messages could be sent quickly from one to another using smoke or fire. The height of the towers meant that a relatively small number were required. A conceptually similar system was the optical telegraph, such as the lines installed for military communications between Madrid and various points along the coast. In these cases, the height of the towers was also essential.

The taller a tower is, provided the signal balance is correct, the larger the area it can cover. Mobile phone networks rely on a huge number of towers to function, as there are restrictions on their height, both due to urban planning and the wind. Using the air or space instead of a tower removes these limitations.

Arthur C. Clarke, who later became a world-famous science fiction writer, was the first to propose, in 1945, the use of geostationary satellites as radio repeaters to provide global coverage. This is one of the great advantages of space: the possibility of direct contact with vast areas of the Earth. In fact, all it takes is three well-positioned satellites to connect with any point on Earth (Clarke, 1945). As early as the 1920s, both Herman Oberth (1923) and Herman Noordung (1929) carried out calculations which would make it possible, if rockets were developed as Oberth himself and Konstantin Tsiolkovsky (1903; 1929) had predicted, to use space in various ways, such as positioning stationary platforms above a point on the Earth’s surface for observation or communications.

For decades, telecommunications satellites have provided global coverage, and for a long time they have been the last resource to fail: anywhere in the world, people can coordinate their activities using satellites or call for help if necessary. The COSPAS-SARSAT international system receives standardised emergency beacon alerts and is in operation continuously throughout the world; there are no areas that are beyond its reach[1]. Similarly, thousands of isolated regions around the world receive mobile phone signals via satellite, enabling their populations to enjoy connectivity.

The altitude at which a satellite must be placed in order to remain stationary above a point on the Earth’s surface is extraordinarily high, at some 36,000 kilometres. Therefore, a high degree of sophistication and highly precise antennas are required for communication and, even so, the signal will always be subject to a certain delay determined by the speed of light. These technologies have been fully developed for many decades now, and modern satellites provide huge data capacities capable of serving thousands of users; however, the delay is a limitation for certain types of uses that require rapid user responses.

Satellites placed in lower orbits can provide a service without delay, but they have other limitations. One is the need for ground-based antennas that track the satellite as it passes at a high speed. The other is the need to place multiple (hundreds or thousands) of them into orbit so that they can ‘jump’ from one to another and ensure uninterrupted service. It has been less than a decade since these technical limitations were overcome, thereby enabling not only online computer games, but also highly significant uses in the fields of security and defence.

Constellations of multiple satellites, such as the current Starlink and OneWeb, have enabled the creation of extremely significant

1 Available at: https://www.cospas-sarsat.int/en

and strategic applications and, therefore, all technology powers are seeking to gain access to a system of this kind. The European Commission has created a flagship programme in this area, known as IRIS[2] (Infrastructure for Resilience, Interconnectivity and Security by Satellite), which is discussed in detail later in this paper.

3 Surveillance and intelligence: permanent observation

Observing the terrain has always been a key objective in the organisation of all human activities, particularly the use of large areas for agriculture or the strategic and tactical planning of military operations. Generals in the past needed a vantage point from which to make decisions and direct the movement of troops, and that necessity remains today. The first use of aviation in warfare was for observation from a truly advantageous position.

Another of the major advantages of space is the possibility of flying observation satellites for virtually indefinite periods of time, by taking advantage of the physics of orbits. Once an observation satellite has been placed in orbit, it can remain there for years with its engines switched off, using only a very small amount of fuel compared to the needs of an aeroplane which would performing the same function. Of course, using geostationary orbit has its advantages, as it simplifies everything, but the great distance from the Earth's surface makes it very difficult to design suitable cameras. Therefore, observation from space is achieved by using satellites stationed in lower orbits. These inevitably move at a high speed relative to ground level, so continuous observation requires having access to multiple platforms, which must be used in succession as they fly over the area to be studied or monitored.

4 Positioning: geographical references

Major empires required precise measurements of the terrain. Both the Roman and Chinese empires carried out precise measurements and placed boundary markers to mark places or specific distances. With increasing precision, we realise that no point on the Earth's surface is static. The Moon's gravitational pull not only causes tides in the oceans but also distorts the Earth's crust from 10 to 50 centimetres (Love, 1911).

The physics of orbits does, however, allow us to place geographical reference points in space whose position is known with great precision over time. This advantage, combined with the altitude, which provides a line of sight to large areas of land, has enabled us to create positioning systems, comprising just a few dozen satellites, which are now essential for a wide range of everyday uses.

5 Source of resources and energy

Another huge advantage of conquering space, although this has not yet been carried out on a useful scale, is the possibility of obtaining raw materials from other celestial bodies to supplement those in scarce supply on Earth. So far, only small amounts of material from the Moon have been recovered and, recently, a few grams from a couple of asteroids. However, the potential is huge and a much more economical access to space could create an entire industry centred on the extraction of raw materials (Lewis, 1996). Currently, many critical materials, which are in scarce supply on the Earth's surface, are the subject of disputes that are not only commercial, but also geopolitical. Discovering a new exploitable source would have a major impact on international relations and the balance of strategic autonomy.

On the other hand, large quantities of solar energy can be harnessed in space, as there are virtually no limits in orbit to the size that photovoltaic or concentrated solar power installations could reach. If the operational challenge of transporting that energy to the Earth's surface efficiently and safely were to be resolved, for which there are theoretical solutions, this could also have a major impact on the distribution of energy on Earth by using assets in space.

6 Research: better than the highest mountain

Since ancient times, observing the sky required good weather conditions and clean air. The mountains have always been the best place, rising above a large part of the cloud cover; that is where the ancient astrologers used to go, and where we now install our telescopes. Just as with observation of the ground, observation of the sky is greatly enhanced when done from space, as this eliminates the distortion caused by the atmosphere, and even allows for observation at wavelengths that do not penetrate the atmosphere at all.

Telescopes in space can be in different orbits, often chosen for operational convenience (for example, INTEGRAL[2]) or because of the maximum altitude that the chosen rocket could reach (for example, the Hubble, placed where the Space Shuttle could reach it for maintenance[3]). The best orbit for many observations is that which allows the universe to be observed without interference from the Sun; in particular, the so-called L2 orbit of the Sun-Earth system (after the great 18th-century mathematician and physicist Lagrange) is mainly used: a position on the Sun-Earth line that is permanently within our planet's shadow.

Space is also used to carry out tests under conditions of prolonged weightlessness, which is of great use in various scientific fields. The current International Space Station is home to hundreds of pieces of equipment where these experiments are carried out. Although it has not yet been possible to carry out on an economically useful scale, the possibility of improving (or even enabling) certain industrial processes using weightlessness should not be ruled out.

7 Technological barriers

Working in space is not difficult because the technology is lacking, but rather because it is the most demanding environment humanity has ever faced. It is not just about advanced engineering, but about engineering pushed to its absolute limits in order to overcome an extremely hostile environment. And yet, here we are.

A hostile environment is not an obstacle; it is a filter. It removes improvisation; only the best-designed technology survives; excellence prevails. Each mission requires strategic thinking, optimisation and cooperation. It forces us to be more resourceful and speeds up the intelligence of our machines. The technological barriers of space are not walls; they are steps that force us to be better.

Sending an object into space requires a huge amount of energy to be released in a very short space of time, which means that technically sophisticated methods are needed to achieve this. A current Falcon 9 rocket generates a take-off power of

[2] Available at: https://www.esa.int/Science_Exploration/Space_Science/Integral_overview
[3] Available at: https://www.esa.int/Science_Exploration/Space_Science/Hubble_overview

around 25 gigawatts (GW). If we wanted to transmit this power via a cable, the cable would be much thicker than the rocket itself. The ability to develop all that power within a lightweight structure and control it with precision requires a range of technologies that only became available from the second half of the 20th century. Notwithstanding the possible emergence of disruptive advancements in the future, currently the main barrier to using the undeniable and numerous advantages of space remains the launch cost, as discussed in the following chapter. The main driver behind the recent falling cost of this technology has been the development of rockets, parts of which return and land in order to be reused. As a result, the cost per kilogram for a large satellite weighing several tonnes has now been reduced from around EUR 25,000 to EUR 2,500. The hope is that future launchers could reduce this price by a further factor of 10, primarily through an increase in the rocket's total capacity and a reduction in the operational costs associated with refurbishing the reusable sections.

What's more, in order to utilise space, it was necessary to overcome other barriers by developing specific technologies, given that no other field of engineering has to operate under the extreme conditions of remoteness, radiation and vacuum that are found in the space environment.

Its remoteness makes any physical maintenance almost impossible, which means that reliability must be much greater than in systems operated on land. It is therefore necessary to design satellites with duplicate systems and with the means to monitor every physical variable (including internal ones) in the various components, in order to detect or even predict failures. A sophisticated car may have a couple of hundred sensors, meanwhile a geostationary communications satellite may have twenty thousand. Not only is it necessary to have duplicate systems, but each one must be far more reliable than the equivalent equipment on land, which could be repaired or replaced much more easily.

The radiation environment, perhaps only comparable to equipment used in nuclear power stations, requires highly specialised technologies, notably in the field of electronics. Each of the integrated circuits in a satellite generally comes from a separate manufacturing line to the circuits for terrestrial use and requires very different techniques to ensure that the radiation in space does not destroy them or alter the contents of their memory.

The vacuum means that all materials that could contain trapped air, solvents or adhesives must be eliminated, as these would be lost in the space environment or, worse still, exert pressure. For example, the welding techniques must be highly specialised, as a bubble could cause them to burst from the inside. On the other hand, the majority of, if not all, electronic components and computers use fans to cool hot parts. Needless to say, that cooling technique is impossible in a vacuum. Although Russia has manufactured satellites in which the electronics were housed within a pressurised compartment, the cooling of electronics in space generally requires a sophisticated system of heat transfer through metals and the concentration of heat in radiators. These methods are entirely different from the technologies used on Earth and which, therefore, make design and manufacturing more difficult and expensive.

8 The value of space in our economy

Space is one of the emerging driving forces of the global economy. Its economic value is not limited to traditional satellite launch or manufacturing activities, but rather it encompasses an entire ecosystem that drives sectors as diverse as telecommunications, navigation, logistics, Earth observation, environmental management, defence, retail and mobility.

Space technologies now form part of the planet’s critical economic infrastructure and bring value to telecommunications and connectivity, as satellite networks enable resilient global communications. Satellite constellations such as Starlink, OneWeb and Amazon LEO are transforming Internet access. In navigation and transport, global positioning systems such as GPS, Galileo and GLONASS underpin global logistics, aviation, and maritime and land transport.

In addition, we must consider the advances that are enabling Earth observation in agriculture, environmental management, maritime security and disaster response, all of which rely on satellite data. Banking, e-commerce, power grids and telecommunications rely on the precise synchronization provided by satellites. And, of course, in defence and security, where space is already a strategic domain in which a large part of modern military superiority is decided, as discussed later in this paper.

The aerospace industry has recently undergone a disruptive transformation through vertical integration, supported by vast amounts of U.S. public funding, which has made access to space more affordable. This has enabled the refinement of a long-standing idea: reusable, high-capacity launch rockets. As a result, the testing cycles for new uses of space are becoming increasingly shorter and more efficient.

Meanwhile, the deployment of satellite constellations has finally made it possible to apply the economies of scale, so prevalent in other industries, to the manufacturing of space vehicles. This has enabled a significant reduction in the cost per unit, not only because of the volume manufactured, but also because the reliability of the entire system is highly resilient to individual failures in certain units, which greatly reduces the cost of quality control at all levels.

This has not only led to the emergence of new companies, but also to a greater number of countries with space assets, which recognise the possibility of joining the scientific endeavour and are also seeking to acquire strategic autonomy.

It should also be noted that investment in space has a significant knock-on effect on innovation, skilled employment, technological development and advanced industry. Entire sectors such as mobility, autonomous transport, space tourism and cybersecurity are becoming more and more dependent on space. In fact, activities such as reliable weather forecasting for agriculture, insurance and transport, e-commerce and digital banking synchronisation, all require satellite services, as do global navigation for maritime transport and aviation, as well as climate monitoring and support for environmental policies. Without this infrastructure, the global economy would be slower, more expensive and less secure and resilient.

New standard communication protocols are emerging that will enable direct communication with mobile phones and cars. In addition, we must consider the changes materialising due to widespread use of Artificial Intelligence (AI) and process automation. As well as that brought about by quantum computing, which represents a paradigm shift in the security for computers, communications and key transmission and generation.

All of the above indicates that space assets have enormous economic value, due to their replacement cost, but above all due to their multiplier effect on economic activity in advanced societies. Therefore, it is not only necessary to consider the protection of assets exclusively used by the armed forces or security systems, but also all other space-based systems, given that, in the event of conflict, they could become targets for an adversary, causing major disruptions to the economy.

Conclusions

The use of space, involving the placement of a wide variety of devices into orbit, offers significant advantages and holds great interest in terms of improving, and in some cases the facilitating, many aspects of society. This has inspired major technological endeavours to overcome the barriers that it presents. During the second half of the 20th century, several technological powers, led by the Soviet Union and the United States, made significant investments in order to conquer space through the sustained and operational deployment of their satellites, and by sending astronauts there. Europe, Japan, India and (currently making a great effort) China have, to some extent, managed to develop their own equivalent technology.

The armed forces, as is usually the case, also recognised at an early stage the need to develop space-related capabilities. Secure and instant communication between any two points; the continuous observation and surveillance of large areas of land; the precise positioning of vehicles, etc., are not only activities that must be protected due to their great importance and economic value to society, but they also constitute operational necessities of the highest priority for the armed forces themselves. As early as 1996, the United States Air Force introduced the concept of space superiority as one of its core competencies, and this trend has only grown since then. In contemporary conflicts, whoever has greater and better access to space-based data and communications has a decisive advantage; and, of course, in the event of a conflict between powers with space capabilities, the tendency will be to attempt to eliminate those of the adversary.

Chapter two

Current and potential European space programmes

Ana Molina Sánchez

Abstract

Europe is facing a decisive moment in the space domain. The growing militarisation of space, the development of megaconstellations, dependence on critical services, and technological competition with the United States and China have turned space into a strategic pillar for Europe's security, economy, and resilience. In this context, the European Union, European Space Agency, and Member States are launching a new generation of programmes aimed at securing essential capabilities. Ongoing programmes such as Galileo and Copernicus provide a solid foundation on which new developments are being built. Particularly noteworthy is IRIS², the future multiorbit secure communications constellation under development through a publicprivate partnership. In parallel, the reinforcement of ISR capabilities and the commitment to disruptive technologies are shaping a new European ambition. Member States are complementing this momentum with national strategies that place greater industrial leadership at the centre of space operations. Both the ESA Ministerial Conference of November 2025 and the ongoing negotiations on the EU's Multiannual Financial Framework are evidence of European ambition and point to a historic increase in space investment. Regarding legislation and governance, the new European Space Law, EU Space Act, stands out.

Keywords

Europe, Space programme, National space strategies, Space governance and budgets, New space developments.

Introduction

Space, due to its very nature, is a transnational environment. Satellites are not bound by borders or geographical features. They provide a global service, and their development, launch and operation require major investments. This means that collaboration between allied states and the development of joint projects is essential when it comes to gaining access to this type of infrastructure.

Nevertheless, the new geopolitical framework in which Europe operates, defined by the growing militarisation of the region, dependence on critical services and global competition with powers such as the United States and China, combined with the disruption that has taken place in the aerospace industry, have changed this situation. For both these reasons, space has become a key strategic domain for Europe's security, defence and technological competitiveness. In the words of the EU High Representative for Foreign Affairs and Security Policy, Kaja Kallas, 'when we defend space, we are defending our economies. The security of our satellites is the security of our societies'[1].

Faced with such a situation, several EU Member States have taken the initiative to achieve strategic autonomy in space and seek a position. The common denominator in all of them is the recognition that bilateral and multilateral cooperation is needed to ensure that their level of ambition and deterrence is credible. This process is simultaneously leading to faster progress in establishing a common European position and the activation of mechanisms and tools for its implementation. We are facing a historic moment in regard to the alignment of interests and the willingness of institutions to facilitate said ambition in a cooperative environment.

Serving as an example is the speed with which the IRIS[2] programme was developed and launched; its aim is to deploy a secure government communications infrastructure for Member States and allied countries. The programme has set a record for the speed of its legislative and acquisition process, whilst simultaneously providing a model for the EU's acquisition of capabilities through a publicprivate partnership mechanism.

[1] European Space Conference, 29 January 2025. Available at: https://www.eeas.europa.eu/eeas/speech-eu-high-representativevice-president-kaja-kallas-17th-european-space-conference_en

Europe, through the EU and the European Space Agency (ESA), has established initiatives that have provided (and will provide in the future) its Member States with strategic autonomy to access space and to develop resilient, technologically advanced infrastructure under European sovereignty. Although these capabilities, mainly those that already exist and those under development, are primarily civilian in nature, they have a direct application in both global geostrategy and defence and security. The current situation has spurred interest and ambition for the development of a Europe of defence, with shared European capabilities in the field of space defence as well. The drive shown by the Commissioner for Defence and Space, Andrius Kubilius, is undeniable, and his determination to restore Europe's position as a space power is acting as a catalyst for the adoption of agreements and the launch of initiatives. Particularly noteworthy are his words at the opening session of the ESA ministerial meeting on 25 November 2025: 'The future belongs to space. Whoever controls space, controls the future'[2].

1 Europe in the global context

In the field of space, Europe, thanks to the initiatives of its Member States, the European Commission and the ESA, has established itself as a key player in the global context. However, it plays a secondary role compared to the hegemony of the United States and the strength of China. This is largely due to the fragmentation of national programmes in a sector where economies of scale are important, and to low investment compared to GDP in the space sector: 0.06% in Europe, compared with the United States (0.26%), Russia (0.17%) and China (0.08%). Figures provided by the Director General of the ESA, Josef Aschbacher, not including military budget[3]. In the words of Kubilius: 'Our public spending on space is too low and also fragmented. Making big, ambitious, long-term projects is very difficult'[4].

Initiatives at European level facilitate the development of large-scale joint programmes by bringing together the needs of Member States. They enable the combining of technological, industrial

[2] Available at: https://ec.europa.eu/commission/presscorner/detail/en/speech_25_2818

[3] At the annual press conference, 9 January 2025. Available at: https://www.esa.int/ESA_Multimedia/Videos/2025/01/ESA_Director_General_s_Annual_Press_Briefing

[4] European Space Conference, 28 January 2025. Available at: https://ec.europa.eu/commission/presscorner/detail/en/speech_25_333

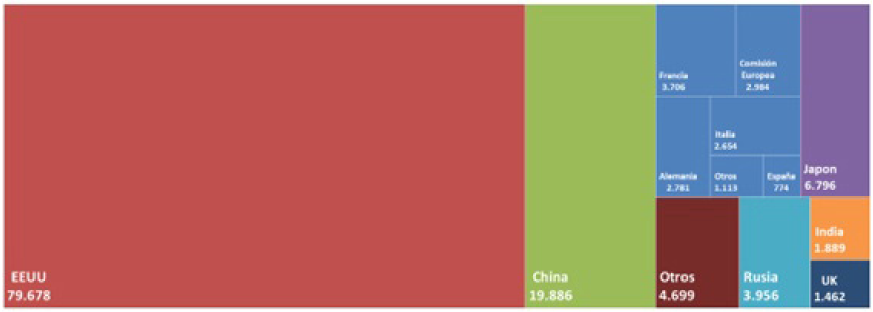

Figure 1. Government spending on space programmes by country in 2024 (in millions of dollars). ***Source*****: Novaspace**

and investment capabilities to facilitate the development of satellite constellations and systems that could not be achieved individually, whilst also fostering shared strategic autonomy. Having a European geopositioning system such as Galileo or a future constellation of secure communications satellites are clear examples of this.

1.1 Bodies in the field of space at European level and associated budgets

Space programmes in Europe are coordinated through the ESA and the European Commission, two complementary actors that are different in nature and function. The ESA is an intergovernmental organisation comprising EU countries, non-EU European countries (Norway, Switzerland and the United Kingdom) and Canada[5], which focuses on technological, scientific and industrial development in the field of space. For its part, the European Commission, through its Space Programme, acts as the political and financial authority, defining strategic priorities and guaranteeing the provision of essential services for EU states.

This duality between the ESA and the European Commission reflects that, although they share common objectives, they differ in terms of their composition and competences. The ESA drives innovation and technical cooperation, whilst the Commission aims to make space a key instrument for the EU's autonomy, security, sustainability and competitiveness. Furthermore, Europe benefits from the EUSPA (European Union Space Agency), established in

[5] Canada has had cooperating state status since 1979 and participates in some projects in accordance with a cooperation agreement.

its current form in 2021 and whose main mission is to manage, operate and maximise the civil and commercial use of its Space Programme.

The ESA is an intergovernmental organisation founded in 1975 with the aim of coordinating and strengthening European capabilities in the space sector. Its primary mission is to develop scientific and technological projects that enable it to compete globally in space exploration[6], Earth observation[7], telecommunications and satellite navigation, always with a focus on peaceful and sustainable cooperation. Spain was one of the ten founding countries. In addition to its scientific role, it is a key driver of European technological development. Although it does not play a direct role in military developments, its programmes contribute indirectly to security and defence, especially in areas such as land surveillance, secure communications, geolocation and protection against space-based threats. When the ESA undertakes technological developments linked to EU-funded programmes, participation is restricted to Member States.

The ESA's funding mechanism is based on the principle of geo-return, consisting of annual contributions from its members, which are decided at a political level and do not come from European taxes. Each Member State commits funds according to the type of programmes in which it participates, so that each country receives industrial contracts in proportion to its financial contribution. In Spain, this is managed by the Spanish Space Agency (AEE). This mechanism has helped countries such as ours to develop a robust space industry, with leading companies in the fields of satellites, propulsion systems, control software, ground segment and other capabilities. Since we participate in programmes such as Copernicus and Galileo, we have established an innovative ecosystem that creates highly skilled jobs and has positioned Spain as a key player in the European aerospace sector.

[6] Space exploration involves studying outer space, understanding how it works, and taking advantage of its resources and phenomenon.

[7] 'Earth observation' is the term employed in civil contexts to refer to remotely-sensing technologies that enable information to be gathered from a distance using sensors to characterise the land, the atmosphere or to detect objects and phenomena. It can be carried out from the ground, from aerial platforms or using satellites, which provide a global view of the planet without any border restrictions. These sensors can be passive (such as optical cameras, infrared sensors or radio-frequency antennas) or active (such as radars or LiDAR systems). For the data obtained to be useful, calibration and correction processes must be applied, which are nowadays supported by advanced Artificial Intelligence techniques.

Within the ESA, there are mandatory programmes and optional programmes, which are reviewed at ministerial conferences every three or four years. The most recent conference was held in November 2025. At it, Spain made a firm and unprecedented commitment to space, allocating EUR 1.854 billion, 8.5% of the total, doubling its contribution compared to the previous cycle. It thus moved up to fourth place among ESA contributors, ahead of Belgium and the United Kingdom, and is the country with the second-highest increase in its contribution after Germany. In total, contributions amounting to EUR 22.07 billion were approved, with 20% allocated to space transport, 17% to scientific programmes, 16% to Earth observation, 13% to exploration, 9% to connectivity and secure communications, 4% to navigation and a further 4% to technology.

While there is no allocation as such for defence-related space programmes and technologies, the ministerial conference in November 2025 marked a turning point in the understanding of the Agency's role in this field. At the final press conference of the event, the Director General of the ESA made it clear that: 'We received a clear mandate from Member States on defence and security. [...] ESA's intergovernmental framework provides the credentials and the tools needed to develop space technologies and systems for security and defence and to conduct the related activities'[8].

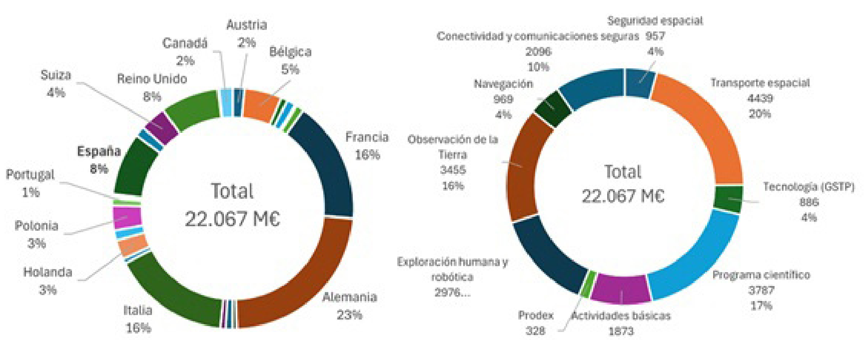

Figure 2. Contributions by country and by thematic area at the ESA Ministerial Conference in November 2025

In conjunction with this, the European Commission, through its Directorate-General for Defence and Space (DG DEFIS),

8 Statements available at: https://www.esa.int/content/view/embedjw/604418

works with Member States to define and coordinate the EU's space programmes, ensuring operational systems that provide strategic capabilities for the economy, security and technological autonomy. Commissioner Kubilius spoke about the relationship between space and defence: 'We need to rebalance our space priorities. We need space for defence and defence of space'[9].

In contrast to the ESA, which is focused on scientific and technological development, the European Commission acts as a political and financial authority, striving to make space a key instrument for the EU's autonomy, security, sustainability and competitiveness. The EU Space Programme brings together all initiatives under a common strategy to provide key services such as navigation, Earth observation, secure communications and space surveillance. This programme is approved through the ordinary legislative procedure, involving the European Parliament and the Council, thereby ensuring political and democratic support for decisions on investments and strategic priorities. Specifically, the DG DEFIS has the following objectives:

- To design and manage the EU Space Programme, which brings together systems such as Galileo (navigation), Copernicus (Earth observation), EGNOS, GOVSATCOM (secure communications) and IRIS² (secure connectivity).
- To strengthen European strategic autonomy and independence from third parties in critical services and technologies such as positioning, surveillance and communications.
- To coordinate the dual nature of space, strengthening resilience against cyber threats and orbital risks.
- To promote industrial competitiveness by supporting European companies and start-ups through programmes such as CASSINI and innovation funds.

Additionally, the EUSPA, with its headquarters in Prague, is the agency responsible for turning the European Commission's policies into concrete services for users. Its responsibilities include operating and commercialising European space systems, as well as guaranteeing the safety and certification of the programme's components[10].

[9] Opening speech to the ESA Council, 11 June 2025. Available at: https://ec.europa.eu/commission/presscorner/detail/en/speech_25_1477

[10] Website: https://www.euspa.europa.eu/

The European Defence Agency (EDA) is an intergovernmental body whose mission is to coordinate joint defence development efforts among the twenty-seven Member States, plus Norway, Serbia, Switzerland and Ukraine[11]. While the EDA is the body that directly addresses the areas of defence capabilities, technologies and cooperation, the growing relevance of space in this field means that it also undertakes activities and initiatives related to space.

The EU establishes its budget plan, setting spending limits and financial priorities, through the Multiannual Financial Framework (MFF) for a seven-year period. The current MFF covers the period from 2021 to 2027 and sets out the resources allocated to space under the EU Space Programme, with a provision of almost EUR 15 billion. In addition to this, the EU allocates funding towards civilian R&D in space through schemes such as Horizon Europe, which has a budget of approximately EUR 1.6 billion. With regard to the military component, the European Defence Fund (EDF) sets out collaborative research projects and joint capability development, with space included in its overall budget of EUR 7.3 billion until 2027.

1.2 Member States are taking the initiative

Due to the importance of space as a key strategic field for security, defence and competitiveness in this new geopolitical framework, throughout 2025, EU Member States have taken the initiative to accelerate their positioning in space. With this in mind, they have begun drafting and publishing their own national space strategies.

In line with this, in November 2025, France published a National Space Strategy aimed at establishing itself as a space power and a European leader. It is based on five pillars: autonomous access to space, with launchers such as Ariane 6 and reusable rockets; the development of a dual and competitive space economy; active defence in and towards space, including resilience and early warning systems; scientific and industrial advancement, including manned exploration of the Moon and Mars by 2035; and European leadership through strategic alliances with Germany and Italy. Objective 14 of the Strategy clearly sets out the French position: 'Foster European leadership on space issues, politically steered by the EU, technically supported by ESA, and drawing on

[11] Available at: https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/search-all-eu-institutions-and-bodies/european-defence-agency-eda_en

the renewed dynamism of the Franco-German-Italian relationships' (Government of France, 2025).

Germany had published its space strategy in 2023 and supplemented it in November 2025 with the National Space Security Strategy. Within it, priority is given to the active protection of space infrastructure and the creation of an integrated European space security architecture. Its objectives are to bridge capability gaps through European programmes, to strengthen resilience by supplementing European systems with the creation of new national systems, and to develop capabilities for military operations in space, cyberspace and the electromagnetic spectrum. It rejects destructive anti-satellite (ASAT) tests and speaks of interoperability with the EU and NATO. The following extract from the official document highlights the German interests: 'We will decisively and rapidly expand Germany's defence capabilities in space. […] We will actively protect and defend our security, prosperity and freedom, including in space' (Federal Government of Germany, 2025).

In January 2025, Italy published government guidelines on space centred on four key areas: knowledge and innovation, industrial competitiveness, a regulatory framework including a new Space Act, and international cooperation with a focus on Africa and South America. Ultimately, it considers space as a pillar of industry and a tool of foreign policy, whilst also seeking to play a greater leading role within the ESA and in the EU programmes. The document stipulates that 'Italy should exercise strong and coordinated leadership within ESA and improve its positioning in EU Space programmes, in order to support the competitiveness of its national industry and stimulate synergies between ESA and the EU' (Government of Italy, 2025).

Meanwhile, Spain published in August 2025 its second Aerospace Security Strategy (ESAN), which refers to civil-military coordination as well as combining the development of strategic national programmes with participation in European programmes[12].

This proliferation of strategic documents and guidelines on space not only highlights the importance of space as a key pillar for Europe's security, defence and economic growth in the coming decades, but also the varying interpretations of what collaboration means within the European context. That said, there are common elements across all of them, such as the importance of

12 Available at: https://www.dsn.gob.es/index.php/eu/node/26807

space in strategic autonomy, national sovereignty and EU leadership, the urgency of making decisions, and the need to approach space from more innovative perspectives in terms of its design, implementation and funding.

2 Present: the European Space Programme

The European Space Programme, managed by the European Commission through EUSPA and in collaboration with the ESA, constitutes the pillar of the EU's space autonomy. It has a budget of EUR 15 billion under the 2021-2027 MFF. The programme aims to guarantee that Europe has its own capabilities in the space field, reducing its dependence on external systems and strengthening its technological sovereignty. In the words of EUPSA Executive Director, Rodrigo da Costa, 'Strategic autonomy is not just a vision—it is a reality being built through EU Space. With programmes like Galileo and Copernicus, we are ensuring European Union's autonomy in key strategic areas'[13].

The current European Space Programme is made up of six flagship programmes. Copernicus (which covers Earth observation), Galileo and EGNOS (global and regional satellite positioning, respectively), IRIS^2 and GOVSATCOM (secure government communications) and Space Situational Awareness. Initial estimates for the next financial framework stand at around EUR 40-60 billion, with the following breakdown:

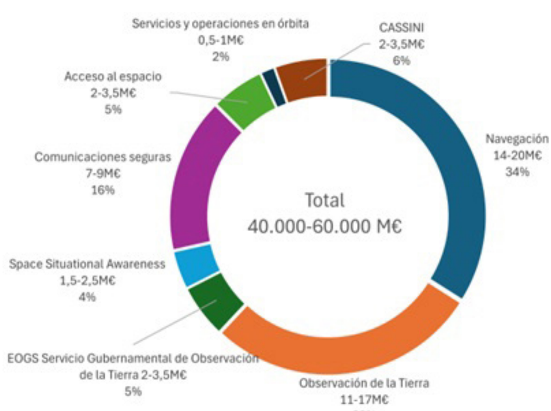

Figure 3. Thematic breakdown of space funding in the next Multiannual Financial Framework (2028-2034)

[13] Statements from 10 April 2025. Available at: https://www.euspa.europa.eu/newsroom-events/news/eu-space-bedrock-building-more-autonomous-europe

2.1 Copernicus

Copernicus is the name of the European Earth Observation Programme. It was launched in 1998 with a manifesto for an environmental surveillance programme under the name of Global Monitoring for Environmental Security (GMES). The programme began its operation in April 2014 with the launch of the Sentinel-1 radar satellite. Currently, the first generations of satellites are being replaced, providing services in addition to the raw images and data obtained.

Copernicus offers its data free of charge and on an open-access basis to all its users, organises courses and provides tools for its use. The reasons behind this decision include viewing Earth observation as an essential service for society, encouraging the creation of companies focused on developing value-added (downstream) services by removing access barriers, and developing a European influence at a global level in the face of other powers seeking to impose their own standards. Despite being a programme with purely civilian origins, initiatives with a greater focus on security and defence are now being developed, such as the Earth Observation Governmental Service (EOGS), which is further discussed below.

The programme is made up of three components: space-based, *in situ* and service-based. The satellite component is made up of the six Sentinel missions and the contributing missions. The Sentinel-1 satellites provide C-band radar images with a resolution of 5 to 2 metres. The Sentinel 2 satellites provide multispectral images in the visible and near-infrared spectrum, with a resolution of 10 to 60 metres. Meanwhile, Sentinel 3 and Sentinel 6 enable marine monitoring services using optical, radar and altimetry data. The Sentinel 4 and 5 satellites are currently payloads and precursors for measuring atmospheric composition and air quality aboard the METEOSAT missions in GEO orbit and the MetOp satellite in LEO orbit, respectively. As for contributing missions, these are missions run by the ESA, Member States or commercial operators that make some of their data available to Copernicus to supplement its products. These types of missions have emerged in response to the problem of competition distortion caused by the Copernicus system for private operators.

The *in situ* component of Copernicus is made up of ground stations, geographical data and sensors, which can be land-based, airborne or buoy-based, used to calibrate, verify and supplement the information obtained from the satellite component.

The services component comprises six specialised solutions offered based on the raw data obtained. Copernicus services cover atmospheric monitoring, climate monitoring, marine monitoring, land monitoring, an emergency management service (offering support in the event of catastrophes such as fires, droughts or humanitarian aid) and a service for security applications (support for border surveillance, safe use of the seas and external action, including the participation of agencies such as the European Border and Coast Guard Agency [FRONTEX], based in Warsaw; the European Maritime Safety Agency [EMSA], based in Lisbon; and the EU Satellite Centre [SatCen][14], located in Torrejón de Ardoz, Madrid).

2.2 Galileo

A Global Navigation Satellite System (GNSS)[15] is a constellation in orbit that provides positioning, navigation and timing (PNT) services worldwide. Electronic warfare (EW) has turned the GNSS signal into an invisible battlefield: jamming and spoofing attacks are employed to disorient autonomous systems and degrade critical capabilities[16], highlighting the vulnerability of the world's dependence on PNT and causing collateral damage to nearby civilian systems.

Galileo is Europe's global satellite navigation system, which has been providing precise and reliable positioning and synchronisation information since 2016. It was born out of the need for an independent system that would guarantee strategic autonomy. The programme began to take shape in the late nineties on the initiative of the then Vice-President of the European Commission,

14 SatCen's mission is to provide geospatial intelligence to European institutions and Member States. Its mission is to support the Common Foreign and Security Policy (CFSP) by analysing satellite imagery and other Earth observation sources.

15 There are three other GNSS systems in operation: The US GPS system, with thirty one satellites in MEO orbit; the Chinese BeiDou system, with forty-four satellites in MEO, GEO and IGSO orbits; and the Russian GLONASS system, with twenty two satellites in MEO orbit.

16 Spoofing consists of emitting false GNSS signals to provide receivers with incorrect positioning data and divert them from the right course. Meanwhile, jamming attacks consist of emitting signals on the same frequencies as the satellites, causing interferences that prevent signals from being received properly and rendering the system inoperable locally.

