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ABSTRACT

Russia's invasion of Ukraine in 2022 was a watershed moment, underscoring the profound impact of modern warfare and civilian resilience on space infrastructures. Ukraine's reliance on Starlink for secure communications and commercial imagery providers such as Maxar, Planet, and ICEYE highlighted the central role of private actors. The Russian cyberattacks and jamming that followed laid bare systemic vulnerabilities, reaffirming outer space as a contested domain and placing strategic autonomy at the core of security debates. In this context, the thesis poses a crucial question: has the conflict compelled the European Union (EU) and the United States (U.S.) to rethink their strategies for achieving strategic autonomy in space? To answer this question, a threefold methodology is employed: review of policy and strategic documents, assessment of industrial and budgetary trajectories, and exogeographic mapping of space competition, providing a comparative basis for tracing discursive and material shifts. The findings suggest that the war acted as a critical juncture. In the U.S., techno-exceptionalism reinforced a 'privatized autonomy' model, embedding firms such as SpaceX within national defence structures. In the EU, securitization reframed space as a matter of sovereignty, legitimizing initiatives such as IRIS² and investments in launch capabilities. The net effect is a shift towards a more multipolar balance within ESA, with France remaining central in heavy-lift launches but counterbalanced by new entrants and the Commission's own framing of autonomy as a collective security imperative. At the global level, the persistence of grey zones in space governance has accelerated competition and entrenched outer space's strategic and military logic. Overall, the thesis contributes by refining the concept of strategic autonomy—anchored in sovereign launch capacity and Low Earth Orbit services—and by advancing exogeographic analysis, showing how terrestrial shocks reshape orbital dynamics and alter governance models.

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INTRODUCTION

In February 2022, Russia's full-scale invasion of Ukraine marked a watershed moment not only for European security but also for the geopolitics of outer space. For the first time in a conventional conflict, satellites and orbital services played a decisive role on the battlefield and in sustaining civilian resilience. The Ukrainian military relied heavily on commercial constellations such as SpaceX's *Starlink* for resilient connectivity. At the same time, private providers like Maxar, Planet, and ICEYE supplied high-resolution imagery and radar data that informed tactical operations and strategic communication. At the same time, satellite connectivity allowed hospitals, schools, and local administrations to remain functional in areas where terrestrial infrastructures had been destroyed, while Earth observation data supported humanitarian monitoring and the coordination of relief efforts. Russia's systematic targeting of satellites and ground infrastructures through jamming, cyberattacks, and interference exposed both the fragility of orbital systems and their centrality to modern warfare and societal continuity. These developments confirmed that outer space had become an indispensable, yet contested, security domain, placing questions of access, resilience, and autonomy at the forefront of international politics.

This thesis develops from the premise, widely recognized in academic literature, that outer space is a subsystem of the international system and is therefore shaped by the same geopolitical dynamics that structure terrestrial politics. In this perspective, geopolitical shocks such as the war in Ukraine reverberate into the geography of outer space itself, influencing patterns of orbital occupation, access to critical infrastructures, and the balance between public and private actors. By exposing vulnerabilities and dependencies, the war acted as a critical juncture that has produced a recalibration of strategic postures on both sides of the Atlantic concerning space strategic autonomy.

The extraordinary salience of space in Ukraine thus underscored a broader problem: both the European Union and the United States had entered the 2020s with ambitious space strategies but differing approaches to autonomy. At the same time, Washington increasingly leveraged commercial actors under technological primacy and warfighting readiness, while Brussels struggled to reconcile its fragmented governance structures, industrial inefficiencies, and reliance on foreign providers. The war revealed the vulnerabilities of both sides, prompting strategic reconsiderations that continue to shape trajectories in the pursuit of autonomy in space.

Academically, this work is situated at the crossroads of international security studies and exogeography. Strategic autonomy has been widely debated in the European Union literature, particularly in defence and digital policy, but its operational meaning in outer space remains underexplored. At the same time, scholars of exogeography have highlighted how the geography of outer space is not a neutral background but a domain increasingly structured by political, economic, and military competition. Recent work in critical security and science and technology studies further examines the securitization of orbital infrastructures, the rise of private actors, and the consequences of mega-constellations for congestion and governance. However, what has been insufficiently analyzed is how external shocks, such as the war in Ukraine, reshape the geography of outer space and the policy trajectories of space powers, compelling them to redefine their approaches to strategic autonomy.