Loyola de Palacio. The formal agreement was signed in 2004, and the first satellite launch took place in 2011. Galileo is fully funded, owned by the EU and, unlike other GNSS systems, is under civilian control. Most of its services are provided free of charge worldwide. It currently has twenty-four satellites operating in medium Earth orbit (MEO), at an altitude of 23,000 kilometres, as well as six spare satellites.

The ground segment consists of two main control centres, one in Italy and the other in Germany, from which the satellites are controlled and the navigation system is managed. Furthermore, it operates GNSS service and safety centres in Spain (Torrejón de Ardoz and Madrid), the Netherlands and several locations in France, from where it provides support for user, safety, reference and search and rescue (SAR) services. There are also monitoring stations in New Caledonia (Pacific Ocean) and Svalbard (Norwegian Sea). All these facilities play a crucial role in the functioning and monitoring of the Galileo system's performance, ensuring its accuracy and safety.

In addition, it currently offers a variety of services, such as the Open Service, which provides free PNT services with an accuracy of around one metre; the SAR service, integrated into the COSPAS-SARSAT system to locate emergency beacons[17]; the High-Precision Service, available from 2023 and capable of achieving an accuracy of up to 20 centimetres; and the Open Navigation Service with message authentication. There are new services currently being developed, such as the Emergency Satellite Warning Service (EWSS), which will transmit warning messages to users when no other terrestrial means are available, and the Public Regulated Service (PRS), intended for government and defence uses.

2.3 European Geostationary Navigation Overlay Service (EGNOS)

EGNOS is the European satellite-based augmentation system (SBAS)[18] that is employed to improve the accuracy and reliability of

[17] COSPAS-SARSAT is an international programme that provides search and rescue services with the ability to detect and locate emergency radio beacons using satellites. Available at: https://cospas-sarsat.int/en

[18] There are various SBAS systems in addition to the European one, such as the US WAAS in North America; the Indian GAGAN on the Indian subcontinent; the Russian SDCM in North Asia; the Japanese MSAS, which covers the Japanese archipelago and surrounding waters; and the Chinese BDSBAS.

GNSS information within a specific geographical area. This is done by correcting signal errors and enabling safety-critical services with more restrictive operational requirements, such as civil aviation. The EGNOS open service was launched in 2009, prior to the entry into operation of Galileo, and it improves the accuracy of basic satellite navigation signals in Europe, including the US GPS and Galileo.

The EGNOS system is currently composed of payloads carried by three geostationary satellites and an interconnected ground network comprising forty positioning stations and two mission control centres. It provides coverage across all EU countries and has the technical capacity to extend its reach to North Africa and the Middle East, pending the construction of additional terrestrial infrastructure and the relevant cooperation agreements.

The services currently offered are the Open Service, which is available across Europe and intended for non-critical uses; the Data Access Service, which enables users to obtain EGNOS data via the Internet; the Safety-of-Life Service, which provides accuracy and integrity for critical applications, particularly in civil aviation; and the Maritime User Support Service, designed for ocean and coastal navigation and port manoeuvres.

2.4 Space Situational Awareness

With the launch of the first artificial satellite, the Soviet Sputnik in 1957, the need arose to track objects in orbit, leading to the establishment in 1958 of the precursor to what is now the US Space Surveillance Network (SSN). The tracking and characterisation of space objects using ground-based sensors[19] has been carried out for decades; however, recently, the increase in the number of objects in orbit, technological advances and improvements in space capabilities, as well as the conduct of potentially hostile manoeuvres in orbit by certain actors, combined with the growing dependence on space services, have highlighted the need to protect space assets.

[19] These types of technologies include telescopes and optical sensors for observing the night sky, which are limited by weather conditions and sunlight. There are also radars designed to actively monitor lower orbits, but these require additional power to reach higher orbits. In addition, there are passive systems that calculate the position of satellites by listening to transmissions from various ground stations, which are useful for monitoring assets in GEO orbit, as well as other technologies currently under development, such as LIDAR. Once the data has been received, it must be processed within a shared network to anticipate potential risks.

The Space Situational Awareness (SSA) component of the European Space Programme aims to provide precise information on the space environment and helps to ensure the uninterrupted operation of space services, which is essential for promoting the strategic autonomy of the EU and its Member States. The preparatory phase of the programme was approved in 2008 within the framework of the ESA and subsequently became part of the European Space Programme. This component works on a contributory basis involving each Member State, bringing together and centralising national capabilities, and offers its services free of charge.

The SSA component of the European programme is made up of three areas. The first area is space surveillance and tracking (SST), a network of connected sensors designed to monitor and track space objects, together with the necessary processing capabilities, information and services relating to objects orbiting the Earth. It includes collision prevention services, re-entry analysis and fragmentation analysis. EU SST currently offers its services to over two hundred public and private organisations and protects more than four hundred satellites from the risk of collision.

The second area of the SSA component is NEO (Near-Earth Objects), which includes capabilities for monitoring the risk posed by natural space objects, such as asteroids and comets, approaching Earth. By promoting network building between facilities and research centres of the Member States, this sub-component supports the development of a routine rapid response service capable of characterising newly detected NEOs. The final area of SSA is Space Weather (SWE). It focuses on the development of spatial weather models based on new forecasting capabilities.

The architecture of the EU SST is based on an advanced network of sensors distributed across various Member States; national operations centres, which are responsible for consolidating information from national sensors and coordinating it to the European level; and the EU SST Operations Centre, which integrates all the data and generates critical services for collision alerts, re-entry predictions and debris detection.

Spain was the largest contributor to the programme in its initial phase (33%), developing its own national S3T (Space Surveillance and Tracking) programme to strengthen its capabilities, setting up operational centres and radars, and integrating into the European network. It currently contributes to the EU SST programme by hosting part of the collision avoidance service at SatCen in Torrejón de Ardoz and providing detection capacities thanks to the S3TSR radar located at Morón Air Base in Seville; with optical capabilities such as the global network of telescopes managed by the Spanish National Research Council (CSIC)[20] or the Motsec telescope, as well as passive radio receptors.

2.5 GOVSATCOM

One of the European Commission's priorities for ensuring strategic autonomy in space services is secure communications for government use. These encompass capabilities for the transmission of information over long distances and with immediate deployment, based on communications satellites, which, due to their specific characteristics, have special security requirements compared to similar services in the civilian sector, such as a higher level of communications encryption, protection against interferences, special protection of ground assets, and the assurance of capacity during crises.

With this in mind, the European Commission launched the GOVSATCOM initiative at the start of the decade, a component of its Space Programme covering multiple programmes aimed at reorganising and strengthening the EU's secure communications capabilities in the governmental domain. It identifies a number of key use cases around which the various associated programmes are organised:

- Crisis management: support for humanitarian operations, civil protection, and civil or military security missions managed by the EU through resilient communications in the event of a disaster, including situations involving the total or partial destruction of terrestrial communications infrastructure.
- Surveillance and security: support communications in critical areas such as borders and maritime surveillance at a global and regional level, with a special emphasis on the Mediterranean, the Black Sea, the North and South Atlantic, and the Baltic Sea.
- Connecting and protecting critical assets: communications for key infrastructure (energy, transport and traffic management,

[20] A network of robotic telescopes across five continents known as BOOTES (Burst Observer and Optical Transient Exploring System).

finance, data centres, government facilities both within and outside of the EU), ensuring protection and function against internal or external threats.

- Special use cases: those that overlap with the above, such as Arctic connectivity, command and control for unmanned systems, or IoT-M2M for sensors.

Among the programmes and initiatives covered by GOVSATCOM, the following are particularly noteworthy:

- Pooling and sharing: this consists of grouping together the available capacity of commercial satellite operators and the capacity of EU Member States for use by authorised government users.
- The GOVSATCOM-HUB project, a matchmaking system designed to facilitate government users' access to the aforementioned pooling and sharing capacities.
- The new flagship IRIS^2 programme for the development of a multi-orbit, non-geostationary constellation for secure communications, as outlined below.

2.6 IRIS^2 programme

Secure communications form the backbone of any modern security and defence system. In a geopolitical context marked by tensions, cyber threats and technological dependence, Europe needs strategic autonomy to guarantee that its Armed Forces, institutions and critical services have access to resilient and sovereign communication channels. The importance that this autonomy has come to hold in critical communications has been evident since the start of the war in Ukraine. Currently, a large proportion of secure satellite capacities come from national assets, but setting up a constellation to provide secure communications involves high costs, is complex and requires major management resources.

The IRIS² programme (Infrastructure for Resilience, Interconnectivity and Security by Satellite) addresses this need by creating a European satellite constellation, designed to strengthen strategic autonomy, crisis resilience and the protection of sensitive data, ensuring that Europe maintains its capacity for independent decision-making and action in the field of security and defence. Compared with the development of the other flagship projects mentioned above, the design of IRIS^2 has set a new record. It was announced in 2022, and work on its definition and development began immediately in 2025, following the signing of the concession contract. Its aim is to bring into service by 2030 a constellation of around three hundred dual communications satellites for governmental use with global coverage, designed to ensure strategic autonomy in the fields of security and defence, supplementing sovereign initiatives by Member States or commercial ventures.

It also represents a new approach to European space programmes because, unlike initiatives such as Galileo or Copernicus, it has made room for the development of private commercial activity. As this is a market comprising established players, IRIS^2 has been set up as a publicprivate initiative between the European Commission and the EU's three main satellite communications operators (Eutelsat, SES and Hispasat), organised under the SpaceRISE consortium. These operators invest in infrastructure in exchange for access to commercial capabilities in a dual-use system.

The consortium is in charge of the design, commissioning and operation of IRIS^2, in accordance with the European Commission's main requirements, including the coordination of infrastructure development activities (upstream) by the ESA and the provision of governmental services (downstream) by EUSPA.

The programme involves an investment of more than EUR 10 billion, comprising public funds from the EU and Member States channelled through the ESA for the development of military capabilities, as well as private funds invested by members of SpaceRISE for the development of commercial activity for civil and governmental services with lower security requirements.

The IRIS^2 satellites will be distributed across two main service tiers. In MEO, with 18 satellites orbiting at an altitude of 8,000 kilometres, and in high LEO, with more than 260 satellites orbiting at an altitude of 1,200 kilometres. In addition, a third tier will be deployed in low LEO orbit at altitudes of 400 to 750 kilometres, comprising a limited number of small satellites designed as a testbed for innovative services, like, for example, the Internet of Things (IoT) or Direct-to-Device, as well as hosted payloads for third-party experimental services, with the possibility of providing comprehensive services across a range of use cases.

IRIS^2 will be a system based on the 5G-NTN standard, regenerative and reconfigurable in orbit, and the service will be provided to military or government users centrally through GOVSATCOMHub.

Furthermore, it will have the capability to connect with other space assets using SDR (Space Data Relay) optical links to ensure the immediate return to EU territory of data generated by these constellations (observation imagery, ISR), thereby adopting a modular approach based on supplementary capacities and avoiding duplication of endeavours by implementing overlapping capabilities across multiple programmes.

The ground stations in charge of managing government communications will be located within the EU territory, a critical decision designed to guarantee information sovereignty and security consistently throughout the entire chain. To enable data to be transmitted immediately and securely from a remote terminal to a ground station, the satellites will be equipped with optical ISL (Inter-Satellite Link), allowing them to communicate with one another without relying on ground-based infrastructure in countries outside the EU that could compromise security or service continuity in the future.

2.7 Access to space

Formally, access to space is not one of the key areas of the European Space Programme, but due to its great strategic importance and the existence of European capabilities, it is a field of the utmost importance that is channelled through other avenues such as the ESA.

In recent years, access to space has undergone a genuine revolution thanks to the emergence of new players and technologies and, above all, thanks to the drastic reduction in launch costs. This has enabled a sector traditionally confined to the states, which used to launch costly assets with a lifespan of decades, to take the risk of launching more assets, at a lower cost, with more innovative and less tried-and-tested components, and by new and diverse players from the private sector.

On top of all this, several companies have revolutionised the industry's traditional artisanal approach. They have verticalized their production chain (manufacturing, launch, operation and service provision), which has led to a drastic reduction in prices.

In 2025, SpaceX dominated the sector with 165 launches, accounting for more than half of the year's successful missions, compared with just seven European launches during that period. The introduction of reusable launch vehicles, particularly its Falcon 9, has led to a drastic reduction in costs. Whilst the Ariane 5 (non-reusable and now out of service) had a cost of approximately USD 10,000 per kg in LEO, subsequently reduced for the Ariane 6 (non-reusable and currently in service) to USD 5,500 per kg in LEO, the Falcon 9 offers launches for just USD 1,600 to USD 2,720 per kg in LEO. This ecosystem has driven the 'democratisation of space,' making satellite launches accessible to new companies, universities and middle powers, as well as enabling the launch of large-scale projects.

Massive constellations in LEO are economically viable thanks to reusable launchers, a capacity that Europe currently lacks. In 2025, approximately 4,500 satellites were launched, almost double the figure of around 2,800 in 2024. As a result, the cost of sending cargo into space has fallen dramatically, paving the way for a new era of competitiveness, autonomy and the proliferation of both civilian and military infrastructure. It is worth noting that this is a field with little regulation, unlike the traditional legislation under which satellites in GEO have operated.

Europe currently has space access capacities through the Kourou Space Centre and the Ariane 6 and Vega C launchers. In addition, new capabilities are being developed, such as the SpaceRider project and the European Launcher Challenge, which are promoting new small launchers, such as the Spanish Miura 5 from PLD Space, as detailed below. However, that was not the case a few years ago. In 2023, following the end of operations for the Ariane 5 launcher and due to delays in the development of the Ariane 6, Europe faced a severe launcher crisis, leaving it without an independent capacity for high-volume missions.

That situation was exacerbated by the loss of access to the Russian Soyuz launcher following the application of European sanctions, over the invasion of Ukraine, as well as the failed launch of the Vega C in December 2022, which was not repeated until two years later. All of this meant that SpaceX had to be called upon to deploy the Galileo satellites. In November 2023, at the Seville Space Summit, the ESA and its main partner countries (France, Germany and Italy) signed the so-called Seville Agreement with the aim of strengthening the Ariane 6 programme: to ensure significant cost reductions and move towards a centralised institutional procurement structure, instead of the ESA's geo-return funding model.

The Kourou Space Centre has been in operation since 1968 and is managed by a consortium made up of the French space agency Centre national d'études spatiales (CNES) and the ESA, whilst also being operated by the French company Arianespace. It is situated at 5° north latitude, which gives it an advantageous location for launches due to the initial velocity provided by the Earth's rotation, which is greatest at the equator. In 2025, the number of launches from this base exceeded three hundred, cementing its status as Europe's gateway to space.

The Ariane 6 heavy-lift launcher consists of two stages, has a height of 63 metres and a maximum capacity of sending 21.6 tonnes into LEO and 11.5 tonnes into GTO. It is not reusable and has carried out five launches from its initial flight in July 2024 up until December 2025[21]. Meanwhile, the Vega C light-lift launcher has a height of 35 metres and is capable of sending up to 3.3 tonnes into LEO and 2.3 tonnes into SSO. It is also not reusable. Its initial flight took place in July 2022, and it has successfully completed five flights[22].

3 Future perspectives in the European context

Europe as a whole is reconsidering what role it intends to play globally in the space domain. This led most countries to boost their investment at the ESA Ministerial Conference in November 2025, whereupon a 31% increase (17% adjusted for inflation) was agreed.

Meanwhile, the European Commission and the Member States are currently negotiating the budgets for the next MFF, which runs until 2034. Although there are no specific figures for the final investment in space, there is a proposal to increase it to EUR 131 billion. According to proposals from European space industry organisations such as ASD-Eurospace[23], the budget could be increased to between 40 billion and 60 billion euros per year, which is between 2.5 and 4 times larger than the current space programme budget.

Within the new financial framework, space-related activities will mainly fall under the European Competitiveness Fund, the Space

[21] For specifications, see: https://ariane.group/en/space-transportation/ariane-6/

[22] For specifications, see: https://www.arianespace.com/vega-c/

[23] See: https://eurospace.org/eurospace-position-paper-space-the-foundation-for-europe-to-understand-and-act-in-the-world-how-the-next-eu-multiannual-financial-framework-can-make-it-happen/

Programme and the R&D programmes (the successor to the Horizon Europe programme[24]).

With this in mind, the European Commission passed a communication in which it established four flagship defence programmes, one of which is the European Space Shield (European Commission, 2025). Although the scope and specific capabilities to be developed are yet to be discussed with Member States over the coming months, this is further evidence of the drive behind space defence at a European level, with the European Commission aiming to play a central role. Finally, some Member States (such as Germany) have announced ambitious budgets for space investment, as stated by their Minister of Defence, Boris Pistorius, on 25 September 2025[25].

3.1 Access to space

At the ESA Ministerial Conference in November 2025, 4.4 billion euros were approved to strengthen the Ariane 6 and Vega C programmes, as well as new space access projects and the creation of a new space centre in the Azores[26], underlining the need to maintain an autonomous and competitive European space access system. Some of the projects in development include Space Rider and the European Launcher Challenge. The first, under the umbrella of the ESA, is a launcher designed to re-enter the atmosphere and land with a payload at the future Azores Space Centre. It will enable the recovery of objects or samples from space, with launch support provided by Vega C.

Meanwhile, the European Launcher Challenge is an ESA initiative launched in November 2023 to promote the competitiveness of commercial launch systems in Europe, either by purchasing new launch services (Component A) or by co-funding improvements to launch capacity (Component B). The five companies shortlisted in July 2025 are the German firms Isar Aerospace and Rocket Factory Augsburg, the Spanish firm PLD Space (for which Spain has provided 169 million euros in funding), the French

[24] It is the EU's framework programme for research and innovation for the period of 2021-2027, with a budget of EUR 95.517 billion.

[25] See statements at: https://www.defensenews.com/global/europe/2025/09/25/germany-unveils-40bn-military-space-investment-citing-new-threats/

[26] See cooperation agreement for the development of a space centre on the island of Santa Maria in the Azores (November 2025) at: https://ptspace.pt/portugal-and-esa-sign-an-agreement-for-the-space-rider-to-land-in-santa-maria/

firm MaiaSpace, and Orbex from the UK, which will compete by demonstrating their technical capabilities, business model and sustainability to secure contracts and demonstrate their capabilities through launches between 2026 and 2030.

3.2 Performance and services in orbit

In the civilian sector, space-related operations and services include the maintenance, assembly, manufacturing and logistics of assets to improve the performance and sustainability of space activities. However, it is worth highlighting the significant dual nature of the technologies being developed to provide this type of service, such as the ability to manoeuvre in close proximity to objects and the shadowing and radiation interferences they may cause. It also features sensor-based inspection capabilities to diagnose satellite malfunctions, as well as robotic arms that can attach to satellites to carry out maintenance tasks, change their orbit, or even capture objects such as inactive satellites or space debris[27].

Specifically, in the civil sector, the European Commission has made a firm commitment to this type of service. On the one hand, there is the preparation of an ISOS4I pilot mission for 2030, which could develop into a new flagship for the European Space Programme. Furthermore, the legislative proposal for an EU Space Act published in July 2025 sets out the requirement to equip satellites launched from 2034 onwards with interfaces for in-orbit services. Finally, the ESA runs various programmes for the development and demonstration of associated technologies.

In the military sector, European defence ministries are taking steps to launch national missions to protect assets in orbit. In addition, through the EDF, there are projects currently underway to protect assets in orbit.

3.3 Earth observation

Within the next financial framework, Copernicus is expected to remain a flagship programme, ensuring its continued operation and strengthening services relating to climate change, disaster management, and security, defence and civil protection

[27] This issue will be addressed in the following chapters of this paper.

applications. The aim is also to encourage SMEs and start-ups to get involved in data exploitation and the development of applications. In addition, there is a desire to expand the Copernicus missions for emissions monitoring, hyperspectral imaging for agriculture, monitoring of polar regions, and tracking changes in ice and climate for maritime safety purposes. Its contribution as a regulatory infrastructure for the certification of emissions is also being considered. In the current context, it is widely accepted that Copernicus will continue to provide data by replacing existing missions.

Apart from the independent capabilities of certain Member States, such as France with CERES and CSO or Spain with PAZ and the future PAZ 2 system, Europe as a whole currently lacks a large-scale constellation capable of providing a high level of revisit frequency, a necessary feature for the immediate detection and precise tracking of threats in contested or conflict-ridden environments.

The EOGS, as mentioned previously, is an initiative proposed by the EU to provide secure GEOINT for defence and civil security, offering Member States high-resolution, secure and sovereign data. The aim is to provide near-real-time surveillance in all weather conditions to strengthen Europe's strategic autonomy. The programme will be based on the EDF's current R&D projects and on the observation component of ESA's European Resilience from Space initiative, which is scheduled to begin in 2028 under the EU's MFF.

3.4 Positioning, navigation and timing

PNT services, which are essential for both civilian and military uses, are now facing a growing risk of degradation and disruption due to the proliferation of conflicts and the increasing affordability and advances in jamming and spoofing techniques, which are even affecting civilian areas close to contested areas. The trends for the coming years are geared towards strengthening GNSS systems (primarily based on MEO platforms) through multi-orbit constellations that increase the system's resilience, combine signals in space with ground-based PNT augmentation systems to facilitate the identification and mitigation of interferences and the cancellation of degraded signals, and, finally, provide an effective estimation of positionings and times based on valid signals.

3.5 IRIS^2 and communications

One of the main lines of focus in the future MFF is communications and the development of the IRIS^{2}programme, both in its current form and in terms of any potential further developments linked to it. Apart from the European initiatives focused on this system, several Member States have identified secure satellite communications as a priority, even assessing the possibility of deploying their own communications constellations to supplement IRIS^2, as is the case with Germany's SATCOMBw4. It is a project currently at the conceptual stage, aimed at creating a military constellation of low-Earth orbit (LEO) satellites dedicated to providing secure, resilient, high-capacity communications for the German Armed Forces. This constellation will supplement Germany's existing GEO assets, incorporating resilience, lower latency and the ability to withstand interference or attacks.

3.6 Space Situational Awareness

The increase of objects in orbit and mega-constellations raises the risk of collisions and adds to the complexity of space traffic management. Europe plans to strengthen its autonomy in the face of dependence on data provided by the United States and external regulations, which threaten its sovereignty and industrial competitiveness. The MFF aims to expand the procurement of SSA data and improve SST capabilities through R&D, to develop technologies for prevention and protection, to drive pilot projects focused on security and defence, and to establish European regulations centred on Space Traffic Management.

Additionally, from a technological point of view, sensors have also recently begun to be incorporated into space as part of constellations providing SSA services to clients, or as additional payloads on satellite platforms to monitor the space around the assets themselves.

3.7 Optical communications

In the last decade, optical communications have emerged as a disruptive technology in the space field, offering alternative capabilities to traditional radio-frequency links. Based on the use of lasers to transmit data, these communication systems enable high transfer rates, low latency and greater security against interferences and cyberattacks. They also have limitations, such as the greater complexity and size of the equipment, the need for an unobstructed line of sight free from clouds, and difficulties with alignment. There are two types of services based on this kind of technology: space-to-space optical and space-to-ground communications.

Space-to-space optical communications, with their high capacity and immunity to the possibility of atmospheric degradation, are an excellent choice for inter-satellite links (OISL), which is why they are currently used for communications between satellites in large constellations.

Space-to-ground optical communications offer greater bandwidth and immunity to jamming than radio-frequency links, but they do require a direct line of sight, an environment free from atmospheric degradation, and complex pointing systems.

Under the new space programme, optical satellite communications are expected to be considered as enabling technologies, both for their data transmission capacity and for their resistance to interception. Constellation backhaul systems are considered as essential technologies for inter-satellite links, as well as a space-based component of the EuroQCI programme[28].

3.8 Quantum Key Distribution

Quantum Key Distribution (QKD) is an emerging technology that uses principles of quantum mechanics to generate and share cryptographic keys between two points. Its main advantage is that any attempt at interception alters the quantum state of the particles (photons), making it possible to detect intrusions and guarantee absolute confidentiality. These transmissions have a maximum range of 100 kilometres over land due to the physical limitations of optical fibre. However, satellites, with their wide field of view, make it possible to distribute keys between ground stations separated by thousands of kilometres.

Europe is addressing this challenge through ESA's SAGA (Security And cryptoGrAphic) initiative, in coordination with the European Commission's EuroQCI, which focuses on QKD via satellites,

[28] The EuroQCI will be a secure quantum communication infrastructure covering all of the EU, including its overseas territories. See: https://digital-strategy.ec.europa.eu/es/policies/european-quantum-communication-infrastructure-euroqci

thereby supplementing the terrestrial quantum encryption networks currently being developed in the Member States[29]. Meanwhile, countries such as Spain are developing technology programmes focused on this technology.

3.9 Quantum gravimetry

This technology involves using sensors based on atomic interferometry to measure the Earth's gravitational field with great precision. It is currently under development, but the possibility of deploying this type of sensor on satellite platforms is being assessed, as they offer a high degree of stability and would enable the creation of a global map of the gravitational field, against which anomalies could then be detected. Possible use cases include the study of volcanoes and the marine environment, but also the development of PNT solutions that do not rely on GNSS systems or additional applications in the military field.

3.10 European Space Act

This legislative proposal seeks to establish a harmonised legal framework for space activities in the EU, replacing the current national approaches. It focuses on three fundamental pillars: safety (object tracking, debris mitigation and anti-collision manoeuvres), resilience (cybersecurity, continuous monitoring and supply chain risk management) and sustainability (environmental impact assessment, lifecycle management and responsible satellite disposal). It is proposed to be implemented by 2030.

If approved, the regulation will apply to operators from both the EU and third-party countries offering space services within European territory, excluding defence and national security assets. It establishes tiered requirements based on the operator's size and risk profile and lays down transitional provisions until January 2030. The EUSPA will manage authorisations and ongoing supervision, and will have the power to conduct inspections, impose financial sanctions and take provisional measures.

Altogether, although the EU Space Act seeks to establish a unified regulatory framework that fosters competitiveness and innovation in the European space sector through a clear regulatory

[29] See: https://www.esa.int/Applications/Connectivity_and_Secure_Communications/Advancing_Europe_s_quantum_secure_communications_from_space

environment, avoids fragmentation and promotes responsible and safe practices, it is currently under review by the Member States and the Parliament, with a view to its approval in 2026.

Conclusions

Space has become a key strategic domain for Europe's security, defence and technological competitiveness. Through the EU and the ESA, initiatives have been put in place, which have proved insufficient to cope with the rapid pace at which events have unfolded. This is the reason several EU Member States have taken the initiative to achieve strategic autonomy in space and to accelerate the development of a common European position.

A clear example of this situation has been the development and launch of the IRIS² programme, which aims to roll out a secure government communications infrastructure for Member States and allied countries. It has set a record for the speed of its legislative and acquisition processes, whilst also contributing a model for the acquisition of EU capabilities through a public-private collaboration mechanism.

The drive shown by the Commissioner for Defence and Space Kubilius is undeniable, and his determination to restore Europe's position as a space power is acting as a catalyst for the adoption of agreements and the launch of initiatives.

The cards have been dealt, and the game currently being played in the space sector is as fast paced as it is thrilling, because we all know that nothing will ever be the same again and that the future is still to be written.

Chapter three

Military operations in space: NATO, the United States and other partners and allies outside of Europe

José María Cifuentes Rivera

Abstract

Since its establishment, NATO has recognised outer space as a fundamental component of security and defence. The use of space capabilities to support military operations in other domains (land, sea, air or cyberspace) has regularly facilitated such operations. However, the state of security in space is changing. The growing proliferation of state and non-state entities who have access to space for their own benefit, coupled with the development of technologies that could be employed to restrict allied countries' access to and freedom of action in space by certain powers, such as China and Russia, has led to increased interest within the Alliance in ensuring the availability and protection of existing space capabilities. Furthermore, the need to promote compatibility and interoperability between these capabilities has been confirmed, as they have been clearly identified as essential elements within the deterrence and defence strategy.

Keywords

Space capabilities, Deterrence and defence, Resilience, Cooperation, Interoperability.

Introduction

The leaders of the Atlantic Alliance have always been aware of the strategic advantage offered by the data, products and services provided by assets deployed in space. Thanks to them, military forces on the ground are able to move, navigate and maintain the necessary communications with command posts, as well as to ensure adequate tracking, command and control over those forces. Furthermore, the Alliance relies on data provided by space-based systems to monitor, anticipate and counter potential threats, such as those arising from missile launches targeting its forces or territory or, where necessary, to strike specific military targets using precision-guided munitions.

This has meant that NATO has mainly relied on the space capabilities provided for its benefit by its Member States, which, in any case, retain full sovereignty and the final say over those capabilities.

However, outer space has evolved from being a relatively controlled environment, accessible only to a handful of countries possessing the necessary technology to exploit it, into a crowded and contested environment where an increasing number of state and non-state entities are competing to gain an advantageous position through the deployment of assets in orbit. In addition to this, certain powers such as Russia and China have demonstrated their ability to develop, and indeed already possess, military resources that could pose a threat to the capabilities of allied nations deployed in space.

In response to this new environment, NATO has gradually been taking measures designed to protect and guarantee access to data, products and services for the benefit of and in support of military missions and operations. Among these measures is the adoption in June 2019 of an Overarching Space Policy (NATO, 2019), which stems from the commitment made by the leaders of the allied countries at the 2018 Brussels Summit. Furthermore, the declaration made in 2019, during the meeting of the Heads of State and Government held in London, that outer space is the fifth operational domain, or the decision to establish a Space Operations Centre (NATO Space Operations Centre) at Allied Air Command in Ramstein as part of the Combined Force Space Component Command, CFSpCC.

Among all these measures, the declaration adopted in 2021 at the Brussels Summit (NATO, 2021) stands out in particular, stating that attacks directed towards, from or within outer space could trigger the invocation of Article 5 of the North Atlantic Treaty, as they represent a clear threat to the security of the Alliance, the impact of which could compromise national and Euro-Atlantic prosperity, security and stability, and be as damaging to modern societies as any other type of attack.

In spite of all the measures that have been taken, NATO does not currently have its own space capabilities nor does it, in principle, plan to develop them (NATO, 2025a). For the success of its operations, it relies on those provided by allied countries or by organisations in the commercial space sector. That is why it is essential to secure the necessary cooperation to guarantee both the exchange of information as well as the coordination and interoperability between the systems of the various entities involved.

In this respect, the allied countries have agreed to develop and maintain the military capabilities necessary for deterrence or, if required, defence against actions by potential adversaries in any of the operational domains, including outer space.

1 NATO and the fifth operational domain

In 2019, NATO declared outer space to be a domain in which military operations can be conducted, just like land, sea, air or cyberspace, thereby implicitly recognising that the battlefield is likely to shift to this new operational domain in the not-too-distant future. Its Overarching Space Policy is based on a series of principles, among which the most important is the recognition of outer space as an essential part in guaranteeing the Alliance's deterrence and defence capabilities. Furthermore, it advocates for the free and peaceful use of space, always in accordance with the rules of international law and the common interest.

It is also expressly stated that allied countries will retain authority and sovereignty over their assets in orbit, whilst committing to voluntarily provide any data, products and services they are able to supply, and which may be necessary for NATO missions or operations (NATO, 2025a). In line with this voluntary contribution, there is a call to encourage cooperation among NATO allies with a view to improving compatibility and interoperability between national systems, as well as to integrate the space domain into NATO-led capability development programmes (NATO, 2019).

NATO's Overarching Space Policy brings together the necessary space capabilities across five functional areas, whilst also detailing the uses and effects sought with each of them.

Space capability	NATO use and effects
Positioning, Navigation, Timing (PNT) and Speed	Precision strikes Navigation Personnel Recovery (PR)/Combat Search and Rescue (CSAR) Network synchronisation
Integrated tactical warning and threat assessment system	Force protection Threat source identification Missile launch warning
Environmental surveillance	Mission planning Ammunition type selection Weather forecasting
Communications	Command and control UAV operations Communications beyond line of sight
Intelligence, Surveillance and Reconnaissance (ISR)	Operations monitoring Battle Damage Assessment Intelligence Targeting

Figure 1. Author's own. *Source*: NATO Science and Technology Organization (2020)

In addition to what is shown in Figure 1, the allied Overarching Space Policy emphasises the need for systems capable of contributing to Space Situational Awareness (SSA), an indispensable function for identifying risks and threats, as well as proposing appropriate mitigation measures.

The declaration that outer space is an operational domain has certain implications from a doctrinal perspective. Unlike the United States, which advocates treating it as a warfighting domain (Cunningham, 2023), that is, a combat domain in which both offensive and defensive military operations can be carried out, just as is the case with the other domains. NATO has opted for the term 'operational domain', which, in the view of some analysts, is linked to the Alliance's customary defensive orientation, mainly focused on the integration and protection of allied countries' space systems, whilst setting aside offensive capabilities that could, if necessary, be employed to deny the adversary the use of outer space (Stickings, 2020).

What is certain is that these statements are fully in line with the principles set out in NATO's Overarching Space Policy, as well as with some of the statements made by the former Secretary General, Jens Stoltenberg, who reiterated that outer space is essential to the Alliance's deterrence and defence. He also underlined that NATO has no intention of deploying weapons in space (Banks, 2019).

In the same vein, one could interpret the declaration adopted in 2021 at the Brussels Summit, stating that attacks directed towards, from or within outer space could trigger the invocation of Article 5 of the North Atlantic Treaty, insofar as the statement itself makes it clear that such invocation could under no circumstances be carried out immediately, but would depend on a specific assessment of the circumstances by the North Atlantic Council (NAC),on a case-by-case basis.

In any case, there is no doubt that NATO's own view of its role in space has gradually been changing from a passive role as a mere observer to a more active one as a guarantor of the security of assets in orbit. It is within this framework that the THOR (Space Threats Operational Response) initiative is being developed, involving Allied Command Transformation (ACT), Allied Command Operations (ACO), the Combined Force Space Component Command, the NATO Communications and Information Agency (NCIA) and the NATO Headquarters.

This initiative aims to address possible threats arising from an adversary's offensive capabilities by developing operational response manuals for such threats, including options tailored to crisis scenarios (NATO Allied Command Transformation, 2025).

1.1 Nato and space capabilities

NATO defines capability as the ability to achieve an effect through the employment of an integrated set of elements, including doctrine, organisation, training, equipment, leadership, personnel, facilities and interoperability. The significance of this definition lies in the fact that when the Alliance establishes, through the planning process, the capability objectives to be achieved, it is in fact defining the effects it wishes to achieve, leaving it up to each ally to determine the type of systems or resources with which it will contribute to those effects (NATO Allied Command Transformation, 2025).

Although the development of national military capabilities is a matter for each country to decide, the Alliance seeks to identify and prioritise those capabilities necessary to fulfil the requirements of deterrence and defence, crisis prevention and management, and cooperative security, through the NATO Defence Planning Process (NDPP).

It consists of five stages spread over a period of four years. In the first stage, the objectives to be achieved are established, and in the second stage, the minimum requirements for achieving them are determined. The third stage concludes with the allocation of these requirements among the various allied countries. Although they are generally carried out sequentially, the fourth stage (facilitating implementation) is an ongoing activity, whilst the fifth (review of results) is carried out twice during each four-year cycle (NATO, 2025b).

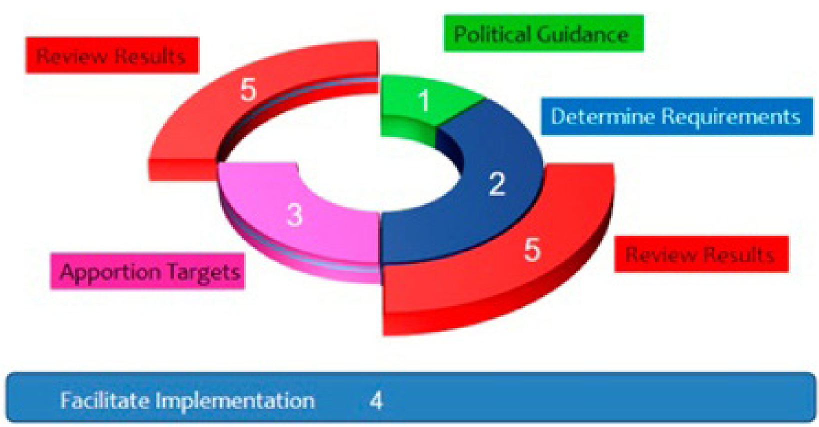

Figure 2. NDPP cycle (original image). ***Source*****: NATO (2025b)**

Following the conclusion of the last planning cycle regarding space capabilities, the process of reviewing the requirements for these is currently underway (phase 2). This process consists of studying each of the elements included in the previous cycle, reviewing the rationale for their inclusion, the effect or effects that can be achieved through them, as well as the characteristics they must possess in terms of sustainability, connectivity and resilience. This entire process will culminate in a document named *Minimum Capability Requirements (MCR)*.