This study addresses this gap by asking whether Russia's 2022 invasion of Ukraine has prompted the European Union and the United States to change their approaches to strategic autonomy in space. The thesis investigates whether, and in what ways, the war has generated policy change by examining pre-2022 postures and the subsequent trajectories. The analysis combines three dimensions: a policy analysis of official documents, strategies, and legislative acts; an investment analysis of budgetary allocations and industrial initiatives at EU, U.S., and global levels; and an exogeographic analysis of how orbital dynamics, congestion, and control are evolving in the course of the conflict. This threefold approach allows for tracing both discursive shifts, such as securitization and strategic framing, and material trends, such as industrial investments and orbital competition, thereby assessing how the pursuit of strategic autonomy has been recalibrated in response to the war.

The contribution of this work is twofold. First, it refines the concept of strategic autonomy by applying it to the space domain and operationalizing it through two industrial pillars: launch capabilities and low-Earth orbit services. Second, it advances the comparative study of U.S. and EU space governance by showing how external shocks interact with institutional logics, industrial structures, and geopolitical cultures to produce divergent, though interrelated, paths. In doing so, it speaks to broader debates on the resilience of liberal democracies in an era of great-power competition, the securitization of critical infrastructures, and the future of multilateralism in outer space governance.

The structure of the thesis reflects this logic. The first chapter lays the analytical foundations by offering an operational definition of strategic autonomy, outlining the EU and U.S. postures before 2022, and situating the war in Ukraine as a geopolitical shock with transformative implications for space policy. The second chapter develops the empirical analysis of post-2022 trajectories, examining how the war has intensified competition for orbital control, exacerbated orbital congestion, and reinforced the conception of outer space as fundamental for terrestrial power projection. The third chapter investigates the causal mechanisms of policy change, focusing on the securitization of space in the EU, techno-exceptionalism in the United States, and the grey areas of governance where public authority and private discretion overlap.

1. THE PURSUIT OF STRATEGIC AUTONOMY

1.1 OPERATIONAL DEFINITION OF STRATEGIC AUTONOMY

Strategic autonomy, in operational terms, refers to the capacity of a political entity—whether national, regional, or supranational—to independently access, operate, and maintain secure and reliable control over space-based infrastructure and services, without undue reliance on external actors[1]. This autonomy is most clearly articulated through two critical industrial sectors: launch systems (upstream) and Low Earth Orbit (LEO) operations (downstream). Together, these domains constitute the core infrastructure through which autonomy in outer space is exercised.

Maintaining control over launch capabilities and LEO-based services enables political entities to ensure uninterrupted access to space in peace and wartime[2]. As space-based services become increasingly integrated into global infrastructures, strategic autonomy in space is directly linked to terrestrial affairs. Thus, Space is not an end in itself, but a means to achieve Earth's economic, political, and military objectives. In this context, achieving strategic autonomy in outer space becomes key to effectively exercising space power and projecting influence across domains. As Bowen notes, outer space functions as a subsystem of the global system, reinforcing the notion that autonomy in space directly influences terrestrial outcomes[3].

Interest in strategic autonomy intensified after the Cold War, as the collapse of bipolarity left many states without the protective umbrella of their former superpower patrons or newly liberated from geopolitical constraints. This transition facilitated the emergence of what scholars call the New Space Age, characterized by reduced costs

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[1] Helwig, N. and Sinkkonen, V., 2022. *Strategic Autonomy and the EU as a Global Actor: The Evolution, Debate and Theory of a Contested Term*. Helsinki: Finnish Institute of International Affairs (FIIA), pp. 2-3;

[2] Klimburg-Witjes, N., 2023. *A Rocket to Protect? Sociotechnical Imaginaries of Strategic Autonomy in Controversies About the European Rocket Program*. *Geopolitics*, 29(3), pp. 823-824;

[3] Bleddyn E. Bowen. Spacepower and Space Warfare" The Continuation of Terran Politics by Other Means. Ph.D. Department of International Politics Aberystwyth University. Cymru. December 2015, p. 205;

due to commercialization, economies of scale, and the significant involvement of private actors. In addition, some scholars talk about a New Space Age 2.0, in which costs are further reduced and critical technologies are transferred to new countries, previously not involved in the space arena[4]. Only a handful of countries had orbital access during the New Space Age. By contrast, in the Second New Space Age, many Global South nations now operate or participate in space missions, narrowing the divide with industrialized powers. In addition to the fact that as of today, 105 states operate a satellite, demonstrating a steep rise since around 2012 (~100% increase)[5].