All the capabilities included in the MCR are grouped into seven areas for the use of combined force. These areas are force preparation; projection; use of force; command and control; sustainment; force protection; and situational awareness. Figure 3 sets out the space capabilities considered in the MCR for the latest planning cycle in 2024. Of all the areas, only two were taken into account (command and control, and situational awareness), with the possible incorporation of some of the remaining areas currently under consideration during this cycle.

Capability area	Type of space capability considered
Command and control	Coordination and integration of space capabilities with other domains Command and control Communications
Situational awareness	Provision of data, products and services in support of operations Operational situational awareness in the space domain Imagery intelligence Signals intelligence Processing, exploitation, and dissemination of intelligence Ballistic missile warnings Ballistic missile defence PNT Meteorological and oceanographic support (including space weather) Geospatial support

Figure 3. Author's own. *Source*: NATO (2023)

In spite of the fact that NATO does not possess its own space capabilities, it has driven and launched a series of initiatives related to this new operational domain (NATO, 2025a).

- Alliance Persistent Surveillance from Space (APSS): an initiative that seeks to improve cooperation in the field of space-based surveillance through the establishment of a constellation of military and commercial satellites, known as 'Aquila', to provide information on what is happening on the ground.
- Northlink: dedicated to the development of secure and resilient satellite communications in the Arctic.
- Starlift: driven by the goal of enhancing access to and use of outer space in support of deterrence and defence policy, through the development of a network of sites capable of car-

rying out space launches at short notice should it be necessary to respond to a threat.

- NATO SATCOM Services 6th Generation (NSS6G): a secure communications initiative provided by allied countries, in which NATO has invested around EUR 1 billion.
- Strategic Space Situational Awareness System (3SAS): aimed at developing a capability to gain a better understanding of objects in orbit, as well as events occurring in space and their potential impacts on other operational domains.

In addition to the initiatives previously mentioned, NATO has invested heavily in driving the recently established Space Operations Centre, through the development of a new information exchange platform known as AXE (Allied Exchange Environment). The purpose of this tool is to centralise all relevant information on outer space, whether relating to Space Domain Awareness, (SDA), intelligence, surveillance and reconnaissance (ISR), or any other area of interest. It is also expected that data generated by the APSS initiative will be utilised (Hitchens, 2025a).

Furthermore, NATO is a military alliance, which, in the words of Bergsmann (2001), constitutes a security agreement between Member States, under which the partners commit to provide mutual assistance through a substantial contribution of resources should a particular contingency arise. In other words, the foundation of any alliance rests on the fact that a country makes its capabilities available for the benefit of collective defence, and this is also what distinguishes such agreements from others that may be entered into between states, such as ententes or neutrality pacts.

In the specific field of space capabilities, countries have always been relatively reluctant to openly share information about their systems, due to the strategic importance these hold for their own national interests. For this reason, during the last cycle of the NDPP, all allied countries were asked to provide detailed and quantitative information about their own capabilities, with the aim of accurately determining what each of them can provide. This information provides a much more precise overview, making it possible to identify potential duplications as well as take advantage of them to guarantee redundancy and operational resilience (Hadley, 2024).

1.2 Deterrence and defence of the Alliance in space

NATO is committed to deterrence as the primary means of defending its space capabilities. This approach is reflected in the declaration adopted in 2021 during the Brussels Summit, stating that attacks directed towards, from or within outer space could justify the activation of Article 5 of the North Atlantic Treaty and, therefore, the exercise of the right to self-defence, both individual and collective, against the party responsible for such attacks.

The main challenge with this declaration lies in the fact that it is not triggered automatically, but only after an assessment of the circumstances by the North Atlantic Council (NAC) on a case-by-case basis. This would require all Member States to reach a consensus, which can be a complex process and is not always easy to achieve. Added to this is the fact that some of these attacks could consist of low-intensity actions carried out by anonymous actors whose links to an adversarial state might be difficult to establish.

To overcome these challenges, the Alliance has committed to strengthening the SDA through the creation of the NATO Space Operations Centre at Allied Air Command in Ramstein, with the aim of making it the main hub for the exchange of space-related information among allied states and, also serve as a place for coordinating efforts in this field and supporting missions and operations (NATO, 2025c). Along the same line is the APSS initiative, which aims to improve situational awareness and facilitate decision-making.

Although there is no official definition, deterrence is understood within the field of NATO as the conviction on the part of a potential aggressor that the consequences of coercive action or armed conflict would outweigh the potential benefits expected from the aggression (NATO, n.d.), and it can take two forms: punishment or denial.

According to Mazarr (2018), deterrence through denial seeks to prevent an action by making it unfeasible or unlikely to succeed, thereby discouraging the potential aggressor from believing they can achieve their objectives, whereas deterrence through punishment threatens the imposition of severe sanctions or strong economic measures should an attack occur.

Of the two types, deterrence through punishment is the most demanding, not only because of the challenges associated with its implementation, but also because of the uncertainty surrounding how it is perceived by the adversary. It is feasible, possibly as a last resort, only for some NATO Member States that possess the necessary space capabilities to carry it out (Traut *et al*., 2022).

To achieve effective deterrence through denial, resilience is fundamental. This is enshrined in Article 3 of the North Atlantic Treaty[1] and is understood within the Alliance as the capability, at both national and collective levels, to anticipate, resist, react to and swiftly recover from any disturbances or disruptions that may affect military capabilities. Resilience can be achieved through a variety of techniques.

These techniques include disaggregation, which involves distributing missions, sensors or functions across independent systems; distribution, which refers to separating subsystems with the same mission that together form a single system; diversification, which enables the same mission or function to be achieved using different means; proliferation, understood as the redundant distribution of different units of the same system; and protection, which encompasses all measures aimed at safeguarding operational capabilities (Console, 2018).

Within the Allied Joint Publication, there are also possible measures to protect the Alliance's space capabilities. Currently, document AJP-3.29[2] is in the developmental stage. It will provide the general principles and guidelines required for planning, conducting and evaluating military operations in space. Until its enactment, all matters relating to space are covered in Chapter 5 of AJP-3.3, which sets out the allied joint doctrine for air and space operations.

Whilst this AJP-3.3 refers to space control to encompass both defensive and offensive measures that can be taken to guarantee freedom of access to one's own space capabilities, whilst denying or limiting access to those of the adversary, the development of the new AJP-3.29 directly incorporates the term 'Defensive and Offensive Space Operations (DOSO)'. This encompasses all

[1] 'In order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack'. See: https://www.nato.int/cps/en/natohq/official_texts_17120.htm

[2] The NATO Space Centre of Excellence (NATO Space COE) in Toulouse is currently responsible for overseeing and leading the work on the development of AJP-3.29, which is scheduled for publication in the second quarter of 2026.

measures that can be employed to guarantee the continued and sustainable use of space by allies, deter potential adversaries, attribute possible attacks, and support the exercise of the legitimate right to self-defence. These measures could include both offensive operations (OSO) and defensive operations (DSO).

1.3 The commercial sector's contribution to Allied space capabilities

One of the lines of work set out in NATO's Overarching Space Policy is to harness technological advances and systems developed by the commercial sector for the benefit of the Alliance, so that, where appropriate, the space-related data, products and services required to support operations can be sourced from that sector. Furthermore, the involvement of the commercial space sector helps to strengthen the Alliance's resilience and guarantee its strategic advantage by providing redundancy and diversity in those in-orbit assets that may be considered critical.

In line with this, on 13 February 2025, NATO approved a commercial space strategy aimed at strengthening its relationship with commercial partners in the sector, with a view to ensuring that the services they can provide are available in a flexible and timely manner throughout all stages of the military operations. In addition to this objective, there are others, such as the possibility of exploring opportunities to exchange data relating to space situational awareness with national space operations centres, both civilian and military, and commercial partners in allied countries (NATO, 2025d).

In line with the provisions of that strategy, the NATO Communications and Information Agency launched a request for information on the capabilities of the private sector that could help support the APSS initiative (Satta, 2025).

Technological advances have made it possible to significantly reduce the costs associated with deploying new assets into orbit, which has paved the way for a growing number of civilian companies interested in this niche market to enter this sector. This situation represents an unparalleled opportunity for NATO to improve its situational awareness capabilities in the domain, without having to face the costs of launching and maintaining its own systems.

Whilst it is true that the use of space capabilities from the commercial sector can bring benefits to NATO, it is equally true that such use is not without certain challenges that must be addressed in order to achieve their full integration into the Alliance's deterrence and defence framework. Among these challenges is the need for commercial space capabilities to incorporate security, confidentiality, availability and access requirements, even under combat conditions, in order to fulfil the requirements of military activities and operations.

Furthermore, the integration of commercial capabilities in support of NATO operations requires the corresponding interoperability; in other words, systems developed by the private sector must be capable of operating alongside other civilian or military measures serving the Alliance and must be able to be fully integrated into its command and control structure.

To assess the level of interoperability, NATO holds the annual Coalition Warrior Interoperability Exercise[3] (CWIX), during which the command and control systems and capabilities of both member countries and their partners are tested to verify their alignment with the interoperability standards. Furthermore, this programme is open to companies in the industrial sector that offer technological solutions capable of being integrated into the allied operational environment.

The integration of the civilian commercial sector into NATO's space capabilities also presents certain risks. Civilian providers may face supply issues or even access problems caused by adversaries, which poses a dilemma for the security of military operations. Furthermore, the use of commercial space solutions for military activities and operations means that they can be considered as dual-use capabilities (civilian and military) and are therefore vulnerable to attack and may even be considered legitimate targets in the event of a conflict (Satta, 2025).

2 The United States and its space strategy

According to Statista (2025)[4], the United States was the country that allocated the most public funds to the space sector in 2024 in the world, with an investment of over USD 79 billion out of the approximately USD 135 billion spent globally, followed at a considerable distance by China, with an investment of just over USD 19 billion (Statista Research Department, 2025). Of that

[3] See: https://www.jftc.nato.int/article/cwix-gold-standard-interoperability/

[4] Based on data provided by Novaspace, a leading space consultancy and market analysis firm.

investment, just over USD 49 billion was allocated to the US defence and national security sector (Hitchens, 2025b).

The growing increase in US investment in the space sector is in line with its 2022 National Security Strategy, in which, after identifying China as the sole competitor with the intent and technological capability to reshape world order, it outlined the courses of action necessary to maintain competitive advantage, including the implementation of the necessary national investments in order to consolidate strengths and guarantee resilience (The White House, 2022). Furthermore, the aforementioned National Security Strategy recognised the need to modernise military capabilities, investing particularly in those considered fundamental for guaranteeing deterrence.

In November 2025, a new National Security Strategy was approved, which once again advocates investing in the most advanced military and dual-use civil-military technologies, placing particular emphasis on those areas in which the United States has the greatest strength. Among these areas are those relating to submarine capabilities, nuclear capabilities and space capabilities (The White House, 2025).

This document establishes that outer space is an essential component for its security and prosperity, and recognises that space capabilities play a vital role within its military power. For this reason, it is necessary to protect them in order to achieve and maintain superiority in each one of the operational domains in which military operations may take place. This is outlined in the 2020 Defense Space Strategy, which defines space power as the set of capabilities possessed by a state that enable it to use space for diplomatic, information, economic or military purposes (including in peacetime as well as in conflict) with the aim of achieving its national objectives (US Department of Defense, 2020). In other words, the country's capability to exploit outer space for its own benefit.

The Defense Space Strategy establishes as its final objective (or strategic goal to reach) the assurance of a space domain that is accessible, stable and secure, and in which the United States is capable of generating, projecting and employing military power across all operational fields and throughout the entire spectrum of conflict.

To achieve the aforementioned final objective, the US Defense Space Strategy establishes a series of key objectives, including maintaining superiority in space, thereby guaranteeing freedom of action in this domain and being in a position to protect and defend its own space capabilities, as well as those of allies, partners and commercial entities. In the same way, the aim is to deter and prevent adversaries from using space for hostile purposes; to provide space support for national military operations, whether at the joint level or in conjunction with other countries; and to maintain a continuous presence in space as a means of preserving stability in this domain (US Department of Defense, 2020).

To achieve these objectives, it is proposed to increase the US' space power capabilities, whilst also taking advantage of collaborating with allies, partners and the space industry.

2.1 North American space capabilities and space operations

In December 2019, the President of the United States, Donald Trump, signed a bill establishing the Space Force as an independent branch of the US Armed Forces, with the mission of protecting national interests in space, deterring any aggression originating from, directed at or conducted in space, and carrying out operations in this domain in a rapid and sustained manner (US Congress, 2019).

Following the creation of this new military branch, the first core doctrine for the US Space Force was published in 2020, setting out the principles that should guide the employment of said force. Furthermore, the concept of 'military space power' is introduced as the capability to achieve strategic and military objectives through the control and exploitation of the space domain (US Space Force, 2020). This same doctrinal publication sets out the core competences that the Space Force must possess, from which the capabilities required to fulfil national requirements effectively and efficiently are derived. These competences relate to space security, combat power projection, space mobility and logistics, information mobility, and space domain awareness.

Through capabilities committed to space security, safe access to outer space is guaranteed for the benefit of national interests. Within these capabilities are also those relating to the exchange of information and those aimed at establishing self-protection measures. Furthermore, the capabilities necessary for combat power projection ensure freedom of action in space, for both the United States as well as its allies, including actions designed to deny the adversary's freedom of action. For this reason, the capabilities associated with combat power projection may include both those designed to carry out defensive operations as well as those intended for offensive operations.

An important difference with respect to the NATO doctrine, which considers offensive operations to be part of the exercise of the right to self-defence by allied forces, is that the North American doctrine allows for offensive operations to be carried out with the aim of seizing the initiative and may even involve neutralising the adversary's capabilities in space, before they can be employed against friendly forces.

Furthermore, the US doctrine establishes the need for capabilities that enable the movement and support of military personnel and equipment into space, within the realm of space mobility and logistics. This means having the means to deploy military assets into orbit; guarantee the sustainment of space-based platforms; and facilitate the recovery of personnel or equipment from the space domain.

Other space capabilities required within the Space Force include those relating to communications; positioning, navigation and timing; nuclear detonation detection; missile warning; and ISR. All these capabilities would be linked to the core competency of information mobility.

Finally, the Space Force must have the necessary means to enable it to collect, synthesize, fuse, and make sense of a large volume of data, with the aim of reaching a comprehensive understanding of the space domain. This knowledge should provide a clear overview of all the actors and factors that may have an impact on military operations in that domain.

2.2 Space as a combat domain

The 2020 US National Space Policy clearly advocated for the peaceful use of outer space, open to all nations for the benefit of humanity (Executive Office of the President, 2020). Nevertheless, the global landscape has changed, and the new 2025 doctrinal publication, known as *Space Force Doctrine Document-1* (SFDD-1), confirms it. In its first pages, it states outright that space is a warfighting domain, not a collection of supporting activities, and that the Space Force is the branch of the Armed Forces responsible for the performance of warfighting operations as an integral part of the joint force (US Space Force, 2025a).

The publication of the SFDD-1 reflects the change in the overall vision for space missions, driven by senior US military officials such as General B. Chance Saltzman, Chief of Space Operations and the highest-ranking officer in the Space Force. In an interview, he noted that in recent years they have been working to transform public perception of the mission of this new branch of the Armed Forces, focusing on the concept of space superiority and the possibility of conflict in space. This new approach stands in contrast to that of previous periods, when the Pentagon itself avoided employing terms that could suggest the use of force in the space domain (Breaking Defense, 2024).

In line with these statements, a planning framework document was published in March 2025, which seeks to set out the basic principles underlying the use of military force in the context of combat operations in space. As such, the primary objective is established as achieving space superiority, defined as the degree of control that enables forces to operate at the time and place of their choosing, free from interferences from space (or counter-space) threats, whilst simultaneously limiting the adversary's capability to do the same (US Space Force, 2025b). In order to achieve that spatial superiority, it may be necessary to carry out offensive and defensive actions that fall under what is known as 'space control'.

These offensive and defensive actions are generally known as counterspace operations, in other words, operations aimed at denying, degrading or destroying enemy space capabilities. Offensive operations may be carried out by targeting assets in orbit, space communication links, or the elements that make up the ground segment. In operational terms, this involves categorising potential targets that could be attacked if considered necessary.

Furthermore, this document provides a framework for applying the theory of 'competitive endurance' to the Space Force, with the aim of successfully achieving space superiority whilst maintaining security, stability and long-term sustainability (US Space Force, 2025).

This theory is based on three fundamental principles. The first is that the Space Force must be prepared to detect any disruption that could compromise its capability to achieve superiority

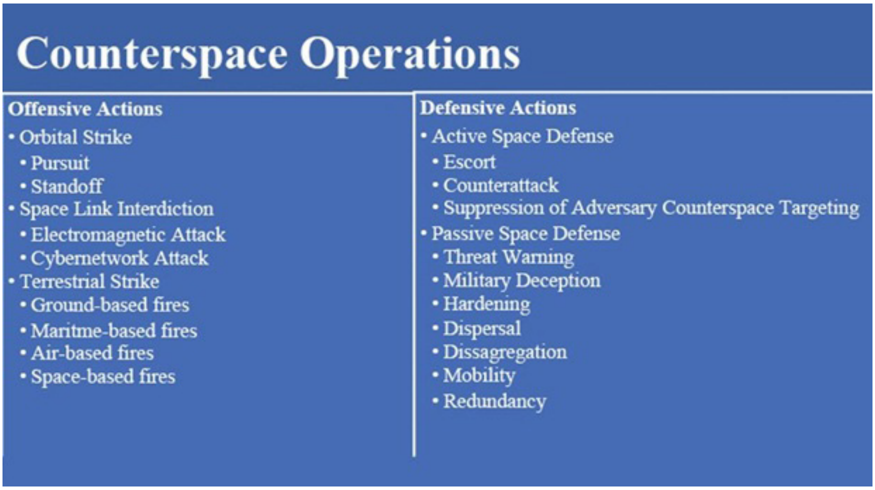

Figure 4. Counter-space operations. ***Source*****: US Space Force (2025b)**

in space. The second, according to which the Space Force must have the capability to neutralise the advantage gained by an adversary through a surprise attack. And the third, which orders the Space Force to be prepared to carry out operations aimed at denying, degrading or destroying enemy space capabilities in a responsible manner. In order implement this theory, the Space Force must have forces that are ready for combat and capable of providing adequate domain awareness, resilient combat effects and counterattacks that do not leave behind any dangerous remnants for its own military capabilities (US Space Force, 2024).

2.3 The Golden Dome Project

In January 2025, President Trump signed an order to develop a project that would bring together the capabilities needed to protect the United States against the threat of potential attacks by ballistic, hypersonic and cruise missiles, as well as other air attacks carried out using advanced means. The project, initially known as Iron Dome for America and later renamed Golden Dome for America, is inspired by the Israeli Iron Dome air defence system.

The Golden Dome is a comprehensive, multi-layered ballistic missile defence system based on a range of capabilities, including the deployment of sensors in orbit, command and control networks, and ground-based interceptors to neutralise incoming threats.

The project also considers the development of kinetic space-based interceptors, consisting of projectiles, capable of stopping a ballistic threat by colliding with the missile in the upper atmosphere before it reaches US territory.

As Alatorre (2025) notes, this project constitutes an integrated system comprising multiple programmes that utilise space-based infrastructure to provide tracking, data collection and communications capabilities, supplementing the entire system with ground-based radars, command centres and mobile units responsible for launching interceptors.

This same author highlights the implications of deploying possible interceptors into orbit, from both a diplomatic as well as a military perspective. In the first case, and given that in 2022 the United States moved towards a unilateral ban on direct-ascent anti-satellite weapon tests, with the aim of laying the groundwork for a future international moratorium on this type of weaponry, the deployment of kinetic space interceptors in orbit could undermine the United States' capability to influence the promotion of a rules-based space order. On the other hand, such a deployment could encourage other countries to follow suit under the pretext of doing so as a response and a defensive measure. From a military perspective, the establishment of this space defence architecture could be used by other countries, such as China and Russia, as a justification for increasing their military presence in space (Alatorre, 2025).

Finally, it should be highlighted that the Golden Dome programme is explicitly mentioned in the new National Security Strategy of November 2025. It is considered one of the essential elements for achieving an effective nuclear deterrence, alongside a modern nuclear arsenal and next-generation missile defences designed to protect the US population, its overseas assets and its allies (The White House, 2025).

3 The United Kingdom: vision and capabilities

Outer space is a vital sector for both the UK economy and its security, as stated in the UK's 2021 National Space Strategy (UK Space Agency, 2021). According to this document, the United Kingdom aspires to become one of the most innovative space-related economies, a goal it intends to achieve by strengthening the industry, fostering international collaboration, participating in research projects within the sector, and developing resilient space capabilities and services.

In line with the provisions of the National Space Strategy, the Defence Space Strategy was published in 2022 with the aim of setting out guidelines to ensure that the defence sector contributes to the United Kingdom's aspiration of becoming a key player in the space domain at an international level (UK Ministry of Defence, 2022). With this in mind, they have set themselves the mission of generating, integrating and operating assets in orbit, with the aim of protecting and defending national interests.

The British Defence Strategy identifies dual use as an important pillar supporting the country's defence space capabilities. In this regard, it advocates conducting an analysis to identify which capabilities should be obtained and maintained under national sovereignty, which can be developed in collaboration with allies and partners, and which can be sourced from the commercial sector. It also announces the creation of a plan for the development of priority space capabilities up until 2030, which must encompass one or more of the following areas: secure satellite communication; space domain awareness; ISR; space command and control; space control; positioning, navigation and timing; and launches.

Published at the end of 2022, the plan establishes a series of objectives for each of the priority areas identified in the Defence Space Strategy, whilst also setting out a series of principles to be taken into account when developing it. These principles include harnessing the benefits of integration and connectivity between space capabilities, capitalising on dual-use opportunities across defence and civil space domains, coordinating collaboration with industry, academia, allies and other key partners, and cohering learning, development and knowledge transfer under the leadership of UK Space Command (UK Minister of Defence, 2022).

All the generated space capabilities are designed to address one of the four core pillars on which, according to the Joint Doctrine Paper (JDP), the role of space power is based: space domain awareness, space control, space support to operations, and the launch and sustainment of assets in space. These operations would fall under what is known as Space Service Support (UK Ministry of Defence, 2023).

With respect to space domain awareness, the joint doctrine publication identifies it as the result of combining intelligence gathered through means of various operational domains alongside space surveillance and tracking (SST), which enables the detection, tracking and identification of objects in space, and space situational awareness, which provides an understanding of the risks and threats resulting from the current congestion in the domain.

It is also worth highlighting the distinction between space domain awareness (SDA) and space situational awareness (SSA). In this regard, whilst the former provides decision-making bodies with indicators regarding the operational relevance of the information held, the latter offers the necessary knowledge to plan and execute operations in space.

However, the control of space involves the use of defensive and offensive capabilities to guarantee freedom of access and action in space. This may entail taking measures to counter an adversary's attempts to neutralise, interfere with or attack one's own systems, as well as taking action against the adversary's space systems to gain a military advantage. The joint doctrine underlines, however, that measures aimed at reducing the threat and preserving the freedom of action may also include diplomatic and legal endeavours, which are considered an integral part of the space control strategy.

Within the space support pillar for operations there following functions are included: those relating to ISR; positioning, navigation and timing; satellite communications (SATCOM), missile warning and tracking; and environmental monitoring. Finally, the JDP emphasises the need for the capability to launch assets into space, as well as to maintain and sustain them, in line with the 2021 National Space Strategy, which considers space launch as a necessary prerequisite for the United Kingdom to be considered as a key player.

With this in mind, the first attempt to launch a satellite horizontally and place it into orbit took place on 9 January 2023. To do this, a rocket was mounted beneath one of the wings of a specially modified Boeing 747 commercial aircraft, which took off from the spaceport in Cornwall. Although the first part of the mission was a success and the rocket flew into space, it ultimately failed to reach the intended orbit. Despite this, the British Government did not hesitate to publicly present the milestone as a demonstration of the country's capabilities in the field of horizontal launches (UK Space Agency, 2023).

4 Canada: space employment policy and capabilities

Canada identifies outer space not only as a domain that is crucial to guarantee the well-being of its citizens, but also as a new opportunity for both technological development as well as national trade. This is set out in its Space Framework Policy, which details the five core principles that should guide Canada's space activities (Canadian Space Agency, 2014). These are: putting Canada's interests first; putting the private sector at the forefront of space activities; encouraging the participation and collaboration of international partners; supporting the development of capabilities in which Canada has achieved a certain excellence; and carrying out communication efforts highlighting the importance of space in order to inspire young Canadians to pursue studies related to science and technology, whilst making an effort to recruit, support and retain highly qualified personnel.

Canada advocates for a safe outer space and promotes its peaceful use, whilst remaining mindful that there are countries developing technologies that could jeopardise the security of this domain and even pose a threat to its own space capabilities. This is set out in Canada's Defence Policy, published in 2017, which promotes the implementation of a set of standards for responsible behaviour in space under Canadian leadership (Government of Canada, 2017).

Furthermore, the aforementioned Defence Policy stipulates that space capabilities must be modernised and protected against possible threats. In this vein, it calls for the acquisition of those designed to improve situational awareness and targeting capabilities, as well as those that enable the identification and tracking of space debris that may endanger both national and allied assets. Similarly, it is considered necessary to have systems in place that improve communications at a tactical level, including coverage in the Arctic region.

As Canada is one of the eight members of the Arctic Council[5] (and one of the five coastal states), this region receives significant attention in its National Defence Policy. It establishes the need to prioritise the development of specifically tailored ISR capabilities.

[5] An intergovernmental forum that promotes cooperation, coordination and interaction among the Arctic states, comprising Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States.

Other capabilities considered crucial for the Canadian Armed Forces include those relating to command and control; meteorological information; positioning, navigation and timing; mapping; and satellite tracking for search and rescue (Royal Canadian Air Force, 2022). Related to this, Canada is one of the four founding countries and an operator of the COSPAS-SARSAT international satellite search and rescue system. Established in 1979 by France, Canada, the United States and Russia, it consists of a global programme that uses radio beacons capable of locating any aircraft, vessel or person found in an emergency situation.

In terms of defending and protecting its space capabilities, Canada is committed to working closely with allies and partners, encouraging collaboration within the framework of international initiatives such as the Five Eyes community[6] and the Combined Space Operations Initiative (CSpO), which focuses specifically on space-related matters. This body consists of the Five Eyes Member States as well as Germany, France, Italy, Japan and Norway. Its mission is to promote cooperation, coordination and the exchange of information with the aim of preserving freedom of action in space, optimising the use of resources, strengthening the resilience of space capabilities, and contributing to conflict prevention through deterrence (US Department of Defense, 2022).

5 Other partners outside of Europe

Australia and Japan are two of the main countries which, despite not being members of NATO, have established collaboration agreements with member states and are actively involved in a number of space-related initiatives led primarily by the United States. Both are members of the CSpO initiative and, in the case of Australia specifically, it is also part of the Five Eyes community and has applied for membership at the NATO Space Centre of Excellence (NATO Space COE).

From a more operational perspective, Australia is one of the seven countries[7] that make up the multinational force of Operation

[6] The Five Eyes initiative is an agreement between Australia, Canada, New Zealand, the United Kingdom and the United States for the exchange of intelligence data. The main area of collaboration relates to signals intelligence (SIGINT), although it has been extended to cover all types of intelligence-gathering methods.

[7] Alongside the United States, Canada, the United Kingdom, France, Germany and New Zealand.

Olympic Defender, established in 2013 under the strategic command of the United States and which achieved initial operational capability in April 2025. Its role is to integrate the participants' space capabilities in order to deter threats and, where necessary, to carry out the necessary military actions to maintain the military advantage.

When it comes to capabilities, Australia considers that they are necessary in four key areas: space domain awareness, SATCOM, ISR and space control. The latter encompasses the defensive and offensive actions necessary to guarantee the freedom of action, including, where necessary, disrupting or denying the adversary's use of the space domain. All of this falls under the concept 'Selene,' which establishes the framework for Australian space operations (Breaking Defense, 2025).

As for Japan, in 2025 the Ministry of Defence presented the first guidelines on space defence, stipulating that satellites operated by the Japan Self-Defence Forces (JSDF) will be fully protected, and that the safe use of space is guaranteed for companies.

Among the principles set out in these guidelines is the need for capabilities that facilitate space domain awareness in the space domain, with the aim of monitoring and anticipating the intentions of assets in orbit operated by other countries. The underlying objective is to develop the means to detect certain threats, including those posed by satellites that could be used as weapons of destruction and anti-satellite weapons.

Furthermore, among the necessary space capabilities, particular importance is attributed to maintaining stable and secure satellite communications for military intelligence, which even enable the exchange of information relating to the detection and tracking of missiles launched by adversary countries. Furthermore, it promotes the development of capabilities designed to interfere with these countries' communications if necessary (Ministry of Defence of Japan, 2025).

In the field of international cooperation, Japan is seeking to strengthen its space partnership with the United States. With this in mind, it is proposed that the necessary steps be taken to ensure that national space capabilities are interoperable with those of the North America, as well as resilient in a contested space domain. In the field of missile warning and tracking, in 2024 both countries announced the start of a collaboration to develop a constellation in low orbit, designed to detect and track missiles and other hypersonic objects. Although it is true that, to date, progress appears to have been limited, the interest of the project lies in the fact that these capabilities could, if necessary, be integrated into the Golden Dome missile defence initiative, driven by the new US administration (Wilson, 2025).

Conclusions

Advanced societies are increasingly reliant on the services provided by sensors and satellites orbiting the Earth to carry out a wide range of activities in the fields of the economy, security and the very well-being of everyday life. This dependence also represents a vulnerability, as it makes space assets potential targets for those who might want to jeopardise an entire country at a given moment. On the other hand, outer space is no longer a realm reserved solely for the few capable of putting objects into orbit, and there are an increasing number of actors keen to partake in the benefits of space exploration.

For all these reasons, a competitive, congested and contested environment is taking shape beyond the atmosphere, thereby heightening Governments' concerns about protecting their space systems, both in peacetime as well as in conflict. With this in mind, NATO has declared outer space an operational domain, thereby recognising the essential role it plays in military missions relating to security, deterrence and defence.

When it comes to space capabilities, NATO, the United States and other partners and allies outside of Europe all consider it necessary to have virtually the same categories in their inventories. As a result, those relating to positioning, navigation and timing; communications or intelligence, surveillance and reconnaissance, are considered essential for providing service and support to all military operations.

In addition to these are those relating to space situational awareness, command and control of the systems in orbit, environmental monitoring, and ballistic missile launch warning. All of these form part of the Alliance's defensive approach, which is based on the deterrence, resilience and interoperability of member countries' space capabilities.

The United States considers space as a combat domain in which both offensive and defensive military operations can be carried out. That is why the list of capabilities includes those that enable the conduct of military operations aimed at seizing the initiative and even allow for the pre-emptive neutralisation of the adversary's operations. All of this is aimed at achieving a supposed space superiority that would enable one's own forces to operate without interferences, whilst denying the adversary that same possibility by degrading or even destroying their space means.

In line with this change in perspective on space, which even considers the use of force, initiatives have been implemented such as the US-led multinational force of Operation Olympic Defender, which aims to integrate the space capabilities of participating countries with the aim of promoting deterrence and, where necessary, carrying out military actions to maintain the military advantage.

The signatories to the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space committed themselves not to place in orbit any object carrying nuclear weapons or any other type of weapon of mass destruction, not to station such weapons on celestial bodies, and not to place such weapons in outer space in any other form. However, programmes such as the Golden Dome appear to be leading to a possible military escalation in this new operational domain.

Finally, major powers such as China and Russia are challenging the hegemony of the United States in many areas, including that of space. History shows that when a hegemonic power fears losing its dominant position, it tries to act pre-emptively to prevent this from happening. This preventive move is perceived by the emerging powers as a kind of attack, with both sides moving, almost unwittingly, towards the brink of conflict.

Chapter four

Strategic competition and the control of space

Dr. José M. Martínez Cortés

Abstract

In recent years, there has been a significant increase in the civil and military use of capabilities linked to outer space. Space technology and the products and services we obtain from it have become essential for our society, a dependence that will almost certainly continue to grow in the coming years. Although the use and the enjoyment of space is a global commons, the necessary freedom to use satellite capabilities has sparked increasing interest among those states that want to secure the use of their own capabilities while managing the increasing use of space by others, thus addressing potential threats. This interest is directly related to the strategic capability of owning satellite systems, both in the civil and military environments, in this case, as a new operational domain. Its growth constitutes the origin of the strategic competition experienced in the space domain, reflected in events and attitudes that are far from peaceful. The growing dependence on satellite capabilities and the need to ensure activities carried out in space and the continuity of services from it require guaranteeing continuous access and freedom of movement in this new operational domain.

Keywords

Outer space, Outer space control, Strategic competition, Satellite capabilities, Operational domain.

Introduction

The world today is immersed in a fierce strategic competition between those states that regard themselves as major powers capable to influence in global events. Although this is not a new situation, it is indeed more aggressive in nature and is evident in areas that were previously out of reach for many. And outer space is no exception.

Far from being a peaceful environment, over the last decade China's economic and military rise (as an element of its strategy of strategic competition with the US), the modernisation of certain Russian capabilities (coupled with a clearly more assertive policy) and the emergence of other actors (such as India, Iran and North Korea) have progressively transformed not only the balance of power, but also the perception of security which, in the short term, is foreseen in the execution of activities in space. Based on the military capabilities developed by these actors, which consequently create an environment where it is more difficult to project and move forces in relation to A2/AD (Anti-access/area-denial) capabilities, the significance of this evolution is that it affects equally all domains, including, of course, the space.

Greater access to technology and the reduction in the cost of satellite systems have turn outer space into a more congested and contested environment than it was just over a decade ago, as evidenced by the increase in annual satellite launches and in the space control capabilities of the major actors. The fact is that, although outer space constitutes a global commons to which access should be free and continuous for all, the reality of technological development and current strategic competition shows that the most powerful actors in the sector are increasingly striving to acquire capabilities that will enable them to implement effective control over space in order to guarantee their continued access and the protection of their space activities, whilst at the same time being able to deny others the use of satellite systems or degrade the information obtained from them, when national interests or their own freedom of action in space are at stake. This growing interest is at the root of the strategic competition over a sort of control of space activities taking place today in the space domain.

The evolution of the outer space has been reflected in the increase of satellite capabilities by actors with less than peaceful intentions which has led to events that are neither peaceful nor encouraging in recent years from a security perspective. Since the declaration of outer space as an operational domain (another domain in which to generate the required operational effects), this has led to a range of developments, from the adaptation of strategic documents to reflect this reality, to the implementation of the resulting doctrinal and organisational changes.

Thus, in the space domain, in addition to threats associated with natural phenomena or non-human-induced events, space activities are threatened by all manner of deliberate actions carried out by other actors in space to exert offensive control, the increase in which can be described as worrying. In addition to a growing dependence on satellite capabilities, this context demonstrates that in this new domain to guarantee a continued access and freedom of movement requires not only the protection of assets, activities and services received from space, but also the ability to exercise a degree of control over the environment and to produce different effects (as is the case in other domains). However, this will depend on space capacities, as well as on technological limitations and other contextual factors of a social nature. All of this becomes more relevant given the fact that the development of the legal regulations does not seem to be helping.