Given the deepening embeddedness of space services in modern societies—spanning civilian, commercial, and particularly military sectors—the stakes of controlling Earth's orbit have significantly risen[6]. Consequently, pursuing independent launch capabilities and sovereign access to LEO is fundamentally driven by terrestrial political, economic, and security considerations.

The most fundamental dimension of strategic autonomy is unrestricted access to space, and it has long been recognized as such by the literature[7]. This dimension encompasses comprehensive control over launch vehicle development, management of launch site infrastructure, logistical scheduling, mission integration processes, and mastery of propulsion technologies. Here, the focus is on the downstream sector of the space industry. Independent launch capabilities are already fundamental technological enablers, without which there is no space policy[8].

Earth geography is essential in this dimension, as launch capability depends significantly on Earth's geographic factors. Ideal launch locations are near the equator,

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[4] Wharton Staff, Why big business is making a giant leap into space. Knowledge at wharton: Estimates suggest that the global space industry will be worth more than $1 trillion by 2040, a 300% increase from the current value, with a commensurate increase in the number of satellites in space, launches, and exploration;
[5] OECD (2024) *Space economy investment trends: OECD insights for attracting high-quality funding*, OECD Science, Technology and Industry Policy Papers, No. 166;
[6] Del Canto Viterale, F., 2023. *Transitioning to a New Space Age in the 21st Century: A Systemic-Level Approach – Study Guide*. Systems, 11(5), pp. 7-10;
[7] Klimburg-Witjes, N., 2023. *A Rocket to Protect? Sociotechnical Imaginaries of Strategic Autonomy in Controversies About the European Rocket Program*. *Geopolitics*, 29(3), pp. 823-824;
[8] Orlova, A., Nogueira, R. & Chimenti, P., 2020. *The Present and Future of the Space Sector: A Business Ecosystem Approach*. *Space Policy*, 52, pp. 3-4;

where Earth's rotation provides additional velocity to launch vehicles (approximately 1,670 kilometres per hour). Equatorial launches minimize the need for orbital transfer manoeuvres, thus simplifying mission design and reducing fuel requirements. Major launch sites, such as NASA's Cape Canaveral, ESA's site in Kourou (French Guiana), China's Hainan Island, and India's Satish Dhawan Space Centre in Sriharikota, are strategically positioned near the equator, typically adjacent to the sea or in sparsely populated regions to enhance safety and avoid congested airspace. Nevertheless, geopolitical and settlement factors can impose specific launch constraints. Israel, for instance, must launch satellites westward—against Earth's rotation—to avoid territories with which it has strained relations, forcing technical compromises and restricting payload size[9]. Similarly, India's launches from Sriharikota must incorporate "dog-leg" manoeuvres to avoid densely populated areas like Sri Lanka[10].

Today, the launcher sector is recognized as the backbone of the satellite industry, producing incredible profits that have attracted new private entities[11]. For example, in 2021, total private investment in the space economy reached ~ $362 billion, of which 11.5% (~ $41.6 billion) went into launch-specific services[12]. In addition, since 2000, nearly 2,000 private space firms collectively raised ~ $300 billion via private equity and venture capital as of 2022[13]. The launcher sector has undergone a revolution in recent years thanks to reusable rocketry and increased competition. In 2024, there were 259 orbital launches globally, a record number, with commercial launch revenue rising to $9.3 billion (a 30% jump from 2023). This surge is attributable primarily to SpaceX's high-cadence operations: out of 145 U.S. orbital launches in 2024, SpaceX conducted 138 (95%) with its Falcon 9/Heavy rockets and Starship test flights[14]. The U.S. now accounts for ~65% of global launch revenue, reflecting its dominance in commercial

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11 Melamed, A., Rao, A., de Rohan Willner, O. and Kreps, S., 2024.cGoing to outer space with new space: The rise and consequences of evolving public-private partnerships. *Space Policy*, 68, p. 2;

12 Semanik, M. and Crotty, P., 2023. *U.S. private space launch industry is out of this world*. U.S. International Trade Commission, Executive Briefings on Trade, November;