Despite the fact that the exploration and use of outer space should be carried out for the benefit and interests of all countries, and concern the whole of humanity[1], as being pointed out, the reality shows that the actions of the main actors in this environment do not exactly merit the description 'peaceful'. Nevertheless, the increase in activities affecting security in space makes it necessary to continue driving the development and adaptation of legal frameworks within the context of international cooperation, taking into account, however, that in the event of an external attack in this new domain, 'self-defence' tailored to that environment should be always permitted, as no one can ensure, even less today, that all parties will respect the rules in force.

At this point when we talk about protecting our space activities, and even more so about denying or degrading the employment of satellite systems, what capabilities and what effects are we

1 The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, was approved on 19 December 1966 and entered into force on 10 October 1967. See: https://www.unoosa.org/pdf/publications/STSPACE11S.pdf

referring to? Any of these activities, whether aimed at self-protection or at degrading/denying an adversary's capabilities, require the capability, however limited, to exercise control over space. This is a complex task involving three activities: the first, the surveillance of outer space; the second, the protection of own space assets and activities; and the third when necessary, the denial of or response to malicious activities carried out by a real or potential adversary.

Leaving aside the first of these activities (the surveillance of space), the strategic competition that affects the space domain, and will affect even more in the future, is mainly centred on the protection of satellites in orbit and, more specifically, on offensive control of space capabilities. In other words, those space capabilities used to deny or degrade an adversary's employment of satellite systems. In the Western context, this primarily refers to response activities in the space domain in the face of malicious actions by real or potential adversaries.

1 Offensive control of space capabilities

Generally speaking, and in accordance with the Space Threat Assessment (CSIS, 2024; 2025) and the Global Counterspace Capabilities (SWF, 2024; 2025), the latter type of capabilities can be classified into four main groups. Among the non-physical capabilities are those based on electronic warfare and cyberspace, whilst the physical capabilities include directed-energy capabilities (non-kinetic physical) and anti-satellite capabilities (ASAT, kinetic or destructive physical).

Furthermore, there is another group of capabilities known as co-orbital capabilities, which carry out Rendez-vous and Proximity Operations (RPO) in an orbit or orbital region where other celestial bodies or satellites are present. Although they are generally linked to less aggressive activities (surveillance and inspection satellites engaged in maintenance or repair of other own satellites, or satellites used by foreign parties in surveillance, espionage or intelligence operations), they could also be focused on offensive capabilities in the form of co-orbital anti-satellite weapons (anti-satellite capabilities originating from another satellite).

In the case of electronic warfare, disruption devices introduce a jamming signal into communications to or from satellites, generating noise on the same radio frequency band, thereby interfering with the communications link (whether uplink towards the satellite or downlink towards the user on the ground), or they introduce a spoofing signal into the user's receiver. Both of these attacks are normally reversible, as communications can return to normal once the disruptive signal is removed.

Meanwhile, in cyber domain, such offensive actions target the data or the systems that employ, transmit and control the flow of data (whether they are ground stations, user equipment or the satellites themselves) with the aim of monitoring data traffic patterns, intercepting data or inserting false or corrupted data or commands into a system, which could result in the loss of data or the satellite service, a situation that could have widespread systemic effects.

Although these actions require a high level of knowledge of the target systems, they do not necessarily require significant resources to carry them out and even can be outsourced to private firms or individuals. Furthermore, accurately identifying the perpetrators can be difficult, and there is limited real and public evidence of cyberattacks. To date, only some cyberattacks targeting space systems have been made public, and almost all of them have been directed at the end-user segment rather than at the satellites themselves. There remains, at present, a clear difference With regard to non-kinetic physical systems or actions, Directed Energy Weapons (DEW), lasers can be employed between the capabilities of the states and those of other actors (SWF, 2024; 2025).

With regard to non-kinetic physical systems or actions, Directed Energy Weapons (DEW), lasers can be employed to temporarily dazzle or permanently blind satellite sensors, or to make components overheat. Furthermore, high-power microwave systems can disrupt a satellite's electronics, causing permanent damage to its electronic circuits or processors, or even corrupting the data stored in its memory. In both cases (lasers and microwaves), these systems can be activated from land-based, naval or airborne platforms, or from other satellites.

At a more aggressive level, kinetic physical effect systems designed to directly attack or detonate a warhead near to a satellite[2] (or a

[2] To date, although only four countries (the US, Russia, China and India) have successfully tested DA-ASAT weapons against their own satellites, none of them has carried out a physical kinetic attack against a third party's satellite. Nevertheless, as early as the 1950s and 1960s, the US and the Soviet Union carried out high-altitude nuclear tests in space (CSIS, 2024; 2025).

ground station) produce a powerful deterrence effect and tend to cause an irreversible damage. Its employment against satellites could generate a large amount of orbital debris (in the form of space junk) that could affect with non-discrimination other satellites, including their own in similar orbits. In the latter case, there are two possible scenarios. The most known is the direct-ascent anti-satellite (DA-ASAT) weapon launched from the Earth's surface. The other option, which remains at project and research stage and is not yet operational, is the co-orbital anti-satellite weapon which would initially be placed in orbit and then manoeuvre towards or near its intended target in orbit. However, as mentioned before, these co-orbital manoeuvres, known as RPO, can be employed not only as co-orbital ASAT systems, but also in less aggressive activities such as routine maintenance or spying and signals intelligence against an adversary's satellites.

The context of strategic competition and the greater access to technologies have led the major powers in this domain to develop capabilities designed to deny or degrade others' employment of satellite systems, in order to secure their own freedom of action—a concept commonly referred to as offensive control of space capabilities. These capabilities, which may still seem like science fiction to some, will likely be included in the inventory of our closest allies in the very near future. It is true, however, that although there is significant research and development activity in several countries across a wide range of destructive and non-destructive capabilities for the control of space, only non-physical capabilities based on the electromagnetic spectrum or cyberspace are being actively used in military operations.

In order to understand the efforts made in this field and the reality of strategic competition between the major powers, in accordance with the Space Threat Assessments (2024/2025) and the Global Counterspace Capabilities (2024/2025) reports, we shall now review the capabilities currently available or under development in this context in countries outside the Western sphere, focusing on the People's Republic of China, the Russian Federation and India, as the most representative and better illustrating the current state of this new domain that is outer space.

2 People's Republic of China

Chinese scientific and technological efforts in space began to pick up pace in the 1980s and, subsequently, after observing

US military performance during the conflicts of the 1990s and early 2000s, the Chinese military embarked on an effort to modernise its weapons systems across all domains, including space, and to update its doctrine to focus on the use of, and countering, the adversary's information warfare (DIA, 2022). China's perception of the importance to the United States and its allies of space-supported operations is thought to have shaped key components of the Chinese military's planning and campaigns.

In recent decades, China has undertaken a sustained effort to develop a wide range of space capabilities in the civil, national security and commercial sectors. These capabilities include a robust programme of manned spaceflights and robotic space exploration, remote sensing for weather and resource management, and military applications such as PNT, SATCOM and optical/infrared and radar ISR. Furthermore, it has plans[3], which are currently well behind schedule, to deploy two large space constellations comprising 27,000 satellites, as it considers the Starlink network as a direct threat due to the vital support it provides to the United States.

In the growing commercial space sector, although state-owned enterprises are the main space contractors, there is a growing emphasis on decentralising and diversifying the industry to increase competition as a means of encouraging innovation within a system dominated by the Government and state-owned enterprises. Besides, after the US, China ranks second in terms of private capital channelled into space companies. This enables it to continue developing and deploying a robust arsenal of space and specific offensive control of space capabilities, collaborating diplomatically with Russia to create an international coalition focused on lunar missions (a direct competitor to the US-led Artemis programme), while seeking strategic cooperation with African, Hispanic American and Asian countries.

Meanwhile, in the general context of the military sphere, China seems to be highly motivated to develop space control capabilities with a view to strengthening its national security. It has also

[3] The Qianfan constellation, intended for global low-orbit Internet coverage essential for autonomous vehicles, the employment of drones and military surveillance, had planned to have 650 operational satellites by the end of 2025, but since launches began in 2024, only ninety have been successfully placed into orbit. Guowang is the other low-orbit satellite Internet project launched in 2022, but it currently only has thirty-four satellites out of the thirteen thousand planned for the coming decade (Vallejo, 2025).

begun to assert more forcefully its regional political, economic and military interests, considering these capabilities to be a key facilitator. Being able to counter US space capabilities, which are very important for projecting its global military power, is a key factor to guarantee its freedom of action and deter potential US military operations within its area of influence.

Consequently, with a primary focus on capabilities for the offensive control of space, China emphasises the application of dual-use technologies, policies and organisations for military benefit (DIA, 2022). It is therefore undertaking a wide range of space exploration and manned spaceflight activities, with plans to modernise and expand its space launch capabilities, to expand its Tiangong space station, to research key technologies for the exploration and development of 'Cislunar' space (including human presence on the Moon), and to expand robotic exploration of Mars and deep space. It also has a robust network of space surveillance sensors (telescopes, radars and other sensors) capable of searching for, tracking and clasifying satellites in all Earth orbits, enabling it to support all its space missions (intelligence gathering, offensive control of space, early warning of ballistic missiles, spaceflights, anomaly resolution and space debris tracking) (Government of China, 2021).

Furthermore, like the other major powers, it has begun to develop the policies, doctrines and organisational frameworks necessary to support the integration of these capabilities into its military planning and operations. However, as almost everything concerning China, it is unclear whether it intends to use offensively its space control capabilities during a future conflict, or whether the aim is to use them as a deterrent against aggression. Nor is there any confirmed public evidence that it is actively using these capabilities in current military operations (SWF, 2024; 2025), although it has conducted operational tests and is likely to be using SSA and electronic warfare capabilities at least in some support roles.

At an organisational level, although in 2015 China proceeded to integrate under a single command its forces dedicated to cyberspace, space, electronic warfare and other information activities under a single command, in 2024 it dissolved this structure, dividing its responsibilities among three equal branches and devoting more efforts to the branch of information. In this way, the three new forces (Aerospace, Cyberspace and Information Support), together with the Joint Logistics Support Force, will support the four services: the Army, Navy, Air Force and Missile Forces, all under the unified command of the Central Military Commission (SWF, 2024; 2025).

It can be said that over the last decade China has established itself as a space power, maintaining its position as the second-largest actor in this field, based on a growing range of space and counterspace capabilities designed to support its national objectives[4]. Although Chinese official statements on space warfare have generally remained consistently aligned with the peaceful uses of outer space, it can be argued that various activities and attitudes suggest that space is viewed as a domain for future conflicts, whether or not this is officially declared[5].

China has demonstrated virtually all the capabilities considered in the field of offensive control of space, including interference and directed-energy systems, as well as DA-ASAT capabilities, and has tested technologies relevant to the development of counterspace weapons systems in orbit, in addition to the possibility that it may have carried out sophisticated cyber operations targeting space or important ground-based infrastructure.

When it comes to non-physical systems, China likely possess significant counterspace electronic warfare (EW) capabilities against GNSS and satellite communications systems, although their exact nature is difficult to determine from open-source information (SWF, 2024; 2025). The Chinese military doctrine places great emphasis on electronic warfare to interfere with or deceive the adversary's equipment. Although there is no evidence of their active use in military operations, there is indeed certainty regarding the research and development of EW capabilities for counterspace applications and indications in open-source material regarding their deployment, as well as the fact that the Chinese Army maintains a series of fixed and mobile electronic warfare systems capable of interfering with satellite communications links (DIA, 2022), radars, user GNSS terminals (by disrupting the downlink) and radar imaging satellites. For example, China is likely to have been responsible for interferences with the

[4] This includes the use of space as an extension of its soft power initiatives to strengthen its economic and diplomatic ties with other countries (CSIS, 2024).

[5] A statement supported by various pieces of evidence. Firstly, China has recently declared space to be a military domain. Secondly, military documents state that the aim of space warfare and operations is to achieve space superiority through the use of offensive and defensive means, as part of a broader strategic approach. And thirdly, the considerable investment it makes in the development and testing of counterspace capabilities.

GPS system in the Indo-Pacific region which has been detected in commercial flights and maritime traffic, at the risk of affecting civilian and commercial transportation and public safety[6].

With regard to the use of cyberspace, China is one of the countries that has demonstrated both the capability and the willingness to carry out offensive cyberattacks against non-space targets. The Chinese military prioritises offensive capabilities in cyberspace as a key component of integrated warfare and therefore, could use these capabilities to support military operations against space assets. For example, it could employ cyberattacks to achieve information superiority at the outset of a conflict, with the aim of restricting an adversary's actions or slowing down its mobilisation and deployment by targeting command, control, communications, and ISR networks, as well as logistical activities or commercial infrastructure.

Furthermore, the Chinese military has the capability to carry out cyber espionage against foreign space organisations, in line with broader state-sponsored industrial and technical espionage to increase its level of available technology and expertise in order to support military R&D and procurement. There are reports that the Army unit responsible for signals intelligence has been supporting cyber espionage against the US and European aerospace industries since at least 2007. According to the CSIS publication *STA-2024*, China has been implicated (or is suspected to be) in several cyberattacks against foreign satellite networks, including meteorological and remote-sensing satellites operated by the US National Oceanic and Atmospheric Administration (NOAA) and an Indian satellite communications network, as well as systems related to critical communications infrastructure.

In relation to non-kinetic physical weapons, such as high-power lasers or microwaves, China has been actively pursuing the development of directed-energy systems for offensive control of space and other applications" since the 1960s. There is also evidence of many scientific and technical discussions regarding research and possible future military applications as part of military projects. In particular, over the last two decades, Chinese defence research is said to have proposed the development of several

[6] In 2023, the commercial airline group Qantas and the International Federation of Air Line Pilots' Associations issued warnings to airlines regarding Chinese warships involved in the disruption of RF and GPS signals in the South China Sea, the Philippine Sea, the Eastern Indian Ocean and North-West Australia (CSIS, 2024; 2025).

counterspace DEW systems of varying power levels designed to reversibly blind electro-optical sensors and even potentially destroy satellite components (DIA, 2022).

Furthermore, according to reports from the US Defence Intelligence Agency (DIA), before the end of the 2020s, China could deploy more powerful systems capable of expanding the threat to non-optical satellite structures. However, given China's secrecy, the exact scope of its developments in directed-energy counterspace weapons remains unknown, and there is very little public evidence of their deployment or use. Whats's more, in accordance with US research, it is also estimated that the Chinese military possesses land-based mobile DEW systems and is conducting R&D on high-power microwave (HPM) mobile systems, although it is unclear whether the latter have applications for the control of space (DIA, 2022; CSIS, 2024). Finally, although there is some worrying evidence that an institute affiliated with the Chinese military may have conducted research into the effects of a nuclear detonation at different altitudes (Chen, 2022), as a way to counter the proliferation of satellite constellations in pursuit of greater resilience, no further research or developments in this regard have been identified.

Meanwhile, with regard to kinetic physical weapons or systems, specifically co-orbital technology and activities, China is conducting scientific experiments in space maintenance and debris removal technologies, as well as developing sophisticated space capabilities in this field, such as the inspection and repair of satellites, and at least some of these capabilities could also function as a weapons system. Furthermore, various demonstrations of this technology in low and geostationary orbits (GEO) prove China's ability to carry out RPO with other satellites in those orbits. Although they do not constitute proof of the availability of weapons in this field, they demonstrate the possession of a capability needed for co-orbital attacks from space in order to achieve an offensive control of space.

In this context, China has a long track record of conducting RPO, typically in geostationary orbit (GEO), dating back to 2010. This capability, as demonstrated by recent activities (2022-2024), reaffirms its capacity to successfully carry out RPO manoeuvres. In January 2022, the SJ-21 satellite moved a decommissioned BeiDou navigation satellite into a high graveyard orbit above GEO. In February 2023, the SJ-23 and a US space surveillance and tracking satellite appeared to move in tandem in

GEO. In addition, the Chinese SJ-17 satellite is equipped with a robotic arm that could be used in a future system to grasp other spacecraft[7].

Furthermore, since at least 2006, the Chinese academic community affiliated with the Government has been researching aspects of aerospace engineering related to space-based kinetic weapons. Research into space-based kinetic weapons including re-entry methods, payload separation, launch vehicles, and transfer orbits in order to carry out attacks from space. On 27 July 2021, China carried out the first fractional orbital launch of an ICBM using a hypersonic glide vehicle. This launch marked the longest distance travelled (around 40,000 kilometres) and the longest flight time (around 100 minutes) of any Chinese land-attack weapons system to date.

Thus, although there is no public evidence of destructive interceptions of targets, nor is there any proof that these technologies are being developed specifically for offensive control of space (beyond the gathering of information for intelligence or other purposes), it is clear that this kind of capability is precisely what is required to carry out co-orbital attacks for offensive control of space, and that it enables China to develop the operational concepts and technical capabilities needed for ASAT orbital systems.

In this regard, and within the context of strategic competition with the US, according to a report published in April 2025 by the Chinese academic journal *Acta Aeronáutica et Astronáutica Sínica*, researchers from the Chinese Army have recently claimed that their country has the capability to launch hypersonic missiles from space using various types of platforms, with the aim of striking targets worldwide using re-entry vehicles, thereby drastically reducing the response time of potential adversaries. Despite the fact that limitations and difficulties in this regard are also mentioned, and that the actual scope of this declaration remains unknown, these events are contributing to the growing uncertainty surrounding the undesirable possibility of the

[7] In particular, the SJ-21, launched in October 2021 and disguised as an experimental space junk mitigation satellite, carried out various RPO manoeuvres around its additional energy source before moving into a position to approach a decommissioned satellite located hundreds of kilometres above the traditional GEO belt. It later emerged that the SJ-21 had placed the decommissioned satellite at a significantly higher altitude than a typical orbit for decommissioned spacecraft, which is highly unusual for a debris-retrieval mission. This performance suggests that the objectives may differ from those announced publicly (CSIS, 2024; SWF 2024; 2025).

weaponisation of space, as does the existence of anti-satellite systems or weapons.

Finally, with regard to kinetic physical weapons, China maintains a significant anti-missile capability with at least one programme currently underway (and possibly up to three) to develop DA-ASAT capabilities, either as dedicated space control systems or as medium-range anti-missile defence systems that could provide capabilities for such control. After conducting multiple progressive tests since 2005 (indicating a serious and sustained organisational effort), China demonstrated this anti-missile capability in a 2007 test against one of its own decommissioned meteorological satellites in LEO that created a large amount of debris. In addition, there are numerous non-destructive (non-intercept) tests in later years that could have reached higher orbits, including GEO (CSIS, 2024).

China is therefore considered to have a mature and operationally deployed DA-ASAT capability against targets in LEO, including on mobile launchers. It is possible, however, that this capability against deep-space targets (MEO and GEO) is still at the experimental stage or under development, given that there is non-sufficient evidence to conclude whether it will become an operational capability in the short term (CSIS, 2024; 2025).

In line with the above, and although China's official declarations on warfare and space systems have remained aligned with the peaceful uses of outer space, there are many factors that do not exactly point in that direction. The identification of space as a military domain, the official declaration that the objective of space warfare and its operations is to achieve space superiority through the use of integrated offensive and defensive capabilities, the analytical work on the reorganisation of forces, and the considerable investment in the development and testing of the aforementioned capabilities, suggest that China views space as a domain for future conflicts, whether officially declared or not. However it is unclear whether it would fully employ these offensive capabilities in a future conflict or if the aim is to use them as a deterrent against potential US aggression, or both purposes simultaneously.

Thus, although there is no public evidence of the active use of destructive capabilities for an offensive control of space in its military operations, this does not imply that it would not resort to such offensive capabilities if they are available and their use are in line with national interests.

3 The Russian Federation

Russia considers its space programme a symbol of international leadership. A pioneer in the space field, a combination of economic constraints and technological setbacks after the end of the Cold War led to the decline of its space capabilities, including space-based remote sensing and satellite navigation. Despite this decline, the International Space Station (ISS) dependence on Russian launch vehicles to transport astronauts between 2011 and 2020 reinforced the perception of Moscow as a global leader in the space field, providing it with a degree of prestige and economic support for its space programme.

However, over the last two decades it has continued to pursue space-based services in support of land applications while expanding its range of satellite systems and developing a number of counterspace capabilities and manned spacecraft. In this regard, and despite some difficulties in 2023[8], in addition to its shipments to the ISS, Russia recently deployed several military surveillance satellites (its second inspection or spy satellite and two further military remote-sensing satellites), as well as the second of two meteorological satellites designed primarily for the surveillance of the Arctic.

Roscosmos, the Russian state corporation responsible for spaceflights and cosmonautics, also has plans for a new space station, a nuclear-powered space tug and two new launch vehicles, and has committed to building a constellation of 264 satellites to enable access to broadband communications, as well as to sending cosmonauts to the Moon by 2040. It is clear that implementing all of this will be difficult, and will depend, among other matters, on economic sanctions and on the overall outcome and consequences of the current conflict, as many of these proposals have been stalled for years due to a lack of funding (CSIS, 2024). Although Russia has shown a willingness to make significant investments in space, it remains to be seen how long it can continue to rely on Soviet-era technology and infrastructure, which form the basis of its capabilities.

Furthermore, as one of the three dominant state-run space actors, it retains substantial space capabilities, many of them dating back to the period of the Soviet Union. However, it relies

[8] With a failed attempt to land on the Moon and three spacecrafts supporting the ISS suffering from coolant leaks (CSIS, 2024).

on imports of Western technology and components to build satellites, components which have become more difficult to obtain due to sanctions. In this respect, although it has explored multiple avenues to mitigate the negative effects, its capacity to manufacture communications satellites has been virtually paralysed since sanctions were imposed in 2022, and space-related activity has been affected overall by the current strategic situation, which has added to the prevailing problems of corruption[9].

Nevertheless, Russia continues to be a power to be watched, particularly when it comes to control of space and space launch capabilities. In fact, in addition to the Crimean Bridge, the construction of the third launch site, the Vostochny Cosmodrome, is the largest infrastructure project of the last twenty years. It has also installed a new space surveillance radar near Moscow, which supplements the Don-2N radar station that has been operating in the same area since 1989 (CSIS, 2024).

When it comes to space situational awareness (SSA), Russia has sophisticated capabilities that are likely only surpassed by the US, which date back to the Cold War era and make use of a significant infrastructure developed for missile warning and missile defence.

Although some of these capabilities disappeared after the fall of the Soviet Union, Russia has undertaken several modernisation efforts since the early 2000s to strengthen them. As a result, Russia's space surveillance network[10] (comprising telescopes, radars and other sensors) is capable to detect, track, and catalogue satellites in all Earth orbits, enabling it to support its different space missions, including intelligence gathering, spaceflight safety, anomaly resolution, space debris tracking, the conduct of counterspace activities, and early warning of ballistic missiles.

Space plays a key role in Russian military thought, which has long emphasised a concept designed to counter US strategic aerospace operations. As an important element of this strategy, these space capabilities must be degraded, in proportion to their importance and the resulting dependence of the United States on

[9] Since the dissolution of the Soviet Union, Russia has only developed one new rocket launcher, which was employed in 2014, whilst the Soyuz rocket, designed in 1966, has carried out more missions than any other rocket in the world (CSIS, 2024).

[10] Given its geographical limitations to the former Soviet Union, Russia is participating in international civil and scientific cooperation efforts to facilitate access to surveillance and monitoring sensor data from other countries (SWF, 2024; 2025).

them, in order to enable air and missile strikes, as well as joint operations. For this reason, Russia would likely seek to degrade or destroy an adversary's space capabilities from the outset of a conflict, even before military hostilities began, as a means of compensating for the US or allied military advantage. For this reason, and despite the obvious technical challenges, Russia will most likely continue to seek parity with the US in space.

At the same time, with regard to space strategy and doctrine, Russian military analysts see modern warfare as a struggle for information dominance and network-centric operations; a struggle which, in space, seeks to mitigate against the superiority of US space assets by deploying a range of ground, air and space-based offensive capabilities. Nevertheless, even though the Russian military doctrine and authoritative writings clearly express that they regard space as an operational domain and that achieving space supremacy will be a decisive factor in winning future conflicts (even if this is not always easy), they officially support space arms control agreements to prevent the weaponisation of space (SWF, 2024; 2025). Furthermore, in terms of organisation, in order to address inefficiencies and due to the shift in focus towards the aerospace sphere, the Russian Aerospace Forces were established in 2015 as one of the five branches of its Armed Forces, merging the former Air Force and Aerospace Defence Forces and incorporating the Space Forces[11].

There is strong evidence that, since 2010, Russia has embarked on a series of programmes aimed at restoring many of its space control capabilities from the Cold War. Based on sophisticated space surveillance and tracking capabilities (and on its missile warning and missile defence infrastructure), Russia has a proven and comprehensive range of systems for the control of space, while continuing to track other nations' satellites and creating confusion and concern regarding the true intention behind these actions. Its doctrine involves the employment of ground, air, cyber and space-based systems to attack the adversary's satellites, through attacks ranging from temporary interference or blinding of sensors to the destruction of the adversary's space vehicles and supporting infrastructure.

[11] The Space Forces lead military space activities, carry out space launches and operate military spacecraft and satellites (including GLONASS), as well as the entire ballistic missile defence system, the satellite control network and the space surveillance network (CSIS, 2024).

With regard to non-physical effects, it has been investing heavily in the modernisation of electronic warfare, with the ambitious aim of incorporating such capabilities throughout its Armed Forces. Although not publicly recognised, it has a wide range of systems (SWF, 2024; 2025) capable of blocking GPS receivers within a local area, potentially interfering with the guidance of several systems such as UAS, UCAV, drones, missiles and precision-guided munitions (PGMs) using systems such as Zhitel, capabilities itwould also employ to protect its own strategic facilities and selected personnel[12].

Additionally, it can block satellite communications user terminals within specific tactical frequency ranges using this mobile electronic warfare system (Zhitel), and it is likely that, from fixed ground stations, it can also block uplink communications over a wide area. Similarly, the Krashukha-4 mobile system is designed to interfere with airborne radar systems (early warning and control and others) with an effective range of 300 kilometres. Due to its range and power, it appears to be equally effective against low-orbit radar imaging satellites.

Russia could also be managing deliveries of a new integrated electronic warfare system (Divnomorye-U) intended to replace the Krashukha, which could be effective against airborne, space-based and ground-based systems. Although there is no evidence of an operational deployment, it could be also developing high-power electronic warfare satellite platforms to expand its existing ground-based capabilities (SWF, 2024; 2025). With regard to its actual use, in addition to the multiple GPS interferences reported in Ukraine and neighbouring countries such as Poland, the Nordic countries and the Baltic states, there are reports of repeated (unsuccessful) attempts to interfere and prevent users in Ukraine from accessing Starlink, thanks to SpaceX's update of its terminals (CSIS, 2024).

Given that the field of information (in particular, its acquisition and transmission from space) is of strategic importance, Russia has taken measures to modernise military organisations and

[12] According to open sources, a GPS disruption has reportedly been taking place around Moscow. It is speculated that this is to protect the city from being attacked by Ukrainian drones. Russia is said to have been installing GPS signal disrupters on domestic infrastructures such as mobile phone towers and in the vicinity of the Kremlin. Furthermore, according to reports from 2020, mobile GPS signal disruption devices in vehicles accompanied President Putin, to guarantee his personal safety (CSIS, 2023).

information-related offensive and defensive capabilities. Since at least 2010, the Russian Army has prioritised the development of forces and capabilities, including operations in cyberspace, for what it calls ‘information confrontation’, a holistic concept designed to guarantee information superiority. While some cyber operations are likely aimed at disabling space capabilities, others are designed to gather intelligence, engage in economic or technological espionage, or cause malicious effects on third parties’ satellite capabilities that support critical infrastructure and functions. Despite the condemnation and potential economic sanctions against the attacking nation, there is little evidence that this deters future cyberattacks, as they continue to occur (CSIS, 2024).

Russia has demonstrated significant capabilities to disrupt Ukrainian command and control (C2) systems reliant on commercial communications satellites, as shown by the cyberattack on 24 February 2022, which disrupted connectivity to the company ViaSat’s satellite network and its thousands of ground terminals, by introducing wiper malware into the network that blocked ground modems via the satellite downlink[13]. Given its long history of malicious activities, it can be said that Russia, in cooperation with like-minded or state-sponsored groups, has extensive capabilities to produce effects in cyberspace with the aim of disrupting satellite systems, or their products or services.

With regard to non-kinetic physical systems, it has a solid technological foundation in physics relating to directed energy and is developing several military applications for laser systems in a range of environments. Among them is the Peresvet mobile laser dazzling system, operational since 2020, that appears to be designed to protect the ICBM Topol-M and RS-24 Yars from being detected by visible-spectrum imaging. Furthermore, based on indications of the modernisation of its space surveillance optical system located in the North Caucasus[14], it is possible that Russia

[13] In addition to the Ukrainian Government and Army, the attack affected other Internet users across all of Central Europe. A subsequent analysis concluded that Russian hackers only needed 45 minutes to deploy the malware that left 45,000 satellite modems disconnected from the network (CSIS, 2024).

[14] Krona system with laser-based dazzling or blinding capabilities. Lasers have long been used to support the optical tracking of space objects, providing, amongst other functions, telemetry for precision tracking. Although this complex has historically included ground-based radars and optical telescopes for tracking, identifying and characterising space objects, an investigation by a *Space Review* journalist discovered reports that would appear to support the *Kalina* project to modernise the facilities of

has developed a new ground-based anti-satellite laser system nicknamed *Kalina*, which could dazzle or blind satellites.

In addition, although this is not their intended purpose, Russian ground-based satellite laser telemetry facilities could also be used to blind optical imaging satellite sensors. In this context, although Russia could have reactivated and continued to develop a previous programme aimed at developing an airborne laser system onboard a modified Ilyushin Il-76 strategic transport aircraft to disrupt the optical sensors of imaging reconnaissance satellites, there is no evidence that it has achieved operational capability. In fact, recent reports would suggest that this programme was most likely cancelled due to the general strategic situation.

With regard to physical weapons or systems, specifically to co-orbital activities, Russia has been testing RPO technologies in LEO and GEO since 2010; however, to date, the majority of these activities can be classified as non-aggressive applications, such as satellite surveillance, inspection and repair, the inspection of foreign satellites, or space-based espionage. Nevertheless, as has been pointed out, this capability to approach satellites can also be used in offensive activities against other countries' satellites, resulting in temporary or permanent damage, non-friendly approach that eventually has become commonplace.

While it has continued to carry out in recent years, Russia has a long history in this type of activities or behaviour, dating back more than a decade. To this end, it operates at least two satellites in GEO orbit (Luch I/II), which are likely to be on a spy mission (they linger for long periods near Western satellites), but which could also carry out other functions. With this type of co-orbital activity, it could be pursuing a threefold objective: first, the testing and validation of capabilities, tactics and operational procedures to facilitate possible developments of co-orbital ASAT satellite weapons; second, the assessment of space activities and operations to be carried out without the risk of escalation by an adversary; and third, the search for ways to exploit space vulnerabilities of its adversaries in order to draw up operational plans for the employment of space control weapons in any conflict.

In this respect, it is likely that over the last ten years several Russian satellites have tested the launch of orbital projectiles to

this laser system. However, it is unclear whether it is operational or capable of carrying out attacks to gain control of space (SWF, 2024; 2025).

be used in low Earth orbit (LEO). In this regard, although tests carried out to date are not conclusive for this purpose, there is some evidence to suggest that Russia could have launched a new co-orbital ASAT programme called Burevestnik, potentially supported by another surveillance and tracking programme called Nivelir and specifically dedicated to satellite inspection (SWF, 2024; 2025). Nevertheless, the fast deployment of small sub-satellites capable of carrying out close-approach manoeuvres (and the existence of multiple releases of space debris) suggest that at least some of the activities carried out in low orbits are of a weaponised nature (SWF, 2024; 2025), a suspicion that is gaining ground as time goes on.

In this context, recent events kept secret by the Russian Federation (but detected by the US Space Force) are fuelling uncertainty and mistrust regarding the Kremlin's true intentions in this respect. In February 2025, Russia launched three satellites into orbit for an undisclosed purpose[15]; the following month, one of them launched an unknown object, an event which was considered by the US Space Force as a possible test of orbital weaponry technology for future conflicts in space[16].

Finally, specifically with regard to DA-ASAT capabilities, Russia, through its historic ballistic missile defence capabilities, has had such a potential for a long time. Moreover, it had development programmes that never became fully operational. After more than a decade of tests and developments, it demonstrated in 2021 this capability by partially destroying a decomissioned satellite in LEO using a Nudol interceptor missile. This was the first in-orbit interception to create space debris (around 1,500 trackable pieces and tens of thousands of untraceable ones), although it is unclear whether this system will be operational in the near future, nor does it appear to have the capability to reach targets beyond low orbits.

With regard to anti-satellite capabilities, there are also reports suggesting that Russia is developing an air-launched ASAT weapon known as Burevestnik, which could be directed against

[15] Cosmos-2581, 2582 and 2583 satellites. According to estimates by astrophysicist Jonathan McDowell, the three satellites launched in February appeared to be carrying out RPO missions or manoeuvring near other objects in space (CSIS, 2025).

[16] As reported in the *Space* publication, some of the potential uses for this object include military experiments, satellite inspection, testing of technology or scientific projects, flight testing, even projectile launch practices (CSIS, 2025).

space systems in low Earth orbit, possibly via a rocket carrying satellites in an anti-satellite role (also potentially supported by the Nivelir surveillance and tracking programme). This system would be based on a previous Soviet-era system designed to launch an anti-satellite missile from a MiG-31 interception fighter capable of destroying targets in near space. Furthermore, in April 2025 NATO Secretary General talked about the possibility that Russia could be considering placing nuclear weapons in space to target satellites, with the aim of compensating for the technological disavantage in its own satellite capabilities[17], which does not bring peacefulness to this respect.

To finish with Russian Federation, regarding the employment of these capabilities in operations, in addition to what has been noted about EW and cyberspace, there are two aspects worth highlighting (Martínez Cortés, 2025). The first in 2022 Moscow deployed space and space control capabilities that were less advanced than expected. In spite of their claims made, advanced weapons such as the Peresvet ground-based laser were not seen in action. The second is linked to the tensions in Eastern Europe and the conflict in Ukraine; in that same year, Russia would have used more than ever its space capabilities and systems for the control of space.

It is also worth noting that, through public rhetoric, in 2023 there were also indications of Russian military thinking regarding space and counterspace responses. Russia warned that Western 'quasi-civilian' satellites (most likely referring to US private satellite communications and remote sensing providers supporting Ukraine's operations in its conflict with Russia) could be legitimate targets.

4 India

Although India launched its first satellite on a domestically produced rocket in 1980 and has only carried out one space launch per year for most of the past two decades, it has recently increased its launch rate to five in 2022 and seven in 2023, more than Europe and Japan combined. Over the past year (as it has continued to expand its space activities), it has made a historic breakthrough by landing a robotic vehicle on the surface of the

[17] Statements made on *Euronews*, 12 April 2025. See: https://www.euronews.com/2025/04/12/nato-chief-warns-of-possible-russian-nuclear-weapons-in-space

Moon and plans to become the fourth nation capable of sending astronauts into space in the coming years. With over five decades of experience in space capabilities, largely focused on the civilian field, India has only recently paved the way for its Army to become an active user of space, creating explicit military space capabilities for this purpose. The Army's first communications satellite was launched in August 2013.

With regard to the context of security, space has received a significant boost over the last two decades. In October 2007, India announced its 'space defence vision', in which it identified intelligence, surveillance and reconnaissance, communications and navigation as key areas. Furthermore, in 2010 the Ministry of Defence drew up the Technological Outlook and Roadmap, which analysed the development of anti-satellite systems for the 'electronic or physical destruction of satellites at an altitude of 2,000 kilometres above the Earth's surface and in geosynchronous orbits'. Thus, in March 2019, it entered the field of weapons for the offensive control of space when it carried out its first (and so far only) anti-satellite missile test by destroying one of its own satellites, thereby becoming the fourth country to successfully test an DA-ASAT capability, a demonstration that has contributed significantly to progress in this field.

Also in 2019, the director of the Defence Research and Development Organisation (DRDO)[18] declared: 'We are working on various technologies such as DEW, lasers, electromagnetic pulses and co-orbital weapons, etc. I cannot reveal details, but we are working on them,' lending credence to the idea that India was already considering several options for counterspace capabilities (SWF, 2024; 2025). Furthermore, while government officials reiterated that a great deal of work had been done in the period of 2019-2020, in order to enhance space capabilities through the development of sensors and satellites, in 2022 a new Defence Space Programme was announced, focusing on five categories of space technology for civil and military satellite-related operations, covering different sectors including launches, software, ground systems, communications and payloads.

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18 As India's military space research and development organisation, the DRDO produces space systems for defence and related technologies, including electronic warfare, missiles and radars, amongst others, whilst the Indian Air Force (currently known as the Indian Air and Space Force) also plays an important role in military space activities. See: https://www.drdo.gov.in/drdo

In this context, after many years of preparation, the work carried out during the decade 2010-2020 bore. The Indian Government officially approved its first national space policy, in 2023, which, although it provided no guidance on its national security space programmes, outlined its vision as follows (SWF, 2024; 2025):

> 'To increase space capabilities; to enable, encourage and develop a flourishing commercial presence in space; to use space as a driver of technology development and derived benefits in allied areas; to promote international relations; and to create an ecosystem for an effective implementation of space applications among all stakeholders for the socio-economic and security development of the nation, the protection of the environment and lives, the search for the peaceful exploration of outer space, and the stimulation of public awareness and scientific quest'.

Further on, still in the same year, the Indian Prime Minister unveiled the Space Vision 2047 document, which sets out India's long-term objectives, including sending people to space, establishing a space station and setting up a lunar base, as well as developing a new-generation launch vehicle.

With regard to the field of defence, although India has never officially developed a military space doctrine, the Indian Army has begun to prioritise space power for national security. In 2017, the Indian Armed Forces published a joint doctrine stating that 'The emergence of space power is analogous to conventional land, sea or air power and it will be identify as a "Revolution in Military Affairs"' (Indian Ministry of Defence, 2017). In 2023, the Chief of the Indian Defence Staff emphasised the need to move from space support to 'space enhancement' in order to focus on developing dual-use platforms, specifically indigenous ISR satellites equipped with optical and hyperspectral sensors, a domestic PNT constellation, and new counterspace capabilities, which would be used to deter threats and protect its space systems. According to this high- ranking official, in order to achieve these objectives, India should need to launch and operate more than a hundred military satellites over a period of seven or eight years.

On an international level, India has been expanding its space alliances through new bilateral and multilateral agreements and working groups (CSIS, 2024). In the civilian field, in June 2023 it signed the Artemis Accords, reaffirming its commitment to cooperation in the civil space exploration. Furthermore, it is involved in a joint project with Japan aimed at deploying a lunar rover to the Moon's south pole. Meanwhile, specifically in the military sphere, the US reportedly shared satellite imagery in 2022 showing Chinese troops along the contested border between India and China, which potentially indicated an interest in increasing intelligence cooperation, including in space, likely as a counterweight to China. In January 2024, it signed an agreement with France to jointly develop and launch military satellites.

India's employment of space has evolved to include greater investment in its domestic capabilities in satellites and launch systems, as well as a greater emphasis on military space capabilities. Whilst while it uses satellite technology for strategic purposes in reconnaissance, communications and navigation, and generates increasing revenue from launching satellites for other countries, it has recently made significant investments in national security space infrastructure and capabilities. It has also incorporated these capabilities into its military operations, placing greater emphasis on employing its growing capabilities for military purposes.

Finally, with regard to the development of capabilities, after the 2019 anti-missile test, the Indian space sector has continued to grow, focusing in particular on satellite imagery (both military and private). Despite the scarcity of public reports on the development of offensive control of space capabilities, and while India continues to insist that it opposes the deployment of weapons in space, it continues to invest in both government and private-sector capabilities, whilst also driving the development of domestic start-ups, and may be moving towards an offensive posture with regard to the control of space.

This move, which most likely is intended to establish a deterrent position as a regional power, seeks to encourage developments in the commercial sector in order to increase its share of the global space economy and its international prestige, as well as to promote its technology and industrial sectors at a national level, while also enabling future dual-use security capabilities, a field in which India is placing a greater emphasis (CSIS, 2023; 2024; SWF, 2024; 2025).

With regard to specific offensive control of space capabilities, in particular to the systems based on electronic warfare, India has demonstrated its capability to counter Pakistani radars and communications systems and has developed several indigenous electronic warfare offensive systems, including the capability to interfere with satellite phones.

On the other side, with regard to non-kinetic physical directed-energy or DEW systems, there are reports that India is in the early stages of developing directed-energy weapons. In August 2019, the director of the Defence Space Research Organisation (DSRO) recognised that they had been working in this area for the last three or four years to develop weapons with a power output of 10 to 20 kW, and in March 2022, the Ministry of Defence identified eighteen types of platforms it wished to be designed and developed by the domestic industry, including DEWs of 300 kW or more. Nevertheless, the targets of these weapons appear to be aerial or electronic; at least for the time being, they do not seem to be aimed at developing space control capabilities in the field of directed energy, although there have been no public announcements or indications of progress regarding these capabilities.

Furthermore, shortly after the ASAT test carried out in 2019, no specific plans were announced for another test of the same type in LEO, but the possibility of tests in a higher orbit was raised, a possibility that can be detected in research discussions across the country. In this respect, taking into account the national anti-missile and long-range ballistic missile defence programmes that the Indian Army has developed as a regional nuclear power, it can be argued that such capabilities could lead to the attainment of anti-missile capabilities should the need arise. Furthermore, in January 2025, it took a significant step towards developing RPO technology for space assets by successfully demonstrating this capability.

5 A comparative overview of offensive control capabilities

From the previous sections, a number of general conclusions can be drawn regarding the development of offensive control of space capabilities in countries not aligned with the West; this development reflects yet another aspect of the strategic competition taking place in the space sector and is, if anything, even more concerning when considered alongside the challenges and difficulties facing regulation and legislation in this respect. Thus, over the last two decades, there has been a clear strengthening, in general, of space capabilities and, in particular, of capabilities linked to the offensive control. It is true that the strategic competition reflected in this domain is not limited to these latter capabilities but is also reflected in other capabilities such as those related to space launch and exploration.

Therefore, with regard to the offensive control capabilities of countries not aligned with the West, the following conclusions can be drawn:

- With India to a lesser extent, it is considered that China and Russia have sufficient capabilities across the electromagnetic spectrum to degrade or interfere with the proper functioning of systems related to space capabilities, though not necessarily the assets themselves.
- Although there have not been many publicised trials, an improvement has been detected in the development of directed energy systems, primarily laser-based ones.
- Despite the inherent difficulties in the employment of anti-satellite weapons, and regardless of their operational status, such systems could be employed if national or strategic interests were at stake. Nevertheless, those difficulties are encouraging research and development into other, less aggressive anti-satellite systems, such as those based on co-orbital technology.
- It is estimated that both China and Russia have sufficient capabilities to carry out co-orbital manoeuvres which, in addition to serving their own needs in terms of the sustainment, repair or relocation of their own assets, can also serve other, less peaceful purposes, such as producing several effects on foreign satellites or carrying out espionage activities. In particular, China is reportedly focusing its efforts on developing these capabilities in order to reach the level it deems necessary to achieve its space objectives.

The following graph reflects the change in capabilities over the past year (2024-2025) for China's co-orbital capabilities and Russia's DA-ASAT capabilities, in both cases in low orbits, based on information provided by the Global Counterspace Capabilities Report (2024 and 2025).

Figure 1. *Source*: Global Counterspace Capabilities

Conclusions

The world today is immersed in a fierce strategic competition between those states that regard themselves as major powers capable to influence in global events. This is also reflected in domains that were previously beyond the reach of most, such as outer space. Far from being a peaceful environment, over the last decade China's economic and military rise as part of its strategic competition with the US, the modernisation of certain Russian capabilities (coupled with a clearly more assertive policy) and the emergence of other actors have progressively transformed not only the balance of power, but also the perception of security which, in the short term, is foreseen in the execution of activities in space, thereby affecting this domain.

A greater access to technology and the reduction in the cost of satellite systems have turn outer space into a more congested and contested environment than it was just over a decade ago, as evidenced by the increase in annual satellite launches and in the space control capabilities of the major players.

The fact is that, although outer space constitutes a global common to which access should be free and continuous for all, the reality of the technological development and strategic competition that we are currently experiencing shows that the most powerful actors in the sector are increasingly striving to acquire capabilities that will enable them to implement effective control over space in order to guarantee their continued access and the protection of their space activities, whilst at the same time being able to deny others the use of satellite systems or degrade the information obtained from them when national interests or their own freedom of action in space are at stake.

This evolution of outer space is reflected in the increase in satellite capabilities by actors with less than peaceful intentions, who have been involved in recent years in events that are neither balanced nor encouraging from a security perspective. This has led to the declaration of space as an operational domain, its incorporation as such in strategic documents, and the resulting doctrinal and organisational changes.

Thus, in addition to risks associated with natural phenomena or non-human-induced events, space activities are threatened by all manner of deliberate actions carried out by other actors to exert offensive control of space, the increase in which can be described as worrying and warrants close attention.

Specifically, with regard to the major powers not aligned with the West, the last two decades have seen a clear strengthening, in general, of space capabilities and, in particular, of capabilities linked to the offensive control of space. Ultimately, this also applies to space launch and exploration capabilities, especially with regard to China. In particular, there are a few points worth noting regarding this country and the Russian Federation. Firstly, they have sufficient capabilities across the electromagnetic spectrum to degrade or interfere with the proper functioning of systems related to space capabilities, (though not necessarily the assets themselves).

Secondly, although there have not been many publicised trials, they have shown an improvement in the development of directed energy systems, primarily laser-based ones. Thirdly, despite the inherent difficulties in the employment of anti-satellite weapons, and regardless of their operational status, they could employ such systems if national or strategic interests were at stake. And fourthly, it is estimated that they have the capability to carry out co-orbital manoeuvres which can serve other non-peaceful purposes, such as producing several effects on foreign satellites or carrying out espionage activities, while the possibility of research and development into some form of weaponry on board a satellite platform cannot be ruled out.

Meanwhile, India, the fourth nation to have demonstrated anti-satellite capabilities, while continuing to invest in government and private-sector space capabilities, may be moving towards an offensive posture with respect to the control of space. This move most likely is intended to establish a deterrent position as a regional power, although it does not appear to be focused on developments in electronics or cyberspace, but rather on commercial ventures promoting its technology and industrial sectors in order to increase its share of the global space economy and its international prestige, while also enabling future dual-use security capabilities.

This context demonstrates that we find ourselves before a new domain in which, in addition to a growing dependence on satellite capabilities, greater attention and enhanced capabilities are required for the control of space, in order to enable us not only to protect our own assets, space activities and the services we receive from the aforementioned aggressive actions, but also the ability to exercise a degree of control over the environment and to carry out different effects against potential adversaries in order to guarantee continued access and freedom of movement.

However, this context of strategic competition and implications takes on greater relevance given the fact that, additionally, the development of legal regulations in this respect does not appear to be helpful due to its inherent difficulty. This should not, however, prevent us from seeking agreements on less sensitive matters of common interest to all actors, nor should it hinder efforts to develop and adapt legal frameworks within the context of international cooperation.

Chapter five

Europe's strategic autonomy in space: conceptually in orbit but constrained by political gravity

Dr. Juan Manuel Chomón Pérez

Abstract

The European Union (EU) has established itself as a leading space actor through flagship programmes such as Galileo, Copernicus, the European Geostationary Navigation Overlay Service (EGNOS) and Governmental Satellite Communications (GOVSATCOM), developed in close cooperation with the European Space Agency (ESA). The ESA concentrates a substantial share of Member States' public space investment and is progressively assuming a growing role in security- and defence-related activities. These programmes are complemented by projects such as the future European secure communications constellation, Infrastructure for Resilience, Interconnectivity and Security by Satellite (IRIS²), as well as initiatives like the Earth Observation Governmental Service (EOGS), aimed at providing strategic Earth observation capabilities for governmental purposes. Alongside these developments, the emerging concept known as the European Space Shield seeks to enhance the resilience and protection of European space infrastructures through the development and use of dedicated capabilities, moving towards a fully dual-use space architecture. The security of these capabilities is, in turn, articulated through the Space Threat Response Architecture (STRA), which is currently under review. Despite these advances, European strategic autonomy in the space domain remains limited.

Keywords

Strategic autonomy, Outer space, EU, CSDP, ESA.

Introduction

In just two decades, the international system has experienced a profound change. After a long period of economic globalisation and technological interdependence, we are now witnessing a process of selective deglobalisation in which the major powers are competing for the control of strategic resources and sensitive technologies, including space-related technologies.

At the same time, a new phase of interconnection is emerging, sometimes referred to as 'globalisation 2.0', on which millions of people rely every day, without knowing it: on space-based services such as satellite navigation systems that guide transport, Earth observation imagery that supports agriculture and civil protection, and communication links that enable emergency management. This invisible dependence makes space a vital infrastructure of advanced societies.

As noted in the EU Space Strategy for Security and Defence in 2023 (European Commission and High Representative for Foreign Affairs and Security Policy, 2023) and in the Council's conclusions on the strategy (Council of the European Union, 2023), outer space has become a strategic and operational domain of equal importance to security as the terrestrial, maritime, air and cyber domains. As we have seen in the previous two chapters, the United States, China, Russia and India are competing in a new space race that is no longer so much about planting flags on the Moon as it is about guaranteeing access to, control over and the defence of the systems orbiting the Earth. The growing vulnerability of satellites to collisions, cyberattacks or interference means that space is now seen today as a potential setting for conflict.

In turn, the recent transformation of the space ecosystem, commonly referred to as 'New Space,' has further intensified this dynamic of change. Whilst for the most part of the history of space initiatives were predominantly state-led and, in many cases, of military origin, the current landscape is characterised by the emergence of a growing number of private companies developing satellites, data services, micro-launchers and commercial constellations. Nevertheless, this privatisation of space does not imply a withdrawal of the state, but rather its reconfiguration, given that most New Space initiatives are only viable thanks to public support, whether financial, regulatory or through institutional contracts that guarantee a stable demand. In this regard, New Space represents a shift from a state-led-military innovation model towards a market-driven civil-industrial model, albeit one that is strategically supported by governments.

The EU is no stranger to this development. In addition to maintaining major institutional programmes such as Galileo, Copernicus and EGNOS, it has started to actively encourage a European New Space ecosystem through the EU Space Programme, contracts managed by European Union Agency for the Space Programme (EUSPA), the promotion of new services and micro-launchers, and funding from the European Innovation Council (EIC), a body created to fund high-risk and high-impact innovation, especially disruptive technologies, including many from the space sector. This approach reflects the EU's commitment to strengthen its strategic autonomy through a broader, more innovative industrial base that is less reliant on external suppliers.

This industrial transformation has been joined by new financial instruments specifically designed to strengthen critical capabilities and the defence technology base. In particular, the European Defence Fund (EDF) funds the research and development of space technologies with direct applications in security and defence, which until now have been absent from the European industrial framework (European Commission, 2023a). At the same time, the Rapid European Augmentation Mechanism for Resilience (RE-ARM) and its successor, RE-ARMED, are driving the accelerated acquisition and expansion of essential industrial capabilities, whilst the European Defence Industry Programme (EDIP), proposed as the structural successor to the EDF, aims to consolidate a more integrated and competitive European industrial capacity for defence. Together, these instruments have started to form the pillars of support for the European New Space, enabling emerging technologies and strategic capabilities to develop and, eventually, be integrated into projects such as IRIS² or the EOGS and into frameworks such as the European Space Shield.

In this context, the EU, in cooperation with the ESA, has reached a prominent position thanks to its major space programmes. Under the umbrella of the EU Space Programme (European Parliament and Council of the European Union, 2021), funded through the Multiannual Financial Framework, the European Commission and the EUSPA exploit systems such as Galileo, Copernicus, EGNOS, and later IRIS², whilst the ESA acts as the main technical and industrial authority for their development and deployment.

However, this cooperation is not without its institutional complexities, as the ESA is an intergovernmental organisation independent of the Union, with Member States that are not part of the EU, such as the United Kingdom, Norway, Switzerland and Canada, which limits its automatic alignment with the Union's political and security priorities (ESA, 1975).

It is worth noting that the ESA's budgetary contribution to Europe's industrial and technological base is considerable. On average, around half of national public space expenditure is channelled through the Agency in the form of mandatory and voluntary contributions, making it the main vehicle for space investment by Member States. In recent years, alongside the growing 'securitisation' of space, the ESA has also started to assume a more prominent role in matters regarding security and defence, driven by increasing contributions from national defence ministries and from programmes that explicitly address dual-use requirements.

Similarly, the EU has recently launched projects with clear dual-use potential. The most advanced of these is the future European secure communications constellation IRIS², which aims to reduce dependence on external providers (European Commission, 2022). This is followed by the EOGS Earth observation programme. Both are priorities within the emerging European Space Shield framework, aimed at protecting European space infrastructure and enhancing its resilience. This framework is fundamentally a political and industrial concept designed to promote the development of space capabilities that support defence through funding, thereby encouraging their interoperability and joint use. Additionally, it identifies gaps that will need to be addressed with new capability programmes, such as in-orbit services or improvements to space domain awareness (SDA).

It is therefore clear that, although the EU has a solid technological foundation, its military and security dimension is still under development. Unlike other major entities, their space capabilities were originally developed for civilian purposes, and it is only in recent years that they have started to be considered as an essential part of defence, acting as enablers. Consequently, the Union is a relatively technological space power but is not a significant military player yet.

However, incidents such as the Russian cyberattack on ViaSat's communications satellite network on 24 February 2022, just hours before the invasion of Ukraine began, illustrate the risks of relying on capabilities and, more broadly, on military operations in the space domain. The incident disrupted communications for Ukrainian military units and affected thousands of civilian users in Eastern Europe. The response to the attack that resolved the service outage did not come from European governmental bodies, but from the private company SpaceX, which restored communications via its Starlink constellation.

Instead, the Union's decisions were focused on protecting its own space infrastructures in the conflict zone. The deployment of Galileo and EGNOS ground stations in Ukraine was stopped for security reasons, and some of the installed equipment was retrieved by the EU Agency for the Space Programme to prevent it from being compromised. Although these steps do not constitute a military response in the strict sense, they do highlight the need to review the relationship between the European space programmes and existing mechanisms for responding to security crises. Within the EU, these mechanisms are centralised within the Space Threat Response Architecture (STRA) (Council of the European Union, 2021), an alert and coordination structure that links the Commission, including EUSPA, the European External Action Service (EEAS) and the Member States to respond to incidents or attacks in the space domain, and which must be linked with crisis management in the security sector.

A military response has not been included for the time being. However, this may well be the case in the near future, as the high representative for Foreign Affairs and Security Policy would always have the prerogative to propose the launch of a military operation in the space domain to the Council. In essence, should such an operation ever be launched, it might be reminiscent of other ongoing EU operations, such as Operation Aspides, which takes place mainly in international waters, a global commons, just like outer space.

For the time being, as it stands, its purpose is to improve detection times, political coordination and the diplomatic and technical response to an act of aggression or a serious disruption in the space domain. But cases such as that of ViaSat highlight two uncomfortable truths. On the one hand, space resilience is just as critical as conventional deterrence. On the other hand, strategic autonomy requires operational control, not just technological ownership.

For all these reasons, the aim of this chapter is to provide a comprehensive overview of European strategic autonomy in space, understood as the capability to guarantee the access to, use of, and protection of the space domain.

1 The concept of strategic autonomy in European space

The term 'strategic autonomy' has been part of the EU's political vocabulary for two decades. In its broadest sense, it describes the capability to act 'with partners where possible and independently where necessary' (Council of the European Union, 2016). The 2022 Strategic Compass defined it as the Union's ability to decide and act on its own when its vital interests require it (EEAS, 2022).

When applied to outer space, this principle entails that Europe must be able to access space, operate its satellites and protect them without relying on third-party states or companies. Strategic space autonomy encompasses the technological, the political as well as the operational capabilities required to ensure the continued functioning of the services that sustain security, the economy and society.

The 2023 Space Strategy for Security and Defence and the 2024 White Paper on EU Space SHIELD (European Commission and High Representative for Foreign Affairs and Security Policy, 2024) expand on this notion, so that autonomy is not limited to owning infrastructures, but also to ensuring their continuity in the face of threats. Effective space autonomy will only be a reality when the EU is able to anticipate, resist and recover from an attack or interference without relying on external assistance. Thus, in the space domain, there are three interrelated dimensions:

- Technological: developing and launching satellites, sensors and support systems using European resources.
- Operational: integrating these capabilities into the planning and conduct of military operations or crisis management missions.
- Decision-making and command and control: establishing procedures and authorities capable of making rapid decisions regarding the use or defence of common space assets.

A lack in any of these dimensions limits their overall effectiveness. The EU may have excellent satellites, but if it cannot employ them in a crisis, its autonomy will remain limited. Coherence between resources, doctrine and political will is, therefore, at the heart of strategic autonomy.

Furthermore, international law considers outer space as a global commons, intended for peaceful use and not subject to appropriation by any state, and the EU has historically defended this view, participating actively in United Nations forums on governance. Nevertheless, the contemporary reality has blurred the line between the civilian and the military environment. Anti-satellite tests, radio frequency interferences and cyberattacks have turned space into an area of strategic competition. It is no longer enough to simply promote rules; we must actively protect European interests in space.

This is where the first major institutional tension arises. Whilst the EEAS maintains a discourse focused on non-militarisation, avoiding the military development of space and promoting its peaceful use, the European Commission is driving technologies in the field of security and defence. According to the EU's founding treaties, it has no defence powers in the sense of the use of the armed forces, but it does have such powers in relation to the defence industry, which enables it to fund research, innovation and dual-use capabilities that can subsequently be employed by Member States in the military field.

This duality reflects the evolution of the European model, which is evolving from normative idealism towards a strategic realism that recognises the need to protect the space domain. Recent examples illustrate this institutional tension. Whilst the EEAS promotes the peaceful use of space and the adoption of transparency and trust-building measures in international forums (EEAS, 2021), the European Commission is driving, through the EDF, the development of technologies with direct applications in security and defence (European Commission, 2023b).

Furthermore, even certain Permanent Structured Cooperation (PESCO) projects developed by groups of Member States that have decided to advance more quickly in developing certain space capabilities have been approved by the Council, but their strategic alignment with the EEAS, which advocates the peaceful use of space whilst acting as their secretariat, is weak to say the least. Projects such as Defence of Space Assets or DOSA (European Defence Agency, 2022), Common Hub for Governmental Imagery or CoHGI (European Defence Agency, 2023a) and Space-based

Persistent ISR and Deployable European Resource or SPIDER (European Defence Agency, 2023b) address capabilities directly linked to military operational support.

Similarly, the EDF funds orbital sensors for early warning (horizon scanning), signals intelligence (SIGINT and ELINT) payloads, and advanced interference protection capabilities, all of which have a clear strategic use. This coexistence of a normative pacifist discourse and a technological drive towards defence which, although limited to non-offensive actions, demonstrates how the European model is evolving in the face of the need to protect its interests in the space domain.

Furthermore, alongside the EEAS's political and regulatory discourse and the Commission's technologicalindustrial drive, the ESA is emerging as an intergovernmental platform through which the states channel a substantial part of their ambitions for autonomy in the space domain, further blurring the line between the civil and military spheres.

Within this framework, which is, to say the least, ambiguous and ever-changing, the EU's Preparedness Union Strategy (European Commission, 2024a) emerged in 2024, seeking to strengthen its response capability in the face of high-impact crises, ranging from pandemics to cyber-attacks and natural disasters. Although its scope is broad, it incorporates space as a cross-cutting critical infrastructure, essential to the functioning of transport, energy, communications and defence. The strategy promotes closer coordination between civil security and defence, relying on common warning and crisis management mechanisms. In this framework, the White Paper on EU Space SHIELD can be considered the space-based version of the Preparedness Union Strategy, applying its principles of resilience to the space domain. Together, both of these initiatives express a new European vision of 'comprehensive space security,' in which protection is not limited to satellites, but rather encompasses the entire network of services, data and communications that sustain modern life.

2 European space capabilities as a component of integration

European space governance is supported by a triangle comprising the Member States, the ESA and the EU, whose powers converge and sometimes overlap in the development of programmes, funding and the definition of strategic priorities, whilst the regulatory function remains fragmented and is primarily based within the EU and national frameworks.

As has been stated, within this framework, the EU has, over the course of two decades, built up its own space ecosystem that combines technological, economic and security objectives. New developments are being added to the EU's space programme and other financial instruments, managed by EUSPA since 2021, which could be included into the conceptual framework of the European Space Shield, one of the four initiatives declared as flagship defence initiatives, alongside Eastern Flank's Watch, the European Drone Defence Initiative and the European Air Shield.

Altogether, these programmes and projects represent both technological achievements and tools that, in a sense, pave the way for political integration, as they are common goods funded through the EU's Multiannual Financial Framework (MFF) (European Parliament, 2021). When sharing critical infrastructures and the resources needed to develop them, Member States are compelled to take joint decisions on its use and protection, thereby generating coordination mechanisms that act as the seeds of a hypothetical future deeper political integration. The Priority Capability Areas recently agreed by the Member States at European Council level, which also identify the space domain as one of the priority areas, constitute a clear political signal regarding the growing centrality of space within the multi-domain operational environment and, at the same time, they demonstrate a strategic convergence that reinforces the concepts set out in the Space Shield.

However, Member States continue to use the ESA as their main instrument for joint investment. As such, nearly 49% of national space expenditure is allocated to the Agency, making it the continent's true industrial and technological hub (European Space Policy Institute, 2025). This concentration of resources explains why the recent shift towards security and defence, reflected in new national strategies and in the creation of space commands, is also beginning to feature on the ESA's programme agenda as well, with the Agency already exploring initiatives of reconnaissance, early warning and resilience, all with a clear defence focus.

Within the European ecosystem, the most iconic programme is Galileo, the European satellite navigation system, operational since 2016 and today is comparable in accuracy to the US GPS. Through Galileo, Europe is, for the first time, controlling a global positioning service under its own authority, thereby strengthening its autonomy in critical sectors such as transport, energy and defence, in addition to the open service and high-accuracy and commercial services (EUSPA, 2023). Its strategic dimension is particularly evident in the Public Regulated Service (PRS), the encrypted and robust service designed for government users, security forces and crisis management entities, whose continuity does not depend on decisions made by third-party states. Galileo also incorporates the Search and Rescue (SAR) service, which is part of COSPAS-SARSAT, helping to accelerate the process of locating emergencies. It is supplemented by EGNOS, which improves positioning precision across Europe and is essential for air navigation, especially during precision approaches (European Commission, 2021a).

The Copernicus programme has become an essential tool for Earth observation thanks to the Sentinel satellites and a wide community of civil and security users (European Commission, 2023d). Although initially designed for civilian purposes and based on open access to data, its security component enables it to support border surveillance, maritime control and certain EU security and defence actions. The current debate on the creation of protected or encrypted services reflects the need for sensitive capabilities, which the future EOGS aspires to provide. This new service, which is still in the evaluation phase, is designed to provide fully government-run observation focused on security, civil protection and defence, and to address the historic lack of a system that combines the technical quality of Copernicus with the level of political control and military requirements demanded by European strategic missions.

The GOVSATCOM provides secure communications for European authorities and armed forces, establishing a private channel for crisis management and defence operations, thereby paving the way for a more operational use of space in the field of European security. On this basis, IRIS² is being developed, designed to provide secure, low-latency communications via a low orbit constellation (European Commission, 2023e). Its dual-use design will expand current capabilities by supporting both defence and emergency management as well as connectivity in remote areas, thereby strengthening the digital resilience of the EU and its Member States. Although it is sometimes presented as the European Starlink, its planned scale with around 280 satellites compared to the thousands deployed by SpaceX, reflects a more modest level of ambition, focused primarily on strategic and governmental priorities.

Within this same process of establishing a coherent European space architecture, the aforementioned supplementary framework, designed not only to provide space-based services for defence, but also to protect those services themselves, has also emerged: the Space SHIELD. Its design as a modular and reconfigurable architecture reflects a trend shared with initiatives such as the US Starshield, moving away from isolated programmes towards comprehensive security frameworks in the orbital domain.

Space SHIELD, as reflected in the Readiness Roadmap 2030 published in October 2025, which builds on the White Paper for European Defence Readiness 2030, and could constitute the European response to the growing militarisation of space (European Commission, 2024b). The protection of space capabilities that Space SHIELD shall provide is planned to be based on three levels, ranging from Space Situational Awareness (SSA) to the active and passive protection of orbital infrastructures, and institutional and doctrinal cooperation. Its aim would be to create an alert and response network linking the civilian dimension, managed by the European Commission and the EUSPA, with the security dimension coordinated by the EEAS, the European Defence Agency (EDA) and the Member States.

On the financial front, designed to strengthen Europe's defence industrial base and accelerate the joint acquisition of critical capabilities, the RE-ARM fund has served as a framework for the Commission and Member States to direct investment into dual-use technologies related to space domain surveillance, the protection of orbital infrastructures and the development of capabilities in analysis, cybersecurity and interference detection. It acts as a catalyst for accelerated funding, enabling the mitigation of budgetary constraints that had previously held back Europe's ambitions in the space domain.

Beyond the budgetary aspect, RE-ARM and its successor, RE-ARMED, represent a qualitative shift in EU action: they are the first instruments capable of funding, accelerating and coordinating the development of security and defence capabilities beyond the rigid traditional intergovernmental framework. They act as a bridging mechanism between the Commission (civil programming), the Council (political and strategic guidance) and the Member States (deployment of capabilities), enabling advancement in dual-use technologies essential for space resilience. These capabilities are not automatically integrated into the

European Space Threat Response (STRA) mechanism, but they do contribute to the ecosystem within which this framework will be able to operate more effectively in the future.

During the war in Ukraine, the measures adopted by the European Union to safeguard its space programmes, such as the suspension of EGNOS and Galileo activities on Ukrainian territory and the recovery of equipment by the EUSPA, demonstrated the importance of having protective mechanisms in place. These incidents marked the start of practical cooperation between the managers of the European space programmes and the STRA, which was created precisely to coordinate the response to threats or acts of aggression in the space domain.

The role of the STRA is reinforced through the aforementioned annual STRA Exercises, which simulate space-related crisis scenarios such as interferences with navigation satellites, cyber-attacks on control centres, or attempts to manipulate signals. These exercises, which involve the Commission, the EEAS, the EDA, the EUSPA, space programme operators and representatives from various European space agencies and space commands, enable the testing of alert protocols, political coordination and joint decision-making (EEAS, 2023a). Its development marks an important step towards the creation of a common operational culture in the field of space security.

For all these reasons, it can be said that the EU Space Programme as a whole, together with supplementary frameworks and concepts such as Space SHIELD and STRA, constitute the backbone of European space autonomy. They represent both technological progress and the political attempt to provide the Union with its own capability in a domain that is already essential for security, but in which military defence is, for the time being, the major unresolved issue, still in its infancy.

3 Structural gaps for strategic autonomy

Despite the advances, European space autonomy faces three major gaps: in technology, investment and operations. All of these ultimately stem from institutional fragmentation and the difficulty of coordinating national policies under a common command.

The technology gap is evident in the dependence on external suppliers for critical technologies. Europe still lacks reusable launchers, ultra-high-resolution optical and radar sensors with full dual-use capability, and low-orbit constellations comparable to those of the United States or China. Active protection of satellites against interferences or cyberattacks is still in the developmental phase. These shortcomings reduce the EU's capability to guarantee the continuity of its space services in a hostile environment. This vulnerability has become particularly apparent after the loss of European access to Soyuz launchers and the accumulated delays in the Ariane 6 and Vega-C programmes.

In April 2024, the European Commission even had to make an exceptional use of a SpaceX Falcon 9 launcher, from US territory, to put two Galileo satellites into orbit in order to avoid a further delay in the constellation due to the lack of an available European launch vessel (ESA, 2024). The fact that a programme as significant for strategic autonomy as Galileo still relies on non-European launchers illustrates a technology gap, compounded, for example, by the lack of capability to send human beings into space, although it is true that the Union has started to use the European Defence Fund (EDF) and the PESCO more systematically as levers to develop space capabilities that do not yet exist at a European scale.

EDF projects such as ODIN'S EYE II, which promotes a space-based early-warning architecture to detect ballistic and hypersonic missiles and anti-satellite threats, or SPIDER, a study of the viability of multi-mission Earth observation constellations dedicated to defence ISR with high reactivity and low latency, aim to close critical gaps in horizon scanning and persistent surveillance. These projects are, in turn, linked to PESCO initiatives specifically focused on space, such as the European Military Space Surveillance Awareness Network (EU-SSA-N), which aims to establish an autonomous military SSA system that is interoperable with the civilian EU-SST framework, or the CoHGI, designed to create a common platform for the secure exchange of government imagery, with the EU Satellite Centre (SatCen) playing a central role. They are not organically integrated within the Space Threat Response Architecture nor the Council Decision (CFSP) 2021/698, which remain the legal and procedural framework for responding to threats against the components of the EU Space Programme, but they do constitute a pool of new observation, early warning and analysis capabilities that Member States and European institutions will be able to exploit under umbrellas such as the EU Space SHIELD, STRA exercises or a potential Union government Earth observation service.

The investment gap is linked to the market fragmentation and the dispersal of resources. Although the EU has significant funds at its disposal through the EDF, PESCO, the SAFE (Security Action for Europe) programme and the RE-ARM initiative, coordination between them is limited. Member States continue to run parallel national programmes that often result in the duplication of efforts. The lack of a single market for space defence drives up project costs and slows down innovation.

This operational gap is reflected, for example, in the absence of a common framework for the use of space capabilities in missions and operations under the Common Security and Defence Policy. The EU's Military Staff or its headquarters (Military Planning Capability Centre [MPCC]), as well as the headquarters that direct its operations (Operational Headquarters [OHQ]) generally lack specialist personnel and suffer from a lack of standardised procedures for integrating space capabilities into the planning and conduct of operations, although some are in the process of being developed. A clear example is the development of the EU Military Staff's doctrinal concept known as the 'Concept in support of the military use of space for EU-led military operations and missions under the Common Security and Defence Policy,' in which the level of ambition, the relationship with the existing NATO doctrine and the role of each of the relevant entities in the European institutional architecture have had to be repeatedly reviewed with a consensus yet to be reached[1].

At the same time, European forces still rely on external support, which limits their decision-making autonomy in crisis situations. Faced with increasing orbital congestion, space debris, the proliferation of threats and the enhancement of global entities' space-based military capabilities, the protection of space assets has become a strategic priority. However, the EU has not opted to create its own Space Command, which could resolve some of its governance issues in the space domain, and it faces certain difficulties in integrating space into its operations and missions.

To the three gaps identified above, a fourth, more subtle but equally decisive, is therefore added: that of governance. The EU lacks an operational level of implementation for its space programmes that would enable them to be put to genuine use in the defence sector. Although the Regulation (EU) 2021/696

[1] An internal doctrinal document of the European Union Military Staff (EUMS) currently being drafted.

establishing the Space Programme sets out objectives relating to security, resilience and autonomy for systems such as Galileo and Copernicus, the coordination of these systems for defence purposes still relies on the legal basis on which they were created, which in many cases does not foresee direct military use. It is hoped that new developments, such as the EOGS or the capabilities derived from the European Space Shield, will incorporate dual-use criteria and mechanisms for cooperation with the defence sector from the design stage, thereby contributing to closing this governance gap.

However, as mentioned, the STRA's toolbox of responses to space acts of aggression or interferences does not currently include a direct operational mechanism that would enable action to be taken on the ground. However, the EU already applies hybrid responses in the cyber domain and applying them in a similar way as a response to threats in the space domain presents a challenge.