13 Guha, O., Collins, J. and Tan, R. (2024) *Right Relationship Between Government and Industry*, Paper presented at the *Space Policy Symposium 2024,* pp. 3-6;

14 Kuhr, J. (2025) '2024 orbital launch attempts by country', *Analysis – Launch*, Payload Space, 3 January;

launch capacity. Other countries are also active: China performed 68 launches in 2024 (slightly up from 67 in 2023), using mainly Long March rockets and an increasing number of commercial small launchers. Russia had about 21 launches in 2024, while Europe struggled with only three launches (due to the Ariane 5 retirement and delays in Ariane 6)[15]. Emerging players like India (5 launches in 2024) and startups in New Zealand (Rocket Lab's Electron, 13 launches in 2024) contribute to a more diversified launch market[16]. Notably, ~70% of global launches in 2024 were commercially procured (not solely government missions), up from 55% in 2022[17], indicating the growing role of the private sector in launch demand.

Notwithstanding these, the commercial sector involvement has not reduced global asymmetries concerning launch capabilities[18]. Only a handful of States possess fully indigenous launch capabilities, with functioning rocket systems able to place payloads into orbit. These include the United States, Russia, China, India, Japan, Iran, North Korea, Israel, South Korea[19], and, more recently, also the European Union (EU), thanks to the successful launch of its heavy-lift rocket Ariane 6, each varying in the maturity and reliability of their launch systems[20]. In contrast, 96 countries operate or own space-based assets, such as telecommunications, navigation, weather, and reconnaissance satellites, yet must depend on the launch infrastructures of a few technologically advanced states[21]. This structural dependency introduces strategic dependencies and vulnerabilities, especially for states seeking to protect sensitive information, national security, or commercial technologies[22].

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[15] Kuhr, J. (2025) '2024 orbital launch attempts by country', *Analysis – Launch*, Payload Space, 3 January;
[16] McDowell, J. (2025) *Space Activities in 2024* (Rev. 1.4, 24 January 2025);
[17] Kuhr, J. (2025) '2024 orbital launch attempts by country', *Analysis – Launch*, Payload Space, 3 January;
[18] Melamed, A., Rao, A., de Rohan Willner, O. and Kreps, S., 2024.cGoing to outer space with new space: The rise and consequences of evolving public-private partnerships. *Space Policy*, 68, p. 2;
[19] Rementeria, S., 2022. *Power dynamics in the age of space commercialisation*. *Space Policy*, 60, p. 6;
[20] European Space Agency (ESA). (2024) *Europe's new Ariane 6 rocket powers into space*. ESA News, No. 36–2024, 9 July: the launch occured on March 6, 2025;
[21] Del Canto Viterale, F., 2023. *Transitioning to a New Space Age in the 21st Century: A Systemic-Level Approach – Study Guide*. Systems, 11(5), p. 31;
[22] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 847;

Even though strategic autonomy entails unrestricted access to space, the concept does not apply to outer space as a whole. Technical restrictions reduce the concept's applicability not only to the whole solar system but to the orbits surrounding Earth, which, according to some scholars, enter de facto into the geography of Earth[23]. As such, not every object launched into space or orbit has the same strategic value. Satellites serve different earthly purposes, and the choice of their orbital regime depends largely on exo-geographic factors specific to each orbital environment.

Low Earth Orbit (LEO) is the most populated and operationally active orbital regime, with altitudes ranging from approximately 100 to 1,920 kilometers above Earth's surface. This orbit remains the most important and the focus of the analysis regarding strategic autonomy, as it has witnessed an unprecedented surge in satellite deployments, primarily due to commercial broadband mega constellations. According to OECD and market data, the LEO satellite market is projected to expand from USD 197.1 billion in 2025 to USD 304.7 billion by 2030, at a compound annual growth rate (CAGR) of 9.1%. The LEO communication segment alone was valued at USD 10.67 billion in 2024 and is expected to reach around USD 11.05 billion in 2025 (CAGR ~3.6%). Researchers have highlighted that most small satellites in LEO are primarily dedicated to Earth observation and remote sensing (51%), followed by communications (21%) and scientific/experimental missions. These satellites serve a mix of civil, military, and dual-use purposes. The low latency and high resolution enabled by proximity to Earth make LEO ideal for imaging, tactical communications, reconnaissance and Internet of Things (IoT) systems. However, its lower altitudes mean that satellites are affected by atmospheric drag, requiring reboost manoeuvres or frequent replacement. At the same time, it means that satellites in LEO complete a full revolution around Earth in approximately 90 to 128 minutes, depending on the altitude. This short orbital period enables high revisit rates, making LEO ideal for Earth observation and rapid-response communications. Though it also requires larger fleets