For the time being, whilst the STRA is becoming the instrument that attempts to fill this gap, its scope remains predominantly one of political and technical coordination, highlighting the operational gap and the lack of a military defence response. The integration of the STRA with the instruments of the Common Security and Defence Policy (CSDP) remains an unresolved issue because Member States retain the final say on the military response to a space-based threat.

In addition to these internal shortcomings, there is a problem of external coordination that directly affects strategic autonomy, namely the risk of overlap between EU and NATO programmes. In the field of Earth observation, for example, the EU's future EOGS and NATO's Alliance Persistent Surveillance System (APSS) pursue partly converging objectives relating to surveillance, early warning and the acquisition of capabilities such as horizon scanning for the detection of missile launches, which support political and military decision-making (NATO, 2023). A similar situation exists in the access to space, where the StarLift initiative, developed within the NATO framework as a new launcher, coexists with European programmes such as REACT, aimed at strengthening the Union's autonomous launch capability. Whilst this apparent duplication may be interpreted as a form of strategic redundancy, the absence of joint planning runs the risk of leading to budgetary inefficiencies, a lack of interoperability, industrial fragmentation and, above all, a loss of coherence when it comes to establishing a genuine Euro-Atlantic space architecture (Council of the European Union and NATO, 2023).

Altogether, these four gaps (in technology, funding, operations and governance) explain why Europe's strategic autonomy in space remains only a partial reality. Europe has built the technological foundations but has not yet managed to establish the political and military architecture that would turn them into a genuine defence capability.

4 Governance of European space: institutional fragmentation as a structural barrier

The institutional framework of European space reflects the political complexity of the Union. It brings together bodies with competences that, without adequate coordination, could overlap: the European Commission, the EEAS, the EDA, the EUSPA and the Council, alongside the political control exercised by the European Parliament. All of them act in a domain which, by its dual nature, lies between the civil and the military spheres, and between EU competences and the sovereignty of the Member States. The landscape, nevertheless, is changing rapidly, and this coincides with the redefinition of the ESA's role, as it becomes increasingly involved in security and defence programmes at European level.

The combination of new defence-oriented national strategies, the establishment of space commands and the growing number of threats in orbit is leading several Member States to use the ESA as a vehicle for developing security and defence capabilities at European level[2]. This is reflected both in the increase in contributions from defence ministries and in the proposals put forward by the Director-General of the ESA to equip Europe with a military-grade reconnaissance constellation and other early-warning capabilities considered as game-changers for European strategic autonomy. In other words, although the Space Strategy for

[2] At the 2025 ESA Ministerial Council meeting, the largest budget package in the organisation's history was approved, amounting to EUR 22.1 billion for the next three-year period, a 30% increase on the previous period, and a mandate was set out to support non-aggressive security and defence. It was within this framework that the European Resilience from Space (ERS) initiative was launched as a system of systems, including Earth observation, secure connectivity and supplementary PNT. Plans were also announced to establish its own security centre in Poland, in order to supplement the existing one in Belgium. This shift is in line with the EU's agenda, reinforcing the approach of increasingly channelling dual-use capabilities through the ESA.

Security and Defence remains the Union's political and doctrinal framework, the EU's limited powers and operational constraints are increasingly shifting the material implementation of space-based security capabilities to an intergovernmental sphere, with the ESA as the main driving force.

Within the EU, the Commission is the dominant entity in the space ecosystem thanks to its funding capacity. Through the MFF, it has access to stable funding to develop technological innovation programmes and projects for civilian purposes, although their nature is often dual-use. Their approach is based on the idea that space is a dual-use asset, and that its infrastructures can serve both civilian as well as security and defence purposes. In this way, the Commission can invest in capabilities which, although presented as civilian, have clear strategic applications, such as the IRIS² or EOGS.

On the contrary, the EDA does not have its own budget to fund the development of major programmes or joint acquisition. Its mission is to coordinate Member States on matters of acquisition, promote common standards and facilitate cooperation projects. In the space field, the EDA has driven initiatives such as the aforementioned SSA Market, which aims to promote space situational awareness services and reduce dependence on external suppliers. However, its results are hampered by a lack of financial resources and by diverging priorities amongst Member States.

This imbalance has led to significant duplication of effort. Whilst the EDA coordinates military-oriented space surveillance projects, the Commission funds the EU SST Partnership through the EU Space Programme, which pursues the same objectives from a civilian perspective. Both aim to track objects in orbit and detect space threats, but they do so under different institutional frameworks, with separate procurement and validation procedures. This duplication reflects the absence of a backbone to coordinate the Union's efforts in the field of space security. Perhaps this is why some voices are informally and hypothetically raising the possibility of a change in approach and a restructuring that would entail revising some EU legal bases, so that the EDA would come under the control of the Commission.

In the absence of a solid framework, the Council Decision 2021/698 of 30 April, concerning the protection of space capabilities, represented an important step forward by establishing a framework for responding to incidents in space[3]. However, its instruments (diplomatic statements, economic sanctions, technical measures) are part of a hybrid toolbox that does not yet allow for an immediate operational response, let alone a military defence in space. In practice, implementation falls to the Member States, whilst policy coordination is channelled through the STRA, which seeks to fill this governance gap. However, it remains a framework for simulation and preparation, not for operational command. There is also a lack of a mechanism to directly integrate space capabilities into CSDP missions and operations. Until this governance framework is adequately developed, the EU’s space autonomy will remain nothing more than a pipe dream.

The challenge of governance therefore lies in moving from a series of successful programmes (Galileo, Copernicus, GOVSATCOM, IRIS², EOGS) and concepts such as the Space Shield to a coherent strategic architecture capable of bringing them together under a common political, operational and technical command. Europe has the technological and financial resources, but it still lacks a single decision-making framework that would enable a coordinated response in the event of a space incident. Such a situation would readily become apparent if a Member State were to invoke Article 42.7 of the Treaty on European Union. The response to the request for mutual assistance could not be provided nor channelled through the EU institutions.

A less obvious but fundamental element of this emerging architecture is the role of the Single Intelligence Analysis Capacity (SIAC), which structurally integrates the work of the Intelligence Centre of the European External Action Service (INTCEN) and the Intelligence Directorate of the EU Military Staff (EUMS INT). The fusion of these two structures (civil and military) would provide a joint strategic analysis that is essential for understanding the evolution of the space environment, developing risk scenarios and contributing to early warning processes.

Within the SIAC, the Space Threat Landscape Analysis has been developed; an intelligence product which identifies, categorises and assesses space-related threats, ranging from interferences and cyber-attacks to anti-satellite actions, orbital congestion and potentially destabilising military activities. This analysis is

[3] Council Decision (CFSP) 2021/698 of 30 April 2021 concerning the protection of the components of the Union’s space programme. See: https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX:32021D0698

an essential input both for the preparation and activation of the STRA as well as for the EU Military Staff's doctrinal design, and for the ongoing review of Council Decision 2021/698. The development of this integrated spatial intelligence represents a significant advancement towards a common understanding of orbital threats and towards a culture of European space security capable of supporting coordinated political and operational decisions.

In this context, the relationship between the EU and NATO has also gradually taken shape in the space domain, giving rise to a specific framework for political and technical dialogue on space that has begun to yield concrete results. A significant example is the cooperation in the field of SSA. Three Member States (Spain, France and Germany) provide space surveillance data, which is channelled through the EEAS and the EU SST Partnership, which has enabled the Union to build its own capacity for understanding the space environment. On this basis, the EU has signed agreements with NATO that open the door to the selective exchange of SSA and SDA information, facilitating a shared view of the orbital situation and strengthening both entities' capability to detect risks and threats in orbit.

However, this advancement in the exchange of information stands in contrast to the still inadequate coordination in the design and development of next-generation space programmes. Whilst the EU-NATO Structured Dialogue on Space demonstrates that it is possible to align political-strategic positions and share operational data, capability development continues to take place largely in parallel, both within the EU and within the Alliance. It is therefore crucial that this structured dialogue evolves from the mere exchange of information towards genuine coordinated capability development, enabling a clearer distinction to be made between which systems should be essentially European, which should be integrated into the NATO framework, and in which areas it makes sense to accept deliberate redundancy as a tool for resilience.

5 The military dimension of space: from civilian discourse to operational use

For years, the EU has defended a vision of space centred on civilian and peaceful use. European diplomacy has been one of the main driving forces behind international forums on space governance and initiatives to prevent the proliferation of weapons in orbit. However, developments in the strategic environment have forced the Union to reconsider this approach. The dependence on space-based services in modern military operations, from navigation and communications to Earth observation, makes space an essential component of European security.

Currently, the military dimension of space is structured around three complementary pillars. The first is the development of dual-use capabilities, such as the IRIS² or EOGS, designed from the outset to serve both civilian and defence purposes. The second is the creation of a protection and response infrastructure, represented by the STRA mechanism and the Space SHIELD concept. And the third is the doctrinal integration of space into the missions and operations of the CSDP.

The STRA exercises represent the point where these three pillars converge. They simulate space crisis scenarios involving civilian and military organisations, ranging from deliberate interferences with Galileo to cyberattacks on GOVSATCOM control centres or the loss of communication links due to orbital sabotage. These exercises enable us to test the coordination between the Commission, the EDA, the EEAS, and the Member States, and represent a step towards a European space security and defence doctrine.

Despite these advances, European institutional discourse remains marked by a constant tension between civilian rhetoric and military necessity. The EEAS advocates for the peaceful use of space in international forums, whilst the European Commission and some Member States are driving projects with a clear defence focus through the EDF and the PESCO. This duality should not be interpreted as inconsistency, but rather as the reflection of a difficult balance between the Union's normative values and the realities of international power, which highlight its lack of effectiveness. For this reason, some of the Member States participating in PESCO initiatives have decided to move forward together on projects such as the DOSA, which speaks openly of the development of military space defence capabilities and assesses the possibility of joint development. Although PESCO projects fall under the EU's Foreign Policy, Member States within each initiative have the right to adopt positions that are in line with their national policies and which are reflected in the development of each programme.

Space, officially declared a strategic and operational domain of the EU, has become a field in which security and defence are inseparable. Space capabilities are no longer just a supplementary support, but rather a condition of possibility, a prerequisite, for the success of any military or crisis management operation. Geospatial information, time synchronisation and secure communications are now just as essential as transport and logistics, which also rely on them.

In this way, space has quietly become integrated into European defence, not through direct militarisation, but rather through the gradual and discreet operationalisation of, and dependence on, space data, products and services, primarily through the development of military capabilities that incorporate their use. Europe cannot do without its satellites, which makes protecting them a strategic priority.

6 Outlooks towards 2035: autonomy or strategic dependence

The year 2035 marks a turning point for European space autonomy. By that date, the IRIS² and EOGS programmes should be fully operational, the Space SHIELD concept established, and STRA exercises an institutional practice. However, the path to autonomy will depend on the Union's capability to resolve three fundamental dilemmas: political integration, economic sustainability and military cohesion.

The first possible scenario is that of gradual integration, in which the EU establishes a fully autonomous space defence system. This would entail effective coordination between the Commission, the EDA and the EEAS; the creation of a unified command for European space operations; and the full integration of the STRA into the CSDP structures. This scenario would position the Union as a global player with an independent response capability comparable to that of the major powers.

The second scenario is that of controlled dependence, in which Europe maintains its own programmes but continues to rely heavily on external alliances, particularly NATO and the United States, to guarantee the effective protection of its space assets. This model would maintain interoperability but would limit operational autonomy.

The third case is that of fragmentation, whereby Member States continue to develop national initiatives that are uncoordinated with one another. The absence of a common governance would perpetuate duplications and reduce the efficiency of investments, thereby weakening Europe's global position.

In an exercise of abstraction and in an attempt to anticipate the future, if we take into account the objectives set out in the new revision of Council Decision 2021/698—which regulates the STRA, the evolution of the Space SHIELD towards a permanent coordination structure and the maturity of the exercises themselves—, in the medium term we could witness the creation of the beginnings of a European Space Defence Centre, under the Council, in which military defence could be exercised solely through the CSDP or in coordination with the Member States possessing military defence capabilities, primarily France, Germany, Italy and Spain.

From a Spanish perspective, this process presents both opportunities and responsibilities. Spain has a solid space industry, with companies and research centres participating in the Galileo, Copernicus and GOVSATCOM programmes, and companies such as HISDESAT at the core of the development of the future IRIS² constellation. Furthermore, the National Aerospace Security Strategy recognises space as a key domain for defence and security and promotes the integration of national capabilities within the European framework, as will be discussed in the following chapters. Spain's participation in space-orientated PESCO or EDF projects, as well as the presence of specialised personnel in the space domain within the EUMS or the MPCC, reinforces its role as a key player in the development of European strategic autonomy.

However, achieving such autonomy will require more than just new programmes or additional investment. Advancing towards full space autonomy will depend on the Union's capability to address the structural weaknesses that limit the transformation of its technological potential into operational capability. From this perspective, several courses of action can be identified that are consistent with the anticipated developments between now and 2035 and which would enable progress towards effective strategic autonomy.

Firstly, it will be necessary to strengthen and institutionalise a more integrated model of governance between the EU and the ESA. Current cooperation is effective from a technical standpoint, but it remains constrained by the fact that the ESA is not an EU agency and includes non-member states, therefore requiring the compartmentalisation of sensitive activities and limits its involvement in security and defence sectors. A framework for strengthened cooperation that combines the EU's political and regulatory leadership with the ESA's technical-industrial role would enable it to overcome frictions and speed up the development of critical capabilities in the space domain.

However, whilst this cooperation has not yet been formally established, the current trend shows us that Member States are significantly increasing their contributions to the ESA budget, as it takes on an increasingly active role in the development of observation, early warning and resilience capabilities with direct applications in security and defence. If Member States continue to opt to channel a substantial proportion of their space defence resources through optional ESA programmes, the Agency could become the main European hub for the development of high-level space defence capabilities, with the EU primarily responsible for providing a regulatory framework, supplementary funding, policy coordination and potential operationalisation through the STRA or the CSDP. This would strengthen the European technological base but would also run the risk of shifting part of the decision-making process outside the institutional framework of the Union, replicating in the space domain the classic tension between community integration and intergovernmental logic.

Secondly, Europe must establish a credible and redundant capability for autonomous access to space. The recent simultaneous unavailability of Ariane 6 and Vega-C, which forced the Galileo satellites to be launched on SpaceX rockets, illustrated a strategic vulnerability that compromises the Union's autonomy and credibility. A binding rather than merely declaratory European space access plan, which coordinates institutional launchers with the new generation of private micro-launchers, reserving priority capacity for the Union's missions and establishing emergency mechanisms (launch-on-demand), will be essential to avoid external dependence.

Thirdly, the Union must fully integrate the space domain into the CSDP and into the EU's command and control structures. This requires the creation of specialist units within the MPCC and the OHQs, the adaptation of doctrinal procedures, and the establishment of an operational connection between the STRA and the Union's military structures. Without this step, space will remain a force multiplier, whose protection and exploitation will continue to rely on fragmented national endeavours.

Fourthly, it is essential to establish a European space defence hub, coordinated amongst those Member States that already possess military capabilities in this domain. This hub, comprising mainly

France, Germany, Italy and Spain, could serve as a functional operational base to support the EU in space crises, to coordinate the exchange of classified information and to act as a natural interface with NATO and the ESA in their respective fields.

At the same time, we should explore whether some of the approaches developed in the land and maritime fields to coordinate EU-NATO cooperation can be applied to the space domain. The most obvious precedent is the framework known as 'Berlin Plus,' which allows the Union to use NATO's command and control capabilities to carry out EU-led operations when the Alliance does not wish to be directly involved. Applied to the orbital environment, a similar model could consider the EU having conditional access to certain NATO space infrastructure, operations centres, surveillance networks, SSA and SDA capabilities, or even, where appropriate, certain communications segments, in order to support CSDP missions and operations. This 'Berlin Space Plus' agreement would, of course, require resolving complex issues relating to information security, classification and cost-sharing, but it would offer a pragmatic way of transforming the current unbalanced dependence into managed interdependence, consistent with European strategic autonomy and NATO's central role in collective defence.

In the long term, the development of this type of approaches, combined with better coordination of potentially overlapping programmes (EOGS and APSS, StarLift and REACT, amongst others), would enable a shift from the mere coexistence of initiatives to genuine structural interoperability between the EU and NATO. This would strengthen the coherence of the Euro-Atlantic community in an orbital environment that is becoming increasingly congested, contested, and strategic.

Finally, the STRA-Space SHIELD partnership must gradually evolve into a genuine technical and operational response capability focused on resilience, incident mitigation and the defence of critical space infrastructures. This would enable the EU to move beyond being merely a hub for political coordination and become an entity capable of acting autonomously in the event of acts of aggression in the orbital domain.

Altogether, these courses of action represent the steps required to transform Europe from a space technology power into a defence power. The real challenge facing the EU in the coming years will be to maintain its orbit between a centrifugal force represented by conceptual and technological expansion and the political gravity typical of an intergovernmental or semi-federal system, which represents a centripetal force. The key to success may lie in striking this balance, allowing a European space defence with a degree of autonomy to emerge.

Conclusions

Recent developments in the European space ecosystem reveal a persistent paradox. The EU has built a first-rate technological base through the major programmes of the EU Space Programme, but its strategic autonomy in space remains, to a large extent, merely a matter of rhetoric. The capability to autonomously guarantee access to, use of, and protection of the space domain continues to be constrained by technological, financial, operational and governance-related dependencies that limit its transformation into effective power.

In terms of capabilities, the EU has gone from being a civil entity to having a dual framework focused on security and defence: EU Space Programme, Space SHIELD, STRA, Preparedness Union Strategy, PESCO and EDF projects, as well as new instruments such as RE-ARM and RE-ARMED, or the future EDIP.

These frameworks make it possible, for the first time, to envisage a comprehensive spatial resilience architecture, supported by domain awareness (SSA and SDA), the protection of critical infrastructures and coordinated responses to incidents. However, Space SHIELD remains a conceptual architecture of capabilities rather than an integrated operational system, and the STRA continues to focus on political and technical coordination, without a clearly defined operational arm within Defence. Perhaps this is why we are witnessing a redefinition of the ESA's own role as an increasingly involved entity in security and defence, channelling a growing proportion of national space budgets towards dual-use programmes and support for European military capabilities.

The gaps identified in technology, investment, operations and governance explain why the EU remains a space technology power rather than just a strategic actor in space. The dependence on non-European launchers, budgetary fragmentation, the absence of established procedures for integrating space into CSDP missions, and the complex relationship between the Commission, the EEAS, the EDA, the EUSPA and the ESA create an institutional framework that is difficult to coordinate. The creation of intelligence products such as the Space Threat Landscape Analysis within the SIAC represents significant advances, albeit still in their early stages, towards a common understanding of orbital threats and their translation into policy and doctrinal decisions.

Added to this is the external dimension. The relationship with NATO, the risk of overlap between initiatives such as EOGS and APSS or StarLift and REACT, as well as the need to move from the coexistence of programmes to genuine Euro-Atlantic structural interoperability. A potential Berlin Space Plus and the consolidation of a European space defence hub could offer pragmatic solutions for transforming the unbalanced dependence into managed interdependence, consistent with European strategic autonomy and the Alliance's central role in collective defence.

The scenarios outlined for 2035 show that the future is not set in stone. The result will depend on the Union's capability to make progress in four key areas: a more integrated governance model with the ESA; credible autonomous and redundant access to space; the full integration of the space domain into the CSDP and command and control structures; as well as the development of frameworks such as Space SHIELD, STRA, RE-ARM and the EDF and PESCO projects into a genuine operational capability for the defence of critical space infrastructure.

Ultimately, Europe's strategic autonomy in space will not be determined solely on the basis of laboratories, agencies or control centres, but rather by the political willingness to transform a constellation of successful programmes into a coherent security and defence architecture. Moving from the conceptual orbit to political reality, from discussions of strategic autonomy to the sharing of space capabilities, and from the development of joint projects to their implementation by EU institutions will be the real challenge for Europe's space ambitions over the next decade.

Chapter six

The space domain within the National Aerospace Security Strategy

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Abstract

The National Aerospace Security Strategy 2025 redefines Spain's approach to security in the air and space domains, highlighting its relevance within the National Security System. By introducing the concept of a 'domain,' it underscores the operational and geopolitical importance of outer space. The strategy establishes three main objectives: safeguarding Spain in the aerospace sphere, enhancing security and defence capabilities, and promoting a safer and more sustainable space environment. It identifies critical national interests and addresses emerging threats linked to the systemic dependence on satellite services. Likewise, it advocates for resilience and European cooperation as essential elements for mitigating risks, and anticipates the need for a National Space Strategy, integrating security, defence, and governance measures to preserve sovereignty and competitiveness in an international context of growing geopolitical rivalry. In addition, it proposes a comparative study of the space strategies of France and Germany, highlighting security and defence aspects, and recommends moving toward a National Space Security Strategy and a National Space Strategy that—consistent with the

National Aerospace Security Strategy 2025—integrate security, defence, and sustainability through a comprehensive whole-of-state approach.

Keywords

Aerospace security, Space governance, Resilience, National security strategy, European cooperation.

Introduction

'Space: the final frontier'. There is possibly no phrase more iconic in science fiction than those words spoken by Captain James T. Kirk, when the United Federation of Planets' Starfleet and its conflicts with the Klingon Empire took us on a journey that transported the Cold War into the galaxy and outer space. The security of the United Federation of Planets depended entirely on its dominance of space, its Starfleet and possessing more advanced technology than its adversaries.

Undoubtedly, we are a long way from Star Trek and travelling faster than the speed of light, but there is no longer any doubt that space has established itself as a new operational domain. Our security on the Earth's surface relies heavily on the services and capabilities deployed and operated from the field of space. Furthermore, if we are to be realistic, we must be fully aware of what is referred to in the National Aerospace Security Strategy 2025 (ESAN 2025) as the new strategic approach[1].

The geostationary orbit is 35,786 km from the Earth's surface (just under six times the Earth's radius); the Lagrange points of the Earth-Moon system are several hundreds of thousands of kilometres away, and those of the Earth-Sun system are millions of kilometres away. But by 2024, approximately 93% of active satellites[2] were in low orbits, and it is becoming increasingly technologically feasible to use lower orbits in a cost-effective manner.

How far does national sovereignty extend? Spain, in accordance with international law, does not recognise an exact boundary demarcating national sovereignty. However, for the purposes of the ESAN 2025, and solely with regard to the coordination of operations between the air and space domains, the theoretical and academic boundary between the two domains is considered to lie at the so-called Kármán line, at an altitude of approximately 100 km.

The ESAN 2025 presents a new strategic approach within the National Security System, with substantial changes compared to

[1] In Order PJC/845/2025, dated 29 July 2025, publishing the Agreement of the National Security Council dated 14 July 2025, on the National Aerospace Security Strategy (*BOE - Official State Gazette* - No. 187, dated 5 August 2025). See: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2025-16214

[2] See: https://www.abiresearch.com/press/over-480-orbital-launches-and-43000-active-satellites-expected-by-2032

the first strategy, which was approved in 2019. During the initial stages of updating this document, there was a debate about whether it would be appropriate to draw up two separate strategies, one for the air domain and another for the space domain, but the conclusion, as reflected in the executive summary of the ESAN 2025, was that it was appropriate to understand 'aerospace security as a single domain for reasons of effectiveness in addressing threats and mitigating risks that are common and interdependent in airspace and outer space.'

Article 10 of the National Security Act 36/2015 (LSN)[3] establishes that areas of national security are understood as 'those that require specific attention as they are fundamental to preserving the rights and freedoms, as well as the welfare of citizens, and to guarantee the supply of essential services and resources; these include "the security of airspace and outer space"'. The Aerospace Security Strategy 2019 identified airspace and outer space as two distinct domains, albeit with a comprehensive approach reflected in a single security strategy that addressed threats and challenges in a unified and coherent manner.

The ESAN 2025 has undergone a substantial development in line with the changes within NATO and the European Union, and the term 'domain' has been adopted to identify operations in airspace and outer space. The introduction of the concept of 'domain' represents a significant step towards underlining the key importance of space in the provision of essential services and resources and allows its specific characteristics to be highlighted. Furthermore, the term 'airspace domain' is reserved to underline that, from the point of view of the National Security System, it has been considered necessary to maintain a comprehensive and unified vision of airspace and outer space security.

The National Security Strategy 2021 (ESN)[4] proposed for the security of global commons, a single course of action in airspace and outer space, namely the creation of the Spanish Space Agency (AEE), which was formally established by Royal Decree 158/2023, dated 7 March, which approved the statute of the state agency known as the 'Spanish Space Agency,' with

[3] Act 36/2015, dated 28 September, on National Security (*BOE - Official State Gazette* - No. 233, dated 29 September 2015). See: https://www.boe.es/buscar/act.php?id=BOE-A-2015-10389

[4] Royal Decree 1150/2021, dated 28 December, approving the National Security Strategy 2021. See: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2021-21884

a component dedicated to national security[5]. Furthermore, the line of action 3 of the ESN 2021 calls for the 'development of the defence, security and space industries, as well as dual-use technologies,' the importance of which has been reinforced by a significant shift towards industrial policies aimed at greater economic security at an international level. Therefore, it became necessary to define new strategic lines of action for the airspace domain.

The National Aerospace Security Council (CNSA) deemed it necessary to update the ESAN 2019, and this analysis was presented to the National Security Council (CSN), which, at its meeting on 15 October 2024, adopted an agreement approving the procedure for preparing a new document[6].

The procedures for preparing sectoral or second-level strategies within the National Security System have been largely standardised, with the councils or committees for each specific field responsible for drafting the documents through a working group. It is important to note two aspects of these preparation procedures. The first is the obligation to obtain contributions from the autonomous communities and cities to the text, through the Sectoral Conference for National Security Affairs. The second is the collaboration of organisations, institutions and individuals with recognised experience, which, in the case of the ESAN 2025, has been extensive.

With regard to the structure of the ESAN 2025, the preparation process had already anticipated the elements it should comprise, such as an analysis of the context in the air and space domains; the risks and threats to air and space security; the objectives and lines of action; and the aerospace security within the National Security System, establishing a clear distinction between aspects related to the concepts of security and operational safety.

[5] Established by the Third Additional Provision of Act 17/2022, dated 5 September, amending Act 14/2011, dated 1 June, on Science, Technology and Innovation. See: https://www.boe.es/buscar/act.php?id=BOE-A-2011-9617. As per Royal Decree 158/2023, dated 7 March, the Statute of the Spanish Space Agency was approved. See: https://www.boe.es/buscar/doc.php?id=BOE-A-2023-6082

[6] Order PJC/17/2025, dated 17 January, publishing the Agreement of the National Security Council, approving the procedure for the preparation of a new National Aerospace Security Strategy. See: https://www.boe.es/boe/dias/2025/01/21/pdfs/BOE-A-2025-971.pdf

1 The ESAN 2025: an approach from the perspective of Spain's security and defence interests

The ESAN 2025 includes a number of terminological clarifications aimed at providing greater clarity regarding terms that are sometimes used interchangeably. A distinction is made between 'seguridad operacional' as the translation of the English term 'safety,' and 'seguridad,' which is reserved for the English concept 'security.' National security is thus clearly linked to the State's freedom of action in fulfilling the provisions set out in Article 3 of the National Security Act, namely, to protect the freedom, rights and welfare of citizens, to guarantee the defence of Spain, its constitutional principles and values, and to contribute to international security. The prosperity and welfare of Spanish citizens is, therefore, an implicit objective of national security.

Based on this definition, it is necessary to determine what constitutes the national interests that require protection. The final section of Chapter 1 of the ESAN 2025 provides a strategic overview of aerospace security and sets out the key interests to be protected. Naturally, those referred to are those whose protection is a priority in order to fulfil the strategic objectives set out in the ESAN 2025, as well as to develop the proposed lines of action for their implementation.

The ESN 2021 anticipated, in addressing aerospace vulnerabilities, a change in the focus towards national interests in outer space. It also recognised outer space as the final frontier of geopolitical confrontation and expressed concern about the dominant position held by non-EU operators in intensive commercial exploitation, which could put those interests at risk. The lack of legal regulation has been extensively exploited, facilitating both unregulated or abusive practices in outer space and the acquisition of near-monopolistic control of the market.

With regard to the space domain, it is important to note that previous documents may not have clearly taken into account the interests of being protected. The ESAN 2025 makes no classification of vital, important, essential or strategic interests, a practice commonly found in some strategic policy documents, but the order in which they appear is clearly significant.

The first notable national interest is the technological and industrial base. It is a vision which, although present in previous documents, is now considered a national interest to be protected.

This consideration is the result of an analysis of the dynamics of transformation in the space domain, where we are witnessing the emergence of a new paradigm, characterised by a transition from a model based on the free market and interdependence to one that prioritises the resilience of supply chains and the protection of strategic industries and sectors.

The new international order, or disorder, though still full of uncertainty, already exhibits some constants that can be observed, such as a greater use of force outside the framework of international law, a form of globalisation that has given way to the prioritisation of resilience and economic security, and the competitiveness of companies as a strategic requirement.

The second national interest to highlight is the free access to outer space, which is essential for freedom of action in the operation and exploitation of space. The ESAN 2025 goes into even greater detail regarding national interests, identifying as a national interest the preservation of the radio frequencies allocated by the International Telecommunication Union (ITU) to national space assets and the orbital positions between them.

Finally, it elevates to the level of national interest that which could otherwise be considered a mere course of action, as is the development of launchers, space and ground-based infrastructures, and centres for the exploitation of aerospace data and services.

2 Conceptual framework for the space domain: the role and activities of the National Aerospace Security Council

The fourth chapter of the ESAN 2025 is dedicated to aerospace security within the National Security System. The ESAN 2019 called for the creation of the CNSA and anticipated the functions that would be assigned to it under Order PCM/218/2020, dated 13 March 2020, namely as a committee specialising in the field of aerospace security and as a supporting body to the CSN within the framework of the National Security System.

It is important to bear in mind how the National Security System functions from an operational point of view in terms of crisis management, and the role of the CNSA as a support body for both the CSN and the Situation Committee. The National Security System is defined in Title II of the LSN 36/2015, which, in Article 18, defines it as the group of bodies, agencies, resources and procedures that form part of the structure foreseen in Article 20.

This structure assigns responsibility for managing the system to the Prime Minister, assisted by the CSN, with the Department of National Security acting as the technical secretariat and permanent working body. The creation of specialised committees is covered in Article 20.3, under which the CNSA acts as the specialised committee for aerospace security.

The regulatory development provided for in the LSN has been implemented through two significant agreements by the National Security Council.

- Order PRA/116/2017, dated 9 February[7], publishing the CSN's agreement on the implementation of mechanisms to guarantee the integrated operation of the National Security System.
- Order PRA/32/2018, dated 22 February[8], publishing the CSN's agreement regulating the Specialised Situation Committee.

These two agreements of the CSN set out the functioning of the crisis management system and the significant role played within it by the unique nature of the Situation Committee, which is responsible for channelling and coordinating the support required by the Government from the crisis management instruments of the National Security System, in accordance with the political and strategic guidelines adopted by the CSN. When the National Security System is activated, the Specialised Situation Committee (known simply as the Situation Committee), through the Department of National Security, centralises the information provided by the authorities to manage crises and, in particular, to monitor incidents that could lead to a situation of interest to national security.

The Department of National Security, in its capacity as a support body to the committee, establishes coordination units comprising one representative from each ministry and agency represented on the committee, with the aim of providing technical advice on both preventive measures and response actions in the field of crisis management. The coordination units can be activated directly by the Director of the Department of National Security without the need for an executive order from the Situation Committee. This possibility of direct activation provides the National Security System with the necessary reactivity.

[7] See: https://www.boe.es/buscar/doc.php?id=BOE-A-2017-1460

[8] See: https://www.boe.es/buscar/doc.php?id=BOE-A-2018-798

In response to the risks posed by the uncontrolled re-entry of objects into the Earth's atmosphere, the CSN approved a space alert protocol by Order PCM/1067/2022[9], dated 4 November. This Space Alert Protocol (and the operational procedures implementing it) has enabled the accumulation of significant experience in crisis management in the space domain, or rather, in the aerospace domain, as one of the measures adopted would be the closure of national airspace.

For example, in the case of the uncontrolled re-entry of debris from the Chinese CZ-5B launcher on 4 November 2022, a decision was made to suspend all aeronautical activity[10], with the exception of state aircraft on emergency services and air defence missions, within a corridor where the risk posed by the uncontrolled re-entry was deemed unacceptable.

Within the National Security System, coordination units compile and analyse the available information to facilitate coordination between all the ministries and agencies involved. Each ministry and agency acts in accordance with its assigned competences; in principle, there is no change to the various regulatory frameworks. The aim is to reduce response times by adapting to crisis scenarios and to provide the instruments that enable coordination and consistency in the actions to be taken by ministries and agencies.

The declaration of a situation of interest to national security, as foreseen in Article 23 of the LSN, would result in enhanced coordination between the competent authorities in the exercise of their ordinary powers under the direction of the Government, within the framework of the National Security System, in accordance with the conditions laid down in Articles 23 and 24 of the LSN.

The ESAN 2025 enshrines this crisis management model within the aerospace field and considers it the most adequate for dealing with scenarios arising from threats in or from space that affect national security. Specifically, it is considered to be the appropriate instrument for cooperation with the EU's Space Threat

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[9] Order PCM/1067/2022, dated 4 November, publishing the National Security Council Agreement, dated 11 October 2022, approving the Space Alert Protocol (*BOE - Official State Gazette* - No. 268, dated 8 November 2022). See: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2022-18336

[10] See: https://ad.easa.europa.eu/blob/EASA_SIB_2022_09_withdrawn.pdf/SIB_2022-09_1

Response Architecture (STRA)[11]. This link between NATO's and the Union's crisis management mechanisms in the space domain is already being established, in line with this model, during participation in both NATO and EU exercises, or in cases where the EU Council Decision (CFSP) 2021/698 has been activated.

Therefore, in Spain, crisis management is carried out in a very direct and executive manner through the channel comprising the Coordination Unit, the Situation Committee and the CSN. However, this does not diminish the importance of the CNSA, because, although it does not intervene directly in crisis management, the studies, protocols and procedures are proposed, examined and reviewed by the Council itself, which, where appropriate, submits them to the CSN for approval.

The CNSA was established and is regulated by a National Security Council Agreement published by Order PCM/218/2020, dated 13 March[12]. Several of its functions are directly linked to the National Aerospace Security Strategy; these include leading the development of the Strategy and submitting it to the CSN, as well as continuously reviewing the level of compliance and, more specifically, assessing the risks to aerospace security.

The CNSA must 'assess the risks associated with the challenges and threats; analyse possible crisis scenarios and their development, particularly those likely to lead to a situation of interest to national security'. In the ESAN 2025, the term 'challenge', which appeared in the previous version of ESAN, has been omitted, as it is considered that its removal provides a more practical approach to risk management. By refraining from assessing the intent behind an event, the focus is placed on the risk, understood as the combination of probability and the impact on the assets to be protected should the threat materialise.

Chapter 2 of the ESAN 2025 carries out an analysis of the threats to national security in the space domain, which presents a number of challenges distinct from those in the air domain. Firstly, seven threats are analysed which are common to both domains; although they have specific characteristics in each case, their degree of interrelation is very important and enables them to

[11] Council Decision (CFSP) 2021/698, dated 30 April 2021, on the security of systems and services whose deployment, functioning and use in the framework of the Union Space Programme may affect the security of the Union. See: https://www.boe.es/buscar/doc.php?id=DOUE-L-2021-80617

[12] See: https://www.boe.es/buscar/doc.php?id=BOE-A-2020-3638

be addressed jointly. These threats include armed conflicts, the consequences of health crises, natural disasters, supply chain disruptions, terrorism, violent extremism, organised crime and serious crime, cyber threats, and espionage.

However, with regard to the space domain, the ESAN 2025 dedicates two specific sections to this within the analysis of the threats in Chapter 2. The first section is dedicated to the threats arising from increased space activity. This is a different scenario from that of 2019, one that the ESN 2021 had partly anticipated, but which has suffered a radical change over the last five and a half years between the ESAN 2019 and its 2025 review.

As a result, new actors are emerging, together with new forms of commercialising space activities. The growing involvement of private companies in the space sector is commonly referred to as "New Space", the best-known examples being Elon Musk's SpaceX and Jeff Bezos's Blue Origin. "New Space" is an umbrella term used to describe a new paradigm in the space sector, characterised by increased private-sector participation, innovation, and commercialisation.

However, the ESAN deliberately avoids making extensive use of the term 'New Space' for several reasons. The 1967 Outer Space Treaty establishes the jurisdiction, control and international responsibility of the registering state over objects launched into outer space. This treaty dedicates several articles to setting out the competences of the states without differentiating between governmental and private activities. Historically, and still today, the private activity in the space sector remains heavily reliant on government contracts and support, whether through state agreements or via international organisations. Whilst the importance of the private sector is recognised, national security constitutes an essential public policy, and in the space domain, the state's function is reinforced by the current regulatory framework, whose limited scope in comparison to other sectors further highlights the centrality of the state's role in space governance.

In light of the above, the issue of the sustainability of space activities arises, stemming both from the growing saturation of orbits and the electromagnetic spectrum, as well as from the accumulation of space debris. Added to this is the risk that these dynamics may pose a significant obstacle to the observation of the universe and, consequently, to the advancement of astrophysics.

The ESAN 2025 recognises the need for a common analysis of and response to space-related threats within the EU. Spain's participation in the EU Space Surveillance and Tracking (EU SST) system[13], in the EU Space Information Sharing and Analysis Centre (ISAC) and in the Space Threat Response Architecture (STRA), highlights the need for, and the advantages of, cooperation at European level. A common European capability for analysing and responding to threats in or from space is required, as no Member State will be able to compete on its own in the competitive global environment.

3 The ESAN 2025: objectives, lines of action and measures for their achievement

Chapter 3 of the ESAN 2025, which sets out the objectives and lines of action, should be examined in conjunction with the Annex containing the list of measures aimed at achieving the three strategic objectives. In this section, there have been significant changes to both the content and structure of the ESAN 2019.

At that time, the approach was based on a single generic objective set out in the ESAN 2017, which was to:

> '[…] guarantee security in airspace and outer space within a shared framework aimed at counteracting the threats and challenges that arise in these environments, and neutralizing the consequences thereof, in accordance with the principles of efficiency and utmost coordination, in both the use of analysis and evaluation capabilities and of capacities to respond to challenges.'

Based on that general objective, five lines of action were established, each of which was broken down into a series of measures, amounting to a total of sixty-eight. These were not numbered, and no indicators were defined to assess the extent to which they had been fulfilled.

The ESAN 2025, without abandoning its role as a strategic policy framework, addresses the objectives of Act 27/2022, dated 20 December[14], on the institutionalisation of the evaluation of public policies within the General State Administration. These must be solidly formulated in technical terms, evidence-based, and

[13] National Space Surveillance and Tracking Programme (S3T). See: https://www.aee.gob.es/Actividades/Nacionales/S3T.html

[14] See: https://www.boe.es/boe/dias/2022/12/21/pdfs/BOE-A-2022-21677.pdf

backed by defined metrics that enable their evaluation. This has been the aim with the ESAN 2025, which has three strategic objectives firmly rooted in the definition of national security set out in Article 3 of the LSN.

- Strategic Objective 1: to protect Spain 'in' and 'from' the air and space.
- Strategic Objective 2: to enhance air and space security and defence capabilities.
- Strategic Objective 3: to contribute to a safer and more sustainable air and space.

These objectives have been set out in thirty-four lines of action designed to provide guidance at a political-strategic level to the various ministerial departments, which are responsible for deciding which programmes to implement within their framework of competences. The proposed lines of action can indeed contribute to the achievement of more than one strategic objective. Nevertheless, to facilitate the evaluation, they have been assigned to just one of them.

The aforementioned annex contains a total of sixteen actions aimed at achieving the three strategic objectives. Each action is associated with a reference for monitoring the extent to which the set objectives have been achieved, and every three years the CNSA will carry out an evaluation of the proposed lines of action and measures, submitting a report to the CSN.

The strategic objectives of the ESAN 2025 cannot be achieved without guaranteeing the security of the supply chain; for this, it is essential to strengthen the competitiveness of the space sector. Undeniably, national resources do not enable us to compete on equal terms with other major actors; we must recognise our own strengths and weaknesses, set the right priorities and drive international cooperation, particularly within the framework of the EU and the European Space Agency (ESA), which have proved so beneficial in the past.

The ESAN 2025 dedicates a considerably greater number of action lines and measures to the space domain than to the air domain, largely due to the novelty of considering the former separately, but also because of the significant and rapid changes it has undergone since the ESAN 2019. A reading of Chapter 3 of the ESAN 2025 and its Annex raises the question of the need for a National Space Strategy, which is addressed in the following sections of this chapter.

4 Security, defence and resilience: from the ESAN 2025 to a National Space Strategy

The Spanish institutional framework presents the following paradox: on the one hand, Spain has a National Aerospace Security Strategy, which was first approved in 2019 and revised in 2025, but it lacks a National Space Strategy.

This shortcoming is by no means insignificant and has been mitigated to some extent by the coexistence within the space ecosystem of various sectoral strategies and plans (security, industry, R&D, defence and others)[15]. However, there is no overarching document to set priorities, coordinate capabilities or establish a national level of ambition in a holistic manner. After the creation of the AEE in 2023, it is expected that the National Space Strategy will be submitted via the Ministries of Defence and Science, Innovation and Universities for approval by the Council of Ministers in 2026.

As set out in the AEE's statute, among its competences are the design and coordination of a National Space Strategy, implemented through plans and programmes for the execution of national space policy via the competitive and efficient allocation of the Agency's own public resources, as well as the monitoring of funded activities and their impact.

Nevertheless, while the National Space Strategy has yet to materialise as a guiding public document, it has meant that the ESAN has played a leading role in the Spanish space field since 2019.

4.1 Strategies beyond exploration: space as a domain of sovereignty and security

The ESAN 2025 sets out how the strategic and technological environment has changed significantly since 2019 and how threats have increased and diversified. Russia's aggression against Ukraine has highlighted some of Europe's vulnerabilities and

[15] National Security Strategy 2021 (ESN 2021); National Aerospace Security Strategy 2025 (ESAN 2025); National Cybersecurity Strategy 2019 (ENC 2019); Spanish Strategy for Science, Technology and Innovation 2021-2027 (EECTI); Digital Spain 2026; Aerospace PERTE (PRTR); Industrial and Technological Plan for Security and Defence (Financial Year 2025); Defence Industrial Strategy 2023 (EID 2023); Defence Technology and Innovation Strategy (ETID 2021-2027); Strategic Agenda for Space R&D&I (PAE 2025); Spain's External Action Strategy 2025-2028.

dependencies in the space sector, prompting both the EU and its Member States to decide to strengthen the resilience of their space infrastructures and their security and military capabilities in this domain.

The need for secure satellite communications was highlighted by the dependence on external commercial capabilities and by the vulnerability of the ground segment to cyberattacks (such as the one carried out against Viasat's KA-SAT network on 24 February 2022, as mentioned in previous chapters of this paper); positioning, navigation and timing (PNT) capabilities demonstrated their continued exposure to interferences (jamming and spoofing) with immediate effects on security and economic activity. Space Situational Awareness (SSA) revealed its limitations in attribution and knowledge of the orbital environment; access to space highlighted the strategic vulnerability arising from having to rely on non-European launchers, and, across the board, supply chains confirmed technological dependencies on critical components and subsystems.

Recently, in November 2025, both France and Germany published their respective space strategies[16]. Although their approaches differ, both strategies highlight the attention and paramount importance that security and defence matters in outer space have come to acquire. In the case of France, this is a national space strategy, whilst in the case of Germany, this is a space safety and security strategy. France already had a space defence strategy, published in 2019, and Germany had a national strategy, published in 2023. Both documents highlight the need to take a proactive approach to space matters in order to ensure the sovereignty, competitiveness and resilience of both their nations and Europe.

In his foreword to the National Space Strategy 2025-2040, the French President Emmanuel Macron noted that 'Today, space is no longer merely a field of exploration: it has become a domain of sovereignty, innovation and security'. (Government of France, 2025). It should be highlighted how security and defence aspects are no longer merely part of a military chapter but have become one of the five pillars of its national space policy. A pillar focusing on resilience and military capabilities, presenting a greater number of strategic objectives, which are even more ambitious than those set out in its 2019 Space Defence Strategy (Government of France, 2019).

[16] As mentioned in Chapter 2 of this paper.

In Germany, too, there has been a development from the 2023 Space Strategy towards their 2025 Space Safety and Security Strategy, which reflects a process of strategic maturation (Federal Government of Germany, 2025). We are moving from a general space policy framework focused on competitiveness, sustainability and technological sovereignty to a sector-specific document that demonstrates the growing importance of the space safety-security partnership as a national priority. From the recognition of space as an environment from which increasingly essential services are received to its treatment as a matter of national security.

In addition to the recent stances taken by these two European countries in strengthening their approaches to space security and defence issues, it is important to recognise the developments experienced by the ESA, which were highlighted at the Bremen Council Meeting in November 2025 (CM25), as discussed in Chapter 3 of this paper.

The ESA is governed by a clear founding mandate, which, in accordance with Article II of its Convention, goes as follows:

> '[…] to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems'[17].

In line with this framework, the ESA has historically functioned as an intergovernmental mechanism for technical-scientific cooperation and for the development of European space programmes, whilst ensuring compliance with the principle of the peaceful use of outer space.

Nevertheless, the final resolution and agreements of the CM25 demonstrate a qualitative shift in the institutional approach towards security and defence. In his opening remarks at the beginning of the summit, the Director-General, Joseph Asbacher, explicitly cited the 'perfect storm' in the strategic environment as the reason for 'requiring a stronger focus on security and defence,' further stating that 'space is dual-use by nature'[18] and linking this approach to the proposal for the new European Resilience

[17] See: https://esamultimedia.esa.int/multimedia/publications/SP-1300/SP-1300_ES_web.pdf

[18] See: https://esamultimedia.esa.int/docs/corporate/CM25_DGproposal.pdf

from Space (ERS) programme as a European crisis response and intelligence infrastructure based on Earth observation, PNT and secure connectivity components.

At the same time, the summit's final resolution expressly recognised that the ESA's intergovernmental framework provides 'the credentials and tools for developing space technologies and systems including for security and defence,' and for implementing activities and programmes on behalf of the Participating States and the European Union, always 'in compliance with the peaceful use of outer space and the Convention'[19]. This is the first time since its creation that defence has been mentioned in the conclusions of an ESA ministerial summit.

4.2 Germany: from a Federal Space Strategy to a Safety and Security Strategy

In just a few years, Germany has undergone a strategic evolution that has crystallised into a single assessment: that space is a domain whose continuity and freedom of action have become a matter of national security and therefore require specific instruments that were not covered by strategies more focused on research and exploration.

In 2023, Germany updated its 2010 Space Strategy with a new Federal Space Strategy[20], designed as a comprehensive framework to guide public action in areas such as competitiveness, innovation, sustainability and technological sovereignty. However, whilst recognising the importance of space infrastructure and the need to protect critical capabilities, the document did not address security and defence aspects in depth; these were instead integrated across the board within a broad approach to space policy. This shift is gathering pace as the strategic environment in Europe deteriorates and it becomes clear that space is a priority target from the initial stages of any crisis.

The recent publication of the German sectoral strategy on *Space Safety and Security* (Federal Government of Germany, 2025) addresses this gap. As its title suggests, it is the first German

[19] See: https://esamultimedia.esa.int/docs/corporate/ESA_CM2025_1_Resolution_on_Elevating_Europe_through_Space.pdf

[20] See: https://www.bundeswirtschaftsministerium.de/Redaktion/EN/Publikationen/Technologie/the-german-federal-governments-space-strategy.pdf?__blob=publicationFile&v=1

document specifically dedicated to safety and security, reflecting the fact that space security is becoming a political priority due to society's and the economy's growing dependence on space.

It is designed as a strategy aimed at ensuring Germany's capacity for action in space across the entire peace-crisis-defence spectrum, based on a dual assessment: on the one hand, the increase in natural and operational risks (congestion, debris, space weather); and on the other, the proliferation of intentional threats and counterspace capabilities. Based on this assessment, a framework for action is established using a whole-of-government approach, translating the policy ambition into an implementation package structured around eleven priorities, three strategic areas of action and sixty-five strategic and operational lines of action, with a view to ensuring coherence in the protection, resilience, defence and governance of space infrastructures.

The eleven priorities address aspects of strategic autonomy at both national and European level, as well as industry, research, innovation, resilience and international cooperation. Of particular note is the priority of developing Space Situational Awareness as a civil-military task through a network of sensors with global coverage, and the capability to carry out military space operations. These priorities give rise to three areas of action in which all national space actors must take action: identifying risks and threats and developing options for action; promoting international cooperation and a sustainable order; and building deterrence, strengthening defence capabilities and resilience.

In turn, these three areas of focus give rise to lines of action and tasks aimed at establishing a space security architecture with a comprehensive government approach, as already outlined in its National Security Strategy published in June 2023 (Federal Government of Germany, 2023).

Of the sixty-five lines of action in the first area, a few stand out, such as the importance of ensuring that the security architecture is fully operational, with resilient command and control, a global sensor network for SSA, and the strengthening of key capabilities (early warning, ISR and SIGINT), alongside the consolidation of control over military satellites, the driving of multi-orbit constellations for communications, inventories of dependencies and vulnerabilities, catalogues of critical infrastructures, and the creation of a national space weather information service.

The second area emphasises bilateral and multinational cooperation, increased participation in exercises such as Olympic Defender, the development of legal positions and rules of engagement, interoperability and standardisation, the strengthening of EU SST, arms weapons control diplomacy, and export control measures.

Finally, the third area highlights efforts to build credible deterrence by developing enhanced capabilities to plan and conduct space operations, including active and passive protection, inspection capabilities, and protective escort satellites. Rapid-response capabilities are also required, together with measures to ensure access to space and strengthen cyber defence and operations in the electromagnetic spectrum. These efforts are framed within a national governance architecture (committees, coordination mechanisms, and incident-response structures) designed to ensure rapid decision-making and permanent availability.

4.3 France: sovereignty, the economy, resilience and security in the New National Strategy

France published its Space Defence Strategy in 2019, based on a dual rationale. On the one hand, a more challenging operational environment, evidenced by threatening activities and demonstrations of power, including ASAT, close-range operations and interferences, which made it necessary to strengthen surveillance and attribution capabilities. On the other hand, structural trends such as the intensification of competition between major powers and the growing dependence on space services, which is ultimately considered a vulnerability (Government of France, 2019).

In this framework, the French Ministry of the Armed Forces enshrined a significant change of approach. Space is no longer merely a means of supporting operational capabilities but is now regarded as a domain in its own right and a potential field of confrontation, and has been incorporated as the fifth domain of military action. The paradigm shift was clear, with space now being considered as an area that must be defended, declared a presidential priority and backed by a roadmap until 2030.

France publicly condemned an incident involving the Russian Luch-Olymp satellite approaching and spying on the Athena-Fidus satellite, which was described as an act of espionage in 2018[21]. Such incidents accelerated the need to improve capabilities for surveillance, tracking, characterisation and attribution. Consequently, the 2019 Defence Space Strategy identified that freedom of access and action could be compromised and made SSA a key pillar for protection and attribution. Furthermore, it signalled greater ambition, evidenced by the creation of a Space Command attached to the Armée de l'Air, and the renaming of the latter to Armée de l'Air et de l'Espace as a historic turning point and an example that several nations, including Spain, have subsequently followed.

After this first space defence strategy, in 2025 the French Government published its National Space Strategy 2025-2040, which incorporates the approach outlined in the previous document on security, resilience and defence into a broader architecture of sovereignty and competitiveness (Government of France, 2025). The new National Space Strategy is structured around five pillars encompassing sovereignty, competitiveness, resilience and international influence, alongside fifteen strategic objectives that will guide France's approach to becoming a space power by 2040.

Pillar 1 ensures autonomous and competitive access to space (the Guiana Spaceport), the development of the Ariane 6 launcher and the preparation of the next generation of launchers. Pillar 2 strengthens a dual space economy through competitiveness in the satellite sector, a downstream data policy, and a talent and R&D agenda aligned with industrial and territorial needs.

On that basis, Pillar 3 focuses on the priorities of resilience; security and defence, with an operational emphasis on ensuring the continuity of critical civilian and military services; autonomy in sovereign capabilities; the enhancement of SSA and SST through sensor networks and faster decision-making cycles; and the consolidation of an active defence posture in and towards space. In terms of objectives, this block translates into strengthening the resilience of critical space infrastructures, guaranteeing operational autonomy, increasing space surveillance for assessment and attribution, and having graded protection and response capabilities consistent with the applicable legal framework.

Pillar 4 maintains the ambition in science and exploration. Meanwhile, Pillar 5 articulates international cooperation and

[21] See: https://www.assemblee-nationale.fr/dyn/15/rapports/cion_afetr/l15b4991_rapport-information.pdf

normative diplomacy for the responsible use of space, combining European leadership (EU and ESA) with selective openness to strategic partners (among which it is notable that it expressly mentions only the intention to revitalise historic collaborations with Germany and Italy) whilst opening up new avenues of cooperation on regulation, standards and European governance.

5 Towards a National Space Strategy: contributions to security, defence and resilience within the EEN

As previously mentioned, during the 2019 review of the ESAN, consideration was given to the suitability of developing two separate strategies, one for the air domain and another for the space domain. Ultimately, the decision was made to understand 'aerospace security as a single domain for reasons of efficiency in addressing threats and mitigating common and interdependent risks in both airspace and outer space'.

However, the ESAN 2025 itself incorporates a nuance of significant scope for doctrinal development, namely that it simultaneously recognises that space constitutes a distinct domain in which threats to essential services for national security have intensified, and underlines that both the EU and NATO have conferred upon outer space the status of a distinct operational domain.

This opens the door for the ESAN, in its next review, to evolve into a model that clearly distinguishes the air domain from the space domain, with the drafting of two separate security strategies. In the case of a space security strategy, this would make it possible to highlight the specific characteristics and most distinctive aspects of the space domain, such as the variety of natural and intentional threats, the complexity of operations in that environment, and the attribution of space incidents, amongst others.

Before this division of a future ESAN can take place, there is an urgent need to develop a national space strategy that articulates the priorities of industry, science, R&D, programmes and users so that they do not evolve in a fragmented manner, precisely at a time when the international environment is shifting the centre of gravity in space from exploration towards sovereignty, resilience and security.

In this context, the national space strategy should incorporate a section on security, defence and resilience that is consistent with the objectives set out in the ESAN 2025, and which complements, amongst others, aspects relating to industry, science, exploration, technology, services, sustainability, regulation and international cooperation.

A section on security and defence should clearly express the need to protect national interests and space capabilities against threats of different origins and types by employing appropriate technologies, systems, and procedures to mitigate risks and ensure credible deterrence based on timely and accurate knowledge of the space environment.

Among the possible lines of action that should be considered in the future national space strategy, several are suggested that include specific objectives: enhancing situational awareness capabilities (SSA and SDA); actively and passively protecting and defending space infrastructure, its data, products and services against physical and electromagnetic threats; improving the space sector's resilience to cyber-attacks; driving the development of dual-use technologies that contribute to security and defence; strengthening cooperation in the field of space security and defence; and developing and testing mechanisms related to space alert protocols, including training in security and defence matters.

Conclusions

The 2025 National Aerospace Security Strategy formalises the recognition of outer space as a critical domain for national security, and incorporates a comprehensive approach that combines resilience, defence and international cooperation in line with European directives and the regulatory frameworks of NATO and the EU. It also analyses the dynamics of transformation in the space domain and defines strategic objectives; lines of action and measures aimed at protecting national interests.

The study of France and Germany's strategies highlights the attention and significant importance that security and defence issues have come to acquire, as well as the need to strengthen the resilience of space infrastructures, guarantee operational autonomy, enhance space surveillance, and develop capabilities for protection and response to threats.

In this context, Spain must evolve towards a national space strategy which, in addition to the priorities of industry, science, programmes and users, is coordinated with the lines of action set out in the ESAN 2025. A national space strategy that clearly expresses the need to protect and defend national interests, whilst acquiring and developing the capabilities required to provide a credible deterrent based on timely and adequate knowledge of the space environment.

To paraphrase the statements made on 26 March 2025 by the Spanish President regarding the EU's new geopolitical landscape and the conclusions of the European Council, as well as his letter of introduction to the ESAN 2025, the nature of contemporary conflicts has undergone a profound transformation, characterised by hybrid instruments of coercion, the blurring of the boundaries between peace and war, and the growing integration of traditional operational domains with new domains such as cyberspace, the electromagnetic spectrum and outer space.

This evolution of the strategic environment makes it essential to strengthen capabilities for anticipation, early warning, resilience and comprehensive response, as well as to develop doctrinal and legal frameworks that enable hybrid and technologically complex scenarios to be addressed effectively.

Ultimately, this is a transformation that requires a far-reaching strategic adaptation in order to safeguard national interests in an increasingly volatile and competitive environment, where dynamics are sometimes difficult to comprehend.

Chapter seven

The capabilities and potential of the national space industry to make decisive contributions to European defence in the space domain

Cecilia Hernández Rodríguez

Abstract

This chapter examines the evolution of the European Union's space policy from a mainly civilian approach toward an integrated dual-use paradigm, in which space has become a strategic domain for security and defence. Through a series of documents, the EU acknowledges the need to protect European space assets and to ensure strategic autonomy in an increasingly contested environment. In this context, Spain emerges as a relevant actor due to a dual institutional architecture, embodied in the Spanish Space Agency, which structurally integrates the civilian and military spheres. In parallel, transformations have taken place within the Armed Forces, including the rebranding of the 'Air Force' as the Air and Space Force and the establishment of the Spanish Space Command (MESPA). Spain contributes distinctive capabilities in space surveillance, secure satellite communications, geospatial intelligence, autonomous access to space, and a growing New Space ecosystem, thereby generating positive interdependencies within the European architecture. Spain's strategy is grounded in contributed sovereignty, aimed at occupying critical niches that strengthen European collective security. This model enables Spain to increase its political influence in European space governance, provided that it sustains investment in innovation, resilience, and operational capabilities.

Keywords

Spanish Space Agency, Strategic autonomy, Dual use, Tax sovereignty, Space domain.

Introduction

Understanding the evolution of the EU's space policy is essential for analysing national capabilities and their integration into the EU ecosystem. This contextualisation makes it possible to identify precisely which expectations and operational needs Spain can satisfy within the emerging European architecture.

During the first decades of the European project, the EU's space activities prioritised functional objectives linked to economic integration, namely the promotion of industrial growth, scientific and technological advancement and the consolidation of the single market. This institutional framework reflected the limits on competences set out in the Treaty of Lisbon (2007) and, at a deeper level, the political reluctance of Member States to transfer sovereign powers in the field of defence.

The result was the consolidation of a model of governance characterised by structural fragmentation, in which, whilst Brussels administered EU-wide civilian programmes developed with the technical capabilities and collaboration of the European Space Agency (ESA), a significant number of capabilities remained under national control and, with few exceptions, lacked formal coordination mechanisms that would allow for the exploitation of operational or industrial synergies. This functional separation between civil and military spheres, whilst politically understandable in the context of national sensitivities regarding sovereignty, gave rise to systemic difficulties that would prove unsustainable in the face of the transformation of the global strategic environment.

1 The evolution of the EU Space Policy: from a civilian paradigm to a dual approach

The publication of the Space Strategy for Europe in October 2016 marked a doctrinal turning point, initiating the transition from the model of civil-military separation towards an integrated paradigm based on the concept of dual use. This strategic document, driven politically by the Commissioner for the Internal Market and Industry, Elżbieta Bieńkowska, challenged the traditional compartmentalisations that had characterised European space governance. Her contribution went beyond mere rhetoric, as she managed to formally institutionalise a concept that had until then remained within the realm of technical discussion: the space-defence duality (Howorth, 2017). To this end, she proposed the formation of coalitions between industrial players, keen to maximise the return on investment in dual-use technologies, and medium-sized Member States lacking the capacity to develop space defence capabilities autonomously.

The central argument of this strategy was based on harnessing space for the benefit of the EU's economy, security and strategic autonomy, by consolidating key programmes such as Galileo and Copernicus and encouraging private investment on the premise of economic efficiency. Given that the majority of space technologies and infrastructure have inherently dual-use characteristics, the persistence of certain institutional silos was economically inefficient in an environment described by the Commission as 'becoming a more contested and challenged environment'[1].

For certain authors, the strategy advocated the systematic exploitation of synergies between the civil and defence fields, with the threefold aim of reducing costs, increasing resilience and improving operational efficiency. This argument, seemingly technical and grounded in criteria of economic rationality, masked a broader political ambition: to use the logic of the single market as a vehicle for gradual integration into the field of defence, an area traditionally beyond the scope of EU action (Fiott, 2018).

However, in order for this industrial vision to be translated into effective operational security capabilities, coordination with the European External Action Service (EEAS) was essential, whose Special Envoy for Space, Carine Claeys, played a vital supporting role. Whilst Bieńkowska articulated the economic rationale for dual-use, Claeys worked on designing the diplomatic architecture and response mechanisms necessary to protect EU assets from threats, in line with the EU Global Strategy (EEAS, 2016). This collaboration transformed operational technological capabilities into foreign policy tools, with programmes such as Galileo and Copernicus, which could serve not only to further economic competitiveness, but also to project influence in contexts of crisis and reduce strategic dependence on non-EU space powers (Aliberti, 2018).

Bieńkowska's proposal for a 'European Space Force', put forward during her speech at the 2019 EU Annual Space Policy

[1] In the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Space Strategy for Europe (COM, 2016: 705end). See: https://eur-lex.europa.eu/legal-content/ES/TXT/PDF/?uri=CELEX:52016DC0705

Conference in response to the announcement of the US Space Force, served as a significant catalyst despite not materialising institutionally. This initiative spurred the debate on the necessity for specific European operational structures for the space domain and encouraged dialogue on the conceptual bases that the EU High Representative for Foreign Affairs and Security Policy, Josep Borrell, and the EEAS would subsequently formalise (Bieńkowska, 2019).

Driven by this dual momentum, political and industrial on the one hand, and operational and diplomatic on the other, the EU's flagship programmes underwent a strategic reorientation. Copernicus and Galileo ceased to be viewed solely as commercial or scientific instruments and became part of the discourse on European strategic autonomy. A systematic assessment of their potential for sensitive applications was launched, particularly in border control and maritime surveillance, which led to a decision to strengthen their security requirements in order to provide robust services to security and defence entities (European Commission, 2016).

Furthermore, during the preparation stage and subsequent launch of the EU Space Programme, gaps were identified in the critical capabilities of Member States, which, acting individually, would be unable to meet their needs efficiently. In response, joint initiatives such as GOVSATCOM (Governmental Satellite Communications) were proposed, designed to guarantee reliable and secure satellite communications for government authorities, recognising the critical dependence of institutional missions on secure and resilient communication services.

The strengthening of the Space Surveillance and Tracking (SST) support programme was also included. Although it was designed in 2016 in response to the proliferation of orbital debris, this initiative has gradually evolved to become an essential sub-component of Space Situational Awareness (SSA). The aim is to be able to address hybrid threats ranging from cyberattacks targeting ground segments to disruptions caused by space weather. The latter are analysed by the Space Weather (SWE) sub-component.

This period validated the principle that EU instruments could legitimately support security and defence objectives, integrating the space domain as a cross-cutting enabler of European collective security.

1.1 The 'securitisation' of the space domain: from the Strategic Compass to the EU Space Strategy for Security and Defence (2022-2023)

The signing of the Strategic Compass in March 2022 by the twenty-seven EU Member States marks the formal culmination of this process of doctrinal transformation. In a geopolitical context that to a certain extent anticipated the imminent Russian invasion of Ukraine, the EU took the decisive step of formally recognising space as a 'strategic domain' under dispute (Council of the European Union, 2022). This act of official recognition constitutes the culmination of a process through which the space domain shifted from the technical-administrative sphere into the domain of 'high politics'. This qualitative leap is supported by the theory of multidimensional security, which argues that security must transcend the strictly political-military sphere to also integrate the economic, environmental and societal sectors (Buzan, Wæver and de Wilde, 1998; Borrell, 2022). It is precisely this conceptual basis that today legitimises the mobilisation of resources and extraordinary measures which, under normal political conditions, would have been met with significant institutional resistances.

This doctrinal redefinition did not occur in a strategic vacuum but was a response to external pressures calling for clarification of Europe's role in the domain. NATO had established a decisive precedent at the London Summit in December 2019, by declaring space to be its fifth operational domain, formally placing it on a par with the land, air, maritime and cyber domains (NATO, 2019b). This Atlantic decision presented the EU with a dilemma of strategic importance: given the Alliance's explicit militarisation of the domain, the EU faced the risk of being relegated to the subsidiary function of a provider of civilian data if it did not develop its own space security doctrine (Aliberti and Lisra, 2020).

The Strategic Compass responded to this challenge by incorporating space security as a *sine qua non* for European political resilience. Whilst the document solved this functional need, it also reflected the structural tensions inherent in the European defence project. On the one hand, the functional need to coordinate space capabilities in order to avoid redundancies and systemic vulnerabilities. On the other hand, the political reluctance of states with more advanced space sectors (such as France, Italy and Germany) to relinquish control over assets considered as an expression of national sovereignty. This tension was particularly evident in the debates on the governance of the Galileo PRS (Public Regulated Service), where France remained adamant about retaining national control over security modules and cryptographic keys, illustrating the limits of European integration in capabilities considered critical to national security.

The validation of this approach translated into two operational mandates with direct implications for Member States. The first involved the development of an EU space strategy for security and defence, designed to extend the tool driven by Special Envoy Carine Claeys to the space domain. The aim was to provide a collective response to hostile threats, such as denial of services or uncooperative manoeuvres in orbit, including a requirement to publish an annual report on space-related risks. Secondly, the document underlined the need to strengthen the EU's autonomous analysis capability, positioning the Satellite Centre (SatCen) in Torrejón de Ardoz as the cornerstone of European geospatial intelligence, acting as a critical provider for decision-making within the Common Security and Defence Policy (CSDP) (Council of the European Union, 2022).

The mandate for this action, one of the sixty actions established in the Strategic Compass, was implemented in March 2023 with the publication of the EU Space Strategy for Security and Defence (EUSSSD). This joint communication, presented by High Representative Borrell and the European Commission, definitively enshrined the convergence between space capabilities and defence objectives, establishing that autonomous, secure and resilient access to space is an indispensable condition for European strategic autonomy (EEAS and European Commission, 2023). Its adoption initiated a phase characterised by the need to translate abstract strategic principles into concrete regulatory instruments, tangible operational capabilities and effective mechanisms for industrial coordination.

Regulation (EU) 2021/696 on the EU Space Programme established the financial framework with a provision of EUR 14.88 billion for the period 2021-2027, of which approximately 442 million are specifically allocated to the GOVSATCOM secure government communications component and the SST sub-component of the SSA[2].

[2] Regulation (EU) 2021/696 of the European Parliament and of the Council, dated 28 April 2021 establishing the Union Space Programme. See: https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32021R0696

Between November 2023 and May 2025, the Council of the EU adopted a series of conclusions that progressively put this agenda into practice, covering its own Space Strategy for Security and Defence, space traffic management, the contribution of space to European competitiveness, and the use of space data for crisis management (Council of the EU, 2023a; 2023b; 2024; 2025). This accelerated regulatory production demonstrates the political will to transform the strategic vision into a functional institutional architecture, although questions remain regarding the funding mechanisms, the distribution of responsibilities with Member States, and the degree of operational integration that will be politically acceptable.

1.2 The shift in European institutions

In recent years, there has been a clear shift in the stance of European institutions, particularly the EU and the ESA, towards a much more explicit integration of the security and defence dimension into space policies and programmes. This shift has been emphasised by European political and institutional officials, including the European Commissioner for Defence and Space, Andrius Kubilius, who stated at the 17th European Space Conference in January 2025 that 'without space, there will be no defence readiness,' reinforcing its recognition as a critical domain for European security, resilience and strategic autonomy[3]. This approach reinforces the observation that Europe has fallen behind other powers in terms of space capabilities for government and defence use.

To address this shortfall, the European Commission and the ESA have, for the first time, aligned their space and defence agendas. At the ESA Council Meeting in Bremen in November 2025, decisions aimed at accelerating the development of priority space systems for the EU were approved, with the aim of supporting them through the next Multiannual Financial Framework from 2028 onwards.

In this context, the ESA presented the European Resilience from Space (ERS) programme, integrating advanced near-real-time Earth observation capabilities, resilient navigation in low orbit and secure government communications. It seeks to provide strategic

[3] See: https://www.swissinfo.ch/spa/comisario-de-defensa-de-ue:-no-podemos-dejar-el-espacio-en-manos-de-autoritarios-agresivos/88790493

intelligence capabilities, supported by existing assets such as major European programmes like Copernicus, Galileo and IRIS². For the first time, the ESA has received a clear mandate in the field of security and defence, stemming from a political resolution adopted by the heads of the Member States' ministries.

Within this new framework, Spain is playing a particularly significant role, contributing EUR 325 million through the expansion of the Spanish component of the Atlantic Constellation (ESCA+) to the ERS Earth Observation programme (ERSEO). It is also acquiring a strategic and leading position in key areas such as secure communications and navigation systems in low orbit, with contributions of EUR 140 and 110 million, respectively. This investment effort positions the Spanish industry and its capabilities as one of the pillars of the new European space security ecosystem. At the same time, the European Commission is proposing a substantial increase in investment in defence and space, alongside the deployment of initiatives such as the so-called 'European Space Shield,' aimed at protecting critical infrastructures and effectively integrating European space capabilities.

1.3 The window of opportunity for national contributions: implications for Spain

The evolutionary trajectory described has radically transformed the European space governance ecosystem. Treating space as a strategic security priority has not only legitimised the dual use of infrastructures previously regarded as exclusively civilian, but it has also given rise to a range of operational, technological and industrial needs that the EU is unable to satisfy without the active and coordinated contribution of its Member States. This dynamic creates a particularly significant window of opportunity for the EU's leading space powers, including Spain.

The space domain is one of the areas where the logic of European aggregation offers the greatest strategic value. High technological barriers to entry, prolonged development cycles and capital costs make it essential to adopt an architecture based on shared capabilities, which no Member State acting alone could build with comparable levels of efficiency. This logic is especially relevant for states the size of Spain, whose sovereign space capabilities, whilst significant, require strategic multipliers to project their influence sustainably in a domain where the major powers set the technological standards and the *de facto* rules of orbital behaviour (Moltz, 2019).

Europe is facing critical dependencies, highlighted by its dependence on critical electronic components manufactured outside of Europe (such as radiation-hardened processors, advanced infrared sensors and others), contested access to geostationary orbits (GEO), and vulnerabilities in the supply chain for critical materials, such as rare earths, which are essential for electric propulsion systems. Mitigating these gaps requires a coordinated response that goes beyond the individual capabilities of Member States.

That said, the mere existence of a European architecture does not automatically guarantee national influence over its design and governance. A State's capability to shape the European agenda depends critically, on the one hand, on its negotiating position within the EU, and on the other, on its ability to identify unmet operational needs by offering contributions which, in addition to fostering positive dependencies among other entities, ensure complementarity.

Spain finds itself in a favourable position, as the contribution and combination of national assets, the hosting of strategic assets such as the SATCEN, as well as our contribution to both contexts (national and European) with industrial capabilities, constitute a portfolio of capabilities that can translate into greater political weight in decision-making.