[23] Dunnett, O. (2023) *The spaces of outer space.* In: Salazar, J.F. & Gorman, A. (eds.) *The Routledge handbook of social studies of outer space*. London & New York: Routledge, pp. 89–90;

of satellites, posing a significant problem to orbital congestion. In fact, LEO contains nearly 80% of all tracked objects while occupying only about 0.3% of near-Earth volume, making it the densest region for orbiting assets[24]. Certain Low Earth Orbit (LEO) satellites are positioned to travel over or near both the North and South Poles during each orbit. This specific type of trajectory, characterized by a steep inclination and low altitude, is referred to as a polar orbit. Because Earth rotates beneath these satellites, each orbit allows them to scan a different longitudinal section of the planet. As a result, a satellite in a polar orbit can potentially observe every location on Earth twice within a 24-hour period.

From a strategic standpoint, LEO is becoming critical for real-time battlefield intelligence, broadband communications, and orbital defense[25]. In addition, LEO is now the prioritized layer for future missile tracking and tactical command architectures. All these taken together make LEO fundamental in achieving strategic autonomy in space.

Other relevant strategic orbits are: the Medium Earth Orbit, the Geosynchronous Earth Orbit, the Highly Elliptical Orbit and Sun-Synchronous Orbits. Medium Earth Orbit (MEO) spans altitudes from approximately 1,920 to 35,680 kilometres and features orbital periods of roughly 4 to 12 hours, with navigation satellites typically orbiting every 12 hours. Although it hosts fewer commercial missions than LEO or GEO due to its high-radiation environment, MEO is strategically significant. It is home to all major Global Navigation Satellite Systems (GNSS)[26], providing precise positioning services for civilian and military use worldwide. Strategically, MEO satellites necessitate fewer satellites with high-coverage navigation capabilities than LEO, enabling a broad geographic reach.

[24] Zhang, J., Cai, Y., Xue, C., Xue, Z. and Cai, H. (2022) 'LEO mega constellations: Review of development, impact, surveillance, and governance', *Space: Science & Technology*, vol. 2022, PP. 3-5;
[25] As demonstrated by U.S. and EU plans to integrate commercial LEO constellations into military architectures (e.g., Starlink and IRIS^2), in chapter 2;
[26] Including the U.S. GPS (31 operational satellites at ~20,200 km altitude), EU's Galileo, Russia's GLONASS, and China's BeiDou constellations;

Geostationary Earth Orbit (GEO), located approximately 35,786 kilometres above the equator, allows satellites to remain stationary relative to a fixed point on Earth, thus completing an orbit in 24 hours. This unique characteristic makes GEO ideal for global communications, continuous weather monitoring, and high-bandwidth broadcasting; as such, it serves as the backbone of global telecommunications[27] and strategic defence infrastructure[28]. While GEO offers excellent coverage and minimal station-keeping, it presents high deployment costs due to the distance, larger satellite mass, and complex propulsion requirements. Nevertheless, GEO remains the preferred domain for national security communications and serves as the primary orbit for many high-value, long-lifespan assets (often 15+ years).

Highly Elliptical Orbits (HEO), including Molniya and Tundra types, feature elongated trajectories that allow satellites to dwell over high-latitude regions—providing persistent coverage where GEO is less effective. These orbits are used primarily for military communications and early warning systems. For example, the U.S. SBIRS constellation includes HEO sensors to monitor polar regions and detect missile launches. On the civil side, HEO offers niche applications in Arctic communications and high-latitude weather tracking. Finally, Sun-Synchronous Orbits (SSO) are a specialized form of polar orbit within LEO, typically ranging from 600 to 800 kilometres with inclinations around 98°. These orbits maintain consistent solar illumination, making them optimal for Earth observation, environmental monitoring, and dual-use intelligence missions. Civil space agencies and defence ministries heavily use SSO for imaging, mapping, and reconnaissance satellites. HEO and SSO reflect the strategic diversification of orbital resources, providing tailored coverage and timing benefits. Their specialized nature means they are limited in volume but high in value—central to states seeking domain awareness in polar or sunlit conditions.

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[27] GEO satellites are widely used for civilian TV broadcasting, high-throughput satellite (HTS) internet backbones, and national meteorological services;

[28] According to the U.S. Government Accountability Office (GAO), over 85% of the U.S. Department of Defense's commercial satellite communication (SATCOM) capacity is sourced from GEO assets through the Commercial Satellite Communications Office (CSCO). In the military domain, systems like the U.S. Space-Based Infrared System (SBIRS) utilize GEO for missile warning, space surveillance, and secure strategic communications;

As such, orbital space has emerged as a fiercely contested, militarized arena in which the ability to place, shield, and—when required—disrupt satellite constellations now serves as a critical barometer of national power and strategic autonomy. Scholars have long recognized this strategic dimension, drawing frequent parallels to the air and maritime domains. Expanding on the maritime analogy, Bleddyn Bowen describes low and medium Earth orbits as a "celestial littoral," crowded "space coasts" traced by U.S. GPS, DSP, and Keyhole satellites or by China's BeiDou and Yaogan constellations—regions that must remain open for friendly use and, when necessary, be denied to adversaries[29]. John J. Klein pushes the comparison further with his concept of Celestial Lines of Communication (CLOCs), reimagining sea lanes as orbital pathways that carry electromagnetic cargo—data streams, timing signals, and command messages—whose protection lies at the heart of space strategy and any future space conflict[30]. However, as Bowen underscores, "command of space" is inevitably temporary: satellites are in constant motion, and control can be exerted only over specific orbit segments for limited time windows, and space power ultimately supports terrestrial theatres rather than replacing them. Space is also often described as the "ultimate high ground," a phrase popularized by U.S. President Donald Trump in 2019 and echoed in Indian military literature. This comparison captures satellites' unrivalled vantage point for observing Earth—but it can be misleading. Unlike a hilltop on land, an orbital position offers no natural cover[31]: satellites cannot dig trenches or hide behind terrain, and once an adversary has sufficient space situational awareness (SSA) and offensive reach, they remain exposed[32]. Kinetic attacks such as direct-ascent anti-satellite (ASAT) missiles can shatter vulnerable low-Earth orbit craft, yet the debris they create threatens friend and foe alike. In this regard, non-kinetic tools, electronic jamming, cyber intrusions, directed-energy weapons, and discreet rendezvous-and-proximity

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[29] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, pp. 15-16;
[30] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, pp. 17-18;
[31] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, pp. 18-19;
[32] Küsters, A., Nolen, N. & Stockebrandt, P., 2023. *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 6-8;

operations are far more attractive. These vulnerabilities set space systems apart from terrestrial and aerial platforms and shape every contest for orbital command.

Space control hinges on three interlocking functions within this environment: assured use, denial, and situational awareness. Assured use depends on deploying hardened, proliferated, or manoeuvrable satellite constellations supported by resilient ground infrastructure and secure communication uplinks. On the other hand, denial involves a broad suite of capabilities—from kinetic interceptors and co-orbital vehicles to directed-energy beams, jamming, spoofing, and cyber operations—that can degrade or disable adversary systems. These are timed and targeted through highly granular space situational awareness, which minimizes the risk of collateral damage and allows for calibrated responses[33].

These same capabilities form the backbone of deterrence in the orbital domain. Deterrence functions along two axes: denial and punishment. Denial-based deterrence aims to convince adversaries that any attempt to disable or interfere with space assets would be too complex, costly, or uncertain to succeed. This is achieved through redundancy, mobility, and technological opacity—for instance, satellites that appear commercial or masquerade as debris or are miniaturized to the point of near-invisibility. A distributed architecture of orbital and terrestrial nodes ensures that even successful strikes cannot eliminate functionality, allowing mission continuity under attack. Punishment-based deterrence relies instead on the credible threat of retaliation. In space, where open conflict risks cascading debris and global disruption, punishment may not always be symmetric or confined to orbit. It can include retaliatory actions through terrestrial or cyber domains and economic, diplomatic, or strategic measures that increase the cost of aggression far beyond the original gain. Crucially, the credibility of both denial and punishment strategies is amplified by visible resilience. The ability to rapidly reconstitute lost capability, maintain continuity of service through redundant systems, and coordinate with allies for data sharing and orbital monitoring

[33] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, p. 4;

sends a powerful message: orbital dominance cannot be secured through a single blow[34].

Furthermore, deterrence in space increasingly acquires a collective dimension. Multinational coalitions that pool space situational awareness and debris mitigation resources—often operating through joint command centres or cooperative monitoring networks—transform national capabilities into a shared security infrastructure. This interdependence multiplies deterrent strength and signals that any attempt to seize, disable, or sabotage a rival's "space coast" would destabilize the broader orbital commons, triggering diplomatic backlash and reputational costs that extend well beyond the celestial shoreline.

Yet space remains a domain where the line between deterrence and provocation is perilously thin. As military capabilities grow more dual-use and attack attribution becomes more difficult, the maintenance of deterrence will depend not only on superior technology but also on strategic clarity, disciplined signaling, and sustained international engagement. In the absence of natural cover or neutral ground, deterrence in space becomes the active construction of an environment where aggression is complex and ultimately self-defeating.

[34] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, p. 4;

1.2. THE EU AND US SPACE STRATEGY

The United States and the European Union share some structural similarities in their approach to Outer Space: both operate within liberal democratic systems, rely on market economies, and increasingly integrate private actors into the space sector. This market-driven orientation contrasts sharply with state-capitalist models such as China's, where the government maintains pervasive control over strategic industries—even as private firms proliferate—ensuring that critical infrastructure remains subordinated to national objectives. In liberal systems, the private sector plays a dual role: reducing public costs and driving innovation. The result is an unprecedented wave of technological progress—especially in launch systems and LEO services—though at the expense of loosening direct state control over assets vital for sovereignty and security. Some scholars[35] argue that the Western approach uses private entities as indirect geoeconomic instruments within a liberal rules-based framework, relying on incentives and regulatory stability rather than state ownership or coercion. In this way, the US and EU seek to embed space governance in a global liberal order that aligns with their strategic and economic interests, without sacrificing the flexibility and vitality of private initiatives. Conversely, China leverages direct state intervention, financing, and political control, prioritizing rapid capability growth over entrepreneurial innovation—a model that further stresses the role of private actors as foreign policy tools[36]. Notwithstanding this, the US and EU models diverge profoundly in their historical trajectories and strategic cultures, mainly in how they view outer space as a strategic arena and deal with increased geopolitical competition and security concerns.

[35] Doboš, B., 2022. *Tortoise the titan: Private entities as geoeconomic tools in outer space*. *Space Policy*, 60, p. 3;
[36] Doboš, B., 2022. *Tortoise the titan: Private entities as geoeconomic tools in outer space*. *Space Policy*, 60, p. 6;

1.2.1 THE US STRATEGY

The United States' model of space governance was inaugurated by the National Aeronautics and Space Act of 1958[37]. This foundational legislation established NASA as a civilian agency responsible for scientific research, space exploration, and technological development, distinct from the military sector, whose space-related functions were delegated to the Department of Defense (DoD) and, over time, to specialized entities such as the US Space Command, the US Space Force, and the National Reconnaissance Office (NRO). This bifurcated architecture—dividing civilian and military mandates—was subsequently reinforced through successive legislative acts, including the Commercial Space Launch Act of 1984, which introduced a legal basis for private launch services, and the NASA Authorisation Act of 2005, which expanded non-NASA use of the International Space Station through the creation of the ISS National Laboratory.

The United States has historically conceived outer space through a security-centric lens, rooted in Cold War logics of deterrence and military preeminence[38]. From the outset, Washington's approach has prioritized orbital dominance and the integration of defence imperatives into its space posture. Unlike the European notion of strategic autonomy, which emphasizes independent access and technological sovereignty, the American understanding has centered on maintaining superiority over adversaries—initially the Soviet Union, and now increasingly China. This logic culminated in establishing the US Space Force in 2019, institutionalizing space as a distinct military domain. The US Space Force Doctrine underscores that spacepower is foundational to deterrence and the operational effectiveness of the Joint Force, framing space superiority as essential for freedom of action across all warfighting domains. US strategic planning categorizes space confrontation across three operational arenas: orbital warfare, electromagnetic warfare, and cyberspace warfare, each involving both

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[37] United States Congress, 1958. *National Aeronautics and Space Act of 1958*, Pub.L. 85–568, 72 Stat. 426, enacted July 29, 1958. Washington, D.C.: U.S. Government Printing Office.

[38] Brandenburg, M. & Lieberman, S., 2022. *Critical Spaces