The key question is therefore not whether space is relevant to European defence, as this has already been decided in doctrine, but rather what specific capabilities Brussels requires, how national contributions can be coordinated within this renewed framework, and what role Spain can assume in this integrated security architecture. Answering these questions requires a detailed examination of both the list of operational needs that the EU has set out in its new space security and defence architecture, as well as the technological and industrial capabilities, both institutional and private, that Spain possesses to satisfy them, highlighting the unique assets that give it an advantage over other partners.

Spain's current position after the council meeting in November 2025 represents a moment of growth for the sector that must be capitalised on to strengthen its position in various negotiating forums, thereby allowing it to take the prominent place it deserves given its economic and technological importance.

2 Spanish institutional architecture: organisational capabilities

For decades, Spanish space policy was characterised by a marked institutional dispersion that limited both its strategic reach and its capability to engage effectively in international forums. National activities were distributed amongst multiple actors such as the National Institute for Aerospace Technology (INTA), the Centre for the Development of Industrial Technology (CDTI), various university research groups, and competences distributed amongst different ministries. There was no effective coordination architecture or unified strategic vision beyond some interministerial coordination forums, such as that created specifically for the national management of the Galileo GNSS.

This fragmentation gave rise to tangible costs, such as inefficiencies resulting from duplication of effort, constraints on the technological-industrial momentum needed to pursue strategies of economies of scale for the development of strategic space projects, as well as difficulties in coordinating national positions within European forums where capability priorities are defined and industrial responsibilities are allocated.

The absence of a single coordinating authority placed Spain at a comparative disadvantage compared to states with established space agencies capable of consolidating domestic demands, negotiating national positions and presenting themselves as sole representatives to European and international institutions. This structural weakness, which nevertheless led to several previous attempts to establish a public agency or organisation for the space sector, translated into years of Spanish participation in certain European programmes, characterised more by a reaction to other countries' initiatives than by the capability to shape agendas.

2.1 The creation of the Spanish Space Agency: institutionalisation of dual-use activities

The turning point in this process came with the enactment of Act 17/2022, dated 5 September. This legislation, which amends the 2011 Act on Science, Technology and Innovation, established the legal framework for the creation of the Spanish Space Agency (AEE)[4], as discussed in Chapter 6.

[4] Act 17/2022, dated 5 September, establishing the Spanish Space Agency (*BOE - Official State Gazette* - No. 214, 6 September 2022). See: https://www.boe.es/eli/es/l/2022/09/05/17

The AEE, instituted by Royal Decree 158/2023 and operational since April 2023, introduces a new perspective to the General State Administration due to its dual affiliation. According to Article 1.3 of its Statutes, 'The Agency is affiliated to the Ministry of Science and Innovation and the Ministry of Defence, within the scope of their respective competences, with the necessary coordination with the departments and bodies whose functions and competences are affected'[5]. This legal formula, institutionalised not as a programmatic aspiration but rather an organising principle, enables Spain to present itself overseas as a partner capable of systematically mobilising civil and military synergies.

This organic duality is reflected in practice in the composition of the Governing Council, the Agency's governing body. Whilst the presidency is held by the head of the MICIU, the Board establishes four vice-presidencies with the rank of Director-General, the first of which corresponds to the Ministry of Defence. This hierarchical structure confers greater institutional weight on the defence component of the AEE than other ministerial departments, reflecting the recognition of the central importance of security and defence considerations in national space policy.

This dual architecture is not accidental, but rather it responds to the doctrinal premise, fully aligned with the EUSSSD, that the sustainability of space capabilities depends on the systematic exploitation of synergies between the civil and military fields. This structural characteristic confers a comparative advantage on Spain within the European context, as whilst other Member States must negotiate certain inter-agency coordination on an *ad hoc* basis, the Spanish model institutionalises this duality, which facilitates the incorporation of dual-use elements from the organisational design stage and enables agile responses to requirements demanding civil-military integration (Ministry of Defence of Spain, 2023).

2.2 Functional mandate of the Spanish Space Agency

The AEE's strategic mandate is structured around four functional pillars, all of which have direct implications for Spain's contribution to European defence.

[5] Ministry of the Presidency, Parliamentary Relations and Democratic Memory (2023). Royal Decree 158/2023, dated 7 March, approving the Statute of the Spanish Space Agency (*BOE - Official State Gazette* - No. 57, 8 March 2023). See: https://www.boe.es/eli/es/rd/2023/03/07/158

- Coordination of space defence programmes. Article 5.b of its Statutes assigns it the coordination of space defence programmes. This competence is essential for advancing the Spanish model.
- Representation in European forums. The AEE coordinates the national position regarding the two pillars of European space: the EU Space Programme and the ESA. The capacity to coordinate a single national position, which brings together civil and defence requirements, maximises Spain's negotiating power and ensures consistency between technological investment and operational security needs.
- Promotion of the space industry ecosystem. The AEE is driving training within the sector through a range of measures, including the administration of competitive lines of funding for space projects, with a particular emphasis on supporting start-ups, SMEs and mid-cap companies, including New Space. This priority responds to the strategic necessity of democratising access to space through disruptive innovation and diversifying the industrial base beyond the traditional major integrators. The aim is to create a robust industrial framework that benefits and drives the entire sector, both for the private sector and for government space capabilities, including defence, by accelerating procurement cycles through the leveraging of commercial innovations (spin-in).
- Development of sovereign capabilities in critical segments. The AEE must coordinate national strategic programmes, paying special attention to their dual-use applications in line with the European industrial policy on technological autonomy. The aim is to mitigate critical dependencies identified in the 2023 Defence Industrial Strategy, guarantee national capacity for access to space for the rapid replacement of assets (Responsive Space), and ensure that critical components of defence systems are manufactured under national jurisdiction or that of allied countries.

2.3 The security and defence pillar: doctrinal and operational transformation

The Spanish capability to contribute effectively to European defence in the space domain does not only depend on its technological and industrial base, but also on the existence of military operational structures capable of generating, projecting and sustaining capabilities in highly complex scenarios.

Historically, despite placing great value on the development of government-controlled space capabilities, the prevailing trend in Spanish doctrine regarded space as a sanctuary where the Armed Forces acted exclusively as privileged users of services provided through various procurement models: public-private partnerships with the Ministry of Defence, supplied by third-party countries (as in the case of Earth observation) or through European programmes or contracted commercial assets.

This stance, consistent with a relatively benign space environment, is currently undergoing a strategic review, among other factors as a result of growing competition and congestion due to the proliferation of space capabilities, which in turn has led to a progressive proliferation of anti-satellite capabilities and the militarisation of the domain by state and non-state entities (Ministry of Defence of Spain, 2023).

The 2025 National Aerospace Security Strategy (ESAN) enshrines this doctrinal shift, explicitly recognising space as a contested operational domain in which Spain must exercise the greatest possible degree of sovereignty. The Armed Forces are no longer passive recipients but are now positioned as actors with a responsibility to exercise control, provide protection and, if necessary, respond to threats. Crucially, this doctrinal shift aligns Spain's position with European and Atlantic developments, where Member States aspiring to influence the definition of collective defence architectures must possess organic structural assets with their own operational capabilities, beyond merely developing their capabilities and accessing services (Department of National Security of Spain, 2025).

2.4 Operational structure of the Ministry of Defence

The first step towards the institutional implementation of this doctrinal transformation was taken through Royal Decree 524/2022, dated 27 June 2022, which was responsible for the renaming of the Air Force to the Air and Space Force. This reform represents the firm decision that contemporary space operations are inherently multi-domain. Air superiority, strategic projection and command and control depend critically on space assets, justifying their organic integration under a unified command capable of planning and executing coordinated operations across the aerospace continuum.

The Spanish operational architecture is based on a dual model that distinguishes between the conduct of operations (operational level) and the preparation of forces (generating level).

- Space Operations Command (MOESPA). As part of the joint operational structure under the Chief of the Defence Staff (JEMAD) as a component command, it constitutes the authority responsible for conducting ongoing presence, surveillance and deterrence (PVD) operations in the space domain. Its primary function is to guarantee freedom of action in outer space, encompassing both the protection of national assets and the contribution to multinational NATO and EU operations. It acts as an operational interconnection with the space commands of other allied countries.

- Space Command (MESPA). Organically part of the Air and Space Force, it is responsible for the operational preparation and direction of its space forces. Its functions encompass the training of specialist personnel, a critical asset in a domain where qualified human capital is in short supply at European level, the development of specific operational doctrine, infrastructure management and, fundamentally, the generation of space situational awareness, which constitutes the foundation of all operational action in the domain. It achieved Initial Operational Capability (IOC) in 2024 and plans to achieve full operational capability in 2027. Under its organisational authority are the Space Surveillance Operations Centre (COVE) and the Earth Observation Space Centre (CESAEROB).

This functional differentiation responds to a precise operational logic. Whilst the MOESPA, as the component command and operational authority, defines the effects to be produced in the space domain in support of joint operations, the MESPA, as the capability provider, determines how to generate these effects by providing operational forces and platforms.

Furthermore, in December 2023, the JEMAD appointed the General in charge of the MESPA as Commander of the Space Component Command. The MESPA thus serves as a key component of Spain's contribution to European rapid response architectures.

2.5 Bodies and agencies attached to the Secretary of State for Defence

Whilst the AEE is responsible for the overall national coordination of the space-related technological and industrial ecosystem, the ultimate responsibility for the assets required to provide space capabilities to the Armed Forces lies with the Ministry of Defence's procurement, operations and sustainment structures. Within these structures, those responsible for procurement on behalf of the Secretary of State for Defence operate through specialised executive bodies and agencies.

- The Directorate-General for Strategy and Innovation of the Defence Industry (DIGEID) assumes leadership of industrial and technological planning for Defence, with these competences separated from the Directorate-General for Armament and Materiel (DGAM) in order to raise its strategic profile. The DGAM, through its sub-directorates, focuses on directing the various strategies required to develop this planning. The Sub-Directorate-General for Planning, Technology and Innovation formulates the strategy for space defence research, development and innovation (R&D&I). Its role is to ensure that the national industrial base possesses the necessary critical technological capabilities before procurement programmes are initiated; it acts as a focal point for Spanish participation in EDA technology development programmes and also participates in Permanent Structured Cooperation (PESCO) projects. For its part, the Sub-Directorate for Strategy of the Defence Industry sets out this same strategy with the mission of driving the Spanish defence industry, its internationalisation and industrial cooperation.
- The DGAM focuses on the executive function of procurement and manages special modernisation programmes, which include the acquisition of space systems. Freed from strategic industrial planning, it focuses its work on the technical and administrative management of the systems' lifecycle, handling everything from the concept and viability proposal stages, through to the direct management of programmes to acquire space capabilities, supervising the execution of contracts, compliance with defined operational requirements and the necessary certifications for the production and operation stages of space assets, as well as their security prior to handover to the Armed Forces. In certain cases, the procurement

model includes the means for sustaining the systems in operational conditions throughout their entire life cycle, as is the case with SEOT Earth observation and SATCOM telecommunications systems.

- The Centre for Information and Communications Technology Systems (CESTIC) is responsible for the technical management of the SATCOM capacity provided by the DGAM, as well as for the secure provision of the SECOMSAT (Spanish Satellite Communications System) services to the Armed Forces. It also coordinates with the Cyberspace Command, which is responsible for receiving and prioritising requests, to grant authorised users access to satellite capabilities, and manage encrypted links, acting as a technical-organisational interface between satellite operators, whether civilian or military, and user units. Its experience in operating complex SATCOM networks and integrating them into multinational architectures positions it as a potential contributor to European initiatives for the management of aggregated government satellite services.
- The INTA is a dual-use asset that plays an essential role, exemplifying the hybrid nature of the Spanish space architecture. On the one hand, it acts as a technology centre supporting R&D&I for defence programmes, driving and developing critical technologies in propulsion, advanced materials, navigation systems, sensors and secure ground segments, amongst others. On the other hand, it provides testing and certification infrastructures that are accessible to both military and civilian programmes, whilst acting as a national reference centre with certification capabilities. In addition, it forms part of the national capacity for full satellite integration, alongside the industrial capabilities of companies in the sector.

  This duality institutionalises the principle that the separation between civilian and military activities in the space field is artificial and counterproductive. These capabilities serve both purposes equally, maximising the efficiency of public investment and generating positive externalities for the domestic private sector (INTA, 2023).

  For its part, the INTA's Space Security Centre focuses on the security of space projects and acts as the competent authority in this regard. Its specific functions include the competences assigned to it as the competent authority in: the Galileo Public Regulated Service (PRS), Competent PRS Authority (CPA); in secure government communications, Competent GOVSATCOM Authority (CGA); and in secure connectivity, Competent Secure Connectivity Authority (CSCA). In addition, it provides scientific-technological support to administrative bodies in GOVSATCOM, promoting R&D initiatives to improve industrial competitiveness (INTA, 2021).

3 Spanish technical and operational capabilities in the space domain

The robustness of Spain's new institutional architecture is supplemented by a range of technical and operational assets that position the country as a key player in European space security. Beyond administrative management, cutting-edge tools have been developed for the surveillance and control of the orbital environment, which are fundamental to the Union's strategic autonomy.

The COVE, a key component that has been integrated into the European Space Surveillance and Tracking Network (EU SST) since 2018, functions under the operational direction of the Space Command (MESPA). It combines the use of its own ground-based sensors with a high data processing capacity. Among its assets, the S3TSR (Spanish Space Surveillance and Tracking Radar) surveillance radar, located in Morón, stands out; it is capable of detecting objects measuring as little as 10 centimetres in low Earth orbit (LEO) at an altitude of up to 2,000 kilometres. Thanks to its advanced orbital analysis capabilities, the COVE generates what the national doctrine refers to as the 'Recognised Space Picture': a continuous, precise and useful understanding of the orbital environment that is essential for operational decision-making and the protection of space infrastructure.

According to data from the COVE Activities Report for 2023-2024 (Air and Space Force of Spain, 2024), the S3TSR carries out approximately fifteen thousand observations of objects in LEO per month, contributing more than 18% of the total observations of the EU SST consortium, making Spain the third-largest contributor in terms of data volume after France and Germany. This role encompasses the catalogue of objects in orbit, the prediction of conjunctions to avoid collisions (Spain issues between forty and fifty collision alerts per month to European operators), the detection of anomalous satellite manoeuvres, and the characterisation of space debris.

Spain’s contribution to the EU SST consortium is structural and qualitatively decisive. Spain not only provides a unique location on the southern flank of Europe, which is essential for monitoring the geostationary arc from low latitudes. The observation geometry from the Iberian Peninsula, between 36°N and 43°N, optimises the detection of GEO satellites in the Atlantic-European segment. In addition to operating first-class surveillance assets, Spain is a founding partner of the EU SST programme, for which the AEE coordinates the consortium that manages it, working alongside France to provide collision-avoidance services for more than six hundred registered satellites. This technical contribution grants influence over the consortium’s governance and decisions regarding the system’s future architecture.

Ultimately, the effectiveness of Space Domain Awareness (SDA) lies in the integration of civilian and military data. This institutional synergy is supported by key collaborative frameworks such as the convention between the Ministry of Defence and the Spanish Space Agency to coordinate surveillance activities in November 2025, and the protocol with the Ministry of Transport in September 2025, which facilitates access to data tracking from academic and commercial sources. This fusion of classified defence information with civilian data generates a more robust and comprehensive image of the orbital environment than that of any single agency acting in isolation, thereby establishing the Spanish model as a point of reference for other Member States.

3.1 Government satellite communications operations

In accordance with the requirements document prepared by the Communications Section of the Joint Cyberspace Command and sanctioned by the JEMAD, the SpainSat NG Programme was established to provide satellite communications (SATCOM) capabilities for the Armed Forces, although this function is not currently part of the MESPA’s IOC. On the basis of this capability, the SECOMSAT programme provides services to the Armed Forces, with their implementation falling to the Centre for Information and Communications Systems and Technologies (CESTIC).

The SpainSat NG programme forms the backbone of this future capability, although its deployment has undergone adjustments compared to the initial projections. The first satellite in the constellation, SpainSat NG-I, was placed into orbit on 30 January 2025. After successfully completing its In-Orbit Testing stage, it was declared operational in August 2025. Its twin, the SpainSat NG-II, was launched on 24 October 2025 but was struck by a particle measuring one millimetre, preventing it from entering operational service. The Ministry of Defence has since been working with INDRA and Hisdesat on the construction of a third satellite, known as SpainSat NG-III, which will facilitate the fulfilment of the commitments made regarding this constellation.

From a technical-operational perspective, the design of the SpainSat NG model represents a qualitative leap forward compared to the previous generation. It integrates payloads in the X-band, military Ka-band and UHF. It is equipped with active receiving and transmitting antennas in the X-band (electronically reconfigurable beam patterns in orbit), enabling flexible allocation of bandwidth and power across changing theatres of operations. Its most significant defensive characteristic is its advanced anti-jamming and geolocation capabilities, which are critical in contested electronic warfare environments. The system is operated by Hisdesat under a public-private collaboration model, whereby the Spanish Government retains an average of 70% of the total capacity for exclusive government use, whilst the remaining 30% is made available to government users from other Member States or allies, in order to recoup the investment (Hisdesat, 2025).

To mitigate the risks associated with a small national constellation (two satellites), Spain has strengthened its involvement in allied solutions. In particular, Spain's incorporation into the NSS6G (NATO SATCOM Services 6th Generation) memorandum in 2025 stands out, which enables the SpainSat NG capability to be made available to the Alliance. At the bilateral level, operational capacity-sharing agreements (pooling & sharing) remain in place, acting as redundancy mechanisms and ensuring interoperability. Under this scheme, Spain can relinquish X-band bandwidth allocations in exchange for guaranteed access to allied assets, creating a resilience network that no partner could achieve unilaterally.

3.2 Geospatial intelligence and Earth observation

Whilst operational exploitation of geospatial intelligence products falls to the Armed Forces Intelligence Centre (CIFAS), the definition of operational requirements for national Earth observation systems is coordinated between the MESPA and the CIFAS. This coordination covers both specific military requirements and those of a dual-use nature. Currently, the PAZ synthetic aperture radar satellite constitutes the Spain's primary sovereign asset. With regard to the optical spectrum, national capacity is based on bilateral agreements with France for the use and exploitation of the CSO (*Composante Spatiale Optique*) system. This infrastructure is supplemented by the procurement of images from commercial operators (sometimes national ones, such as Deimos2), access to global services, and participation in strategic programmes such as Copernicus Security Services and the future EU Satellite Imagery Programme.

The PAZ satellite has been operational since 2018 and has a service life extending until 2028-2030. It provides radar images that are independent of weather and lighting conditions, with resolutions of up to one metre in spot-light mode (target-focused imaging mode) and coverage of up to 300 kilometres in ScanSAR mode (wide-area scanning mode). In 2023, it captured more than eight thousand images, of which approximately 35% responded to requirements from government users (defence, security, civil protection) and 65% to civil and commercial applications. The system is operated by Hisdesat under a model similar to that of SpainSat NG. This capability, which is relatively scarce at European level (only Germany, with SAR-Lupe, and Italy, with COSMO-SkyMed, operate comparable defence radar constellations), confers the capacity to negotiate within the European geospatial intelligence (GEOINT) architecture on Spain.

Spain's readiness to share PAZ capacity with European partners within the framework of the Copernicus Emergency Management Service has fostered reciprocity, improving Spanish access to the capabilities of other Member States in areas where the Spanish system presents gaps. Through exchange agreements, Spain regularly gains access to high-resolution optical imagery from systems such as *Pléiades Neo* (from France, with a resolution of 30 centimetres) and CSG-2 (from Italy, with a resolution of 50 centimetres), supplementing its national capabilities with superior performance in the visible and infrared spectrum.

3.3 Rapid response capability and autonomous access

Beyond traditional platforms, by the end of 2025 Spain's strategic importance saw itself enhanced by the development of emerging New Space areas, introducing unprecedented resilience capabilities that will supplement the current national architecture.

In the field of Earth observation, the development of the Atlantic Constellation (in cooperation with Portugal) stands out within the framework of the Strategic Plan for Economic Recovery and Transformation (PERTE) applied to the aerospace field. This constellation of small satellites will provide a High Revisit Rate, operating at an optimal level. The contract for the manufacturing of the satellites for the Spanish component (ESCA) was signed in October 2025 with Open Cosmos[6], considering the deployment of eight optical microsatellites per country with a resolution of 3 to 5 metres and the capacity for daily revisit over priority areas of interest. The first deliveries are scheduled for 2026, with the project due to be completed by the end of 2027, in time for testing and launch preparations[7].

This capability will enable the generation of intelligence for near-permanent surveillance of areas of maritime and land-based interest, supplementing the high resolution of large-scale systems with the temporal persistence required to detect patterns of activity and movements of forces in near real time. ESCA will be significantly strengthened with the launch of ESCA+ as the Spanish cluster within the Earth Observation component of ESA's European Resilience System (ERS-EO)[8].

At the same time, a milestone in European strategic autonomy is taking shape: namely, the procurement of its own launch capability. The Miura 5 launcher from the Spanish company PLD Space is at an advanced stage of qualification and testing of its subsystems[9]. Its first launch is scheduled for 2026 from the European spaceport in Kourou, French Guiana. With the capacity to place up to 540 kg into sun-synchronous orbit (SSO at 500 kilometres) and up to 1080 kg into low equatorial orbit, the system is designed for on-demand commercial launches with reduced lead times. Although it does not compete in the heavy-lift segment of the Ariane 6, this capability places Spain in a vital strategic niche: Responsive Space operations.

[6] See: https://www.open-cosmos.com/news/open-cosmos-wins-the-spanish-atlantic-constellation

[7] For more information, see: https://www.esa.int/Newsroom/Press_Releases/Decisions_and_announcements_following_337th_ESA_Council

[8] See: https://www.ciencia.gob.es/va/Noticias/2025/octubre/morant-liderazgo-industria-espacial-espa-ola-520-millones-esa.html

[9] See: https://www.pldspace.com/en/news/pld-space-develops-miura-5-consolidates-europe-s-leadership-access.html

The development of a lightweight national launcher (a capability identified by the JEMAD, and the Space Command as a future tactical priority) would enable industrial production to be aligned with the rapid restoration of capabilities in the event of a degradation or attack on satellite infrastructure. This potential on-demand launch capability to replenish tactical assets (such as small communications or reconnaissance satellites in low orbit within weeks rather than years) constitutes a deterrent through resilience. To date, this operational flexibility has been absent from the list of capabilities of most European partners, giving Spain a potential role as a hub for the restoration of capabilities in crisis situations.

3.4 The Satellite Centre as a strategic asset on Spanish soil

The SatCen constitutes one of the EU's geostrategic assets of greatest political value to the European space security and defence architecture on Spanish soil. Established in 2002 as an intergovernmental body with the status of an EU agency, it provides geospatial intelligence products derived from satellite imagery to support decision-making within the framework of the CSDP, crisis management operations and the verification of international agreements.

In 2023, the SatCen produced more than 1200 geospatial intelligence reports for institutional users within the EU, the EEAS and the Member States, covering crisis areas such as Ukraine, the Sahel region, the Near East and the Horn of Africa. The products include analysis of damage caused by missile strikes on critical Ukrainian infrastructures, monitoring of military deployments in the Sahel region, assessment of refugee camps in humanitarian crises, and verification of compliance with arms embargoes through analysis of port and airport traffic. The Centre operates with an annual budget of approximately EUR 35 million as of 2024 and employs 140 staff members, of whom approximately 22% are Spanish nationals.

The location of the SatCen's headquarters on Spanish territory is not merely an administrative matter; rather, it places Spain in a privileged position to influence the development of the Union's space intelligence capabilities. Spain contributes approximately 8% of the budget (EUR 2.8 million per year). Although it is proportionally smaller than its weight in terms of GDP or population, this is largely compensated for by high-value contributions in kind. These include, in particular, the provision of secure infrastructures, physical security services, classified connectivity and preferential access to national capacities such as PAZ.

Despite receiving instructions directly from the EEAS, Spain's role as host country, combined with the institutional presence of highly qualified personnel within its structure, enables the country to influence the decisions made by the SatCen's Board of Directors, regarding its investment priorities, to facilitate coordination between national and European capabilities, and to position itself as a natural interlocutor in discussions on the future architecture of the EU's space intelligence.

3.5 The European GNSS Service Centre: Galileo in Spain

In the field of satellite navigation, Spain is home to the headquarters of the European Global Navigation Satellite Services Centre (GSC), the body responsible for managing the EU's GNSS. Located at the INTA facilities in Torrejón de Ardoz, this centre is an integral part of the European GNSS infrastructure and acts as the single interface between the Galileo system and the end users of the services. The Centre manages the Open Service (Galileo OS) and the Commercial Service (Galileo CS), which includes advanced features such as the High Accuracy Service (HAS) and security and trust mechanisms, such as the Navigation Message Authentication (OSNMA) and the Commercial Authentication Service (CAS).

Currently, the European GNSS Service Centre (GSC) is an accredited and fully operational centre within the framework of the Galileo system's global operations and is connected in real time to the ground segment. It is designed to be a centre of expertise, knowledge transfer and support for the development and evolution of value-added applications for the various sectors in which satellite navigation plays a significant role, such as transport. It plays an essential role in providing Galileo's high-accuracy and authentication services, whilst also offering other value-added services such as alerts, forecasts, system data and on-demand documentation, which are key to the development of applications across different user communities.

The GSC is constantly developing its activities and infrastructure to satisfy the demands of a growing user ecosystem. This capacity for adaptation is its main distinguishing feature and forms part of the Galileo Service Operator (GSOP) framework, which is the organisation or industrial consortium responsible for ensuring the technical exploitation and overall operational functioning of the entire system.

3.6 The Security Monitoring Centre: a key element for the EU

A critical strategic capability for the security of space systems is provided by the Galileo Security Monitoring Centre (GSMC), which is part of the Galileo infrastructure. It has two sites, one in Saint-Germain-en-Laye (France) and another in San Martín de la Vega (Spain), housed at the INTA facilities in La Marañosa (Madrid).

The GSMC is organised as a Security Operations Centre (SOC), overseeing and taking action in response to security and cyber-security threats and alerts, and in particular regarding the operational status of the Galileo system components. The aim of this monitoring is to detect accidental or deliberate security incidents that could cause a disruption to the programme's services. Furthermore, it is responsible for managing access to the PRS and guarantees that sensitive information relating to its use is managed and protected appropriately. It also provides knowledge and analysis regarding the security of the PRS and Galileo.

Within Europe, the Council is responsible for issuing instructions to the European Union Agency for the Space Programme (EUSPA) in the event of a threat to the security of the EU or its Member States, or in the event of serious damage to essential interests resulting from the deployment, functioning or use of the systems established, as well as the services provided under the European Space Programme. The GSMC is responsible for the application of these instructions.

For Spain, hosting this centre offers strategic positioning advantages, boosts the domestic industry's involvement in high value-added contracts and helps to contribute to consolidating the country's knowledge and technological capabilities in the field of space security.

4 Analysis of areas with potential to contribute to the European architecture

The transition from isolated technical capabilities to strategic influence in European governance requires identifying areas where national contributions generate distinctive value within the system of systems defined by the EUSSSD. In this model, a Member State's relevance does not stem from the aggregate volume of its assets, but from its capacity to provide functional nodes that close critical gaps in the collective architecture.

European experience in domains such as cyber defence and intelligence sharing suggests that influence within the EU's governance structures correlates with the provision of critical, non-duplicated capabilities that other actors structurally require. Spain is currently in a stage of institutional consolidation that enables it to identify which national assets respond to the European operational needs explicitly set out in recent strategic documents issued by the Council of the EU.

The following analysis examines four areas where the convergence of Spanish capabilities, geographical or industrial comparative advantages, and documented European requirements suggests opportunities for contributions of high strategic value.

4.1 Space surveillance and tracking: geometric complementarity on the Southern Flank

The very location of the Iberian Peninsula provides a unique topographical advantage: the aforementioned observation geometry of the geostationary arc from mid-low latitudes optimises the detection of GEO satellites in the Atlantic-European segment and allows for the coverage of approach vectors from the south (transfer or GTO orbits) which Central European sensors observe at sub-optimal elevation angles. The EU Council's conclusions of 23 May 2023 on the fair and sustainable use of space underline the need to improve European coverage in transfer orbits, a gap in capabilities that the Spanish sensor network directly addresses.

Since July 2023, the EU SST consortium has been operating in collaboration with EUSPA, which manages the service interaction point. The Spanish COVE has begun developing advanced analytical capabilities using algorithms for detecting orbital anomalies and integrating non-space data for the attribution of manoeuvres. The development of this function would position Spain as a provider of distinctive space intelligence, rather than merely raw data tracking.

4.2 Geospatial intelligence: the role of the host state of the SatCen

The SatCen's location in Torrejón gives it the capability to influence the development of European space intelligence capabilities. The conclusions of the EU Council on space capabilities for crisis management and security, adopted on 21 May 2025, recognise the need to advance towards the fusion of multi-domain intelligence, integrating GEOINT with SIGINT (signals intelligence), OSINT (open-source intelligence) and cyber intelligence

As the host country, it facilitates this transformation by providing expanded infrastructure and security frameworks that enable analysts from different domains to work together. This function positions Spain as a key enabler of the common European intelligence architecture. The life cycle of the PAZ satellite raises strategic decisions regarding the reconstitution of radar capabilities. Spain can offer its all-weather capabilities through reciprocal access agreements to partners' very high-resolution optical capabilities, optimising operational returns through functional complementarity.

4.3 Government communications: federated governance of GOVSATCOM

Spain has operationally validated pooling and sharing models for resources, enabling reciprocal access that enhances the resilience of all participants. The GOVSATCOM initiative tackles the challenge of aggregating diverse national capabilities without relinquishing control over sovereign assets. The Council's conclusions on the EU Space Strategy for Security and Defence, adopted on 14 November 2023, recognise this tension and propose models of 'voluntary federation,' which Spain exemplifies through its existing operational agreements[10].

Furthermore, Spain's accession to NATO's NSS6G memorandum in 2025 confirms the full interoperability of SpainSat NG with allied SATCOM capabilities. This milestone enables Spain to act as a bridge between the Atlantic and European defence frameworks, guaranteeing consistency in technical standards and operational procedures.

[10] See: 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/

4.4 The new space ecosystem and rapid response capabilities

The Spanish ecosystem has undergone a qualitative transition towards a diversified industrial base with capabilities in launchers, small satellite platforms and critical subsystems. Recent analyses by the European Space Policy Institute and work on democratising space access (Weinzierl and Sarang, 2021) identify this diversified ecosystem as a critical factor for European strategic autonomy in the New Space segment.

The Miura programme embodies the concept of Responsive Space, which involves the rapid reconstitution of capabilities through on-demand launching. Europe currently lacks this capability in the light-launcher segment, relying on institutional schedules that prioritise scientific missions over reactive defence needs. The Spanish proposal introduces a supplementary resilience vector that enables rapid tactical responses, whilst long-term cycles remain within traditional vectors.

The EU Council's conclusions of 23 May 2024 identify swift access to space as a critical capability gap[11]. Spain can lead European initiatives through framework contracts for reserved capacity for rapid response missions, with the capability to integrate small and medium-sized European satellites and lead in defining technical standards for distributed tactical constellations that ensure interoperability between national developments.

Conclusions

The evolution of European space policy from a civilian paradigm towards a dual security and defence approach, promoted since the 2022 Strategic Compass and with specific action towards the diplomatic and operational levels set out in the 2023 European Union Space Strategy for Security and Defence (EUSSSD), redefines the strategic framework for action both within the EU and in its Member States. Spain, by consolidating its dual institutional framework and developing distinct technical-operational capabilities, is positioning itself to play a key and significant role in this new landscape. An examination of the situation in Spain at the end of 2025 allows us to draw four strategic conclusions regarding its integration into the European space defence domain.

[11] See: https://www.consilium.europa.eu/media/fluagure/euco-conclusions-19122024-es.pdf

The AEE's architecture, with its simultaneous affiliation to the Ministries of Science and Defence, has proved to be an effective tool for the systematic exploitation of civil-military synergies. The available evidence shows that this structure makes it possible to maximise the return on public investment. Space surveillance infrastructures simultaneously serve both scientific requirements for characterising debris and operational needs for threat detection.

Technological developments in propulsion and communications funded by the AEE benefit both commercial applications and defence programmes. And the fusion of civilian and military data generates space intelligence and situational awareness products that surpass those that either field could produce on its own.

This model consolidates Spain's position as a European leader in both public-private governance and dual-use technology. Whilst other Member States must negotiate inter-agency coordination through *ad hoc* mechanisms, the Spanish model institutionalises this duality from the very operational design of its Agency, facilitating swift responses to European requirements that call for civil-military convergence, and which also enable the optimisation of limited resources in a domain characterised by high barriers to entry and lengthy development cycles.

For the model to be effective, it requires robust coordination and planning at a national level, as well as stable budgeting and funding mechanisms, with priorities aligned across scientific-technological and operational agendas.

An analysis of capabilities suggests that the most effective way for Spain to exert influence in European space governance is not through a model of self-sufficiency in capabilities, but rather through 'contributory sovereignty,' achieved by consolidating positions of excellence in critical functional niches where Spain offers unique value that cannot easily be replicated by other actors.

The areas identified (space-based surveillance of the southern flank, the operation of the SatCen as an intelligence fusion centre, validated and operationally tested models for sharing satellite communications capabilities and rapid launching) share a common feature: they generate positive interdependence.

European collective space security structurally benefits from these Spanish contributions, which translates into greater political capital in the decision-making forums where the future architecture of the domain is defined.

Nevertheless, this strategy of contributory sovereignty poses risks that must be managed. The dependence on external valuation of Spanish contributions means that changes in European priorities or the emergence of competing capabilities in other Member States could erode the strategic value of Spanish assets in certain contexts, which would require the redirection of developments in the appropriate direction.

The sustainability of Spain's influence and such a redirection of efforts will require continued investment in technological innovation and the renewal of capabilities, particularly in areas where the obsolescence cycle is accelerating.

This reasoning is especially relevant in the context of discussions regarding the funding of space defence capabilities under the European Multiannual Financial Framework after 2027. States that demonstrate tangible contributions to collective security would be better placed to influence the distribution of industrial responsibilities, the location of shared infrastructures and the definition of capability priorities.

The integration of Spain's New Space ecosystem into defence planning represents an opportunity to take a leading role in a field where European doctrines are currently being consolidated. The emerging capability for on-demand launches and the deployment of distributed constellations of small satellites align Spain with the most advanced space defence doctrines, which prioritise resilience through proliferation and rapid reconstitution over the passive protection of scarce strategic assets.

Spain has what it takes to lead the European response to this challenge, drawing on a strong industrial base in the New Space segment, infrastructure for testing and certification capabilities in line with recognised standards, a facilitating regulatory framework for commercial space operations, and the political will to integrate these capabilities into defence architectures.

Despite the opportunities identified, Spain also faces structural challenges that hinder its ability to fully leverage its potential contribution. Firstly, there is the budgetary shortfall, with space expenditure falling below the average for comparable states, which has limited the capacity to sustain investment across multiple areas simultaneously. On a positive note, following the ESA

Ministerial Council meeting in November 2025, Spain has become the fourth-largest contributor to the agency.

Furthermore, the critical dependence on European decisions regarding the funding of dual-use programmes raises questions about the sustainability of national capabilities in the face of potential delays or shifts in EU priorities. In addition, the shortage of qualified personnel in space engineering and related disciplines constitutes a bottleneck that no institutional architecture can resolve without long-term policies on education and talent attraction.

Recognising these limitations underlines the fact that Spain's establishment as a key player in the European space sector requires not only appropriate strategic decisions but also sustained political will and the capacity to mobilise resources in a context of intense budgetary competition with other defence priorities.

The decisions adopted during the next strategic cycle regarding capacity-building investment, sharing agreements and industrial leadership will be decisive for Spain's aspiration to establish itself as a key player in the European space domain. The institutional response coordinated since the creation of the AEE and the ongoing industrial programmes suggest that Spain has understood the nature of the challenge. The success of this endeavour will be measured not only by the weight of Spain's contributions in international forums, but also by the country's capability to translate its current comparative advantages into lasting structural interdependencies.

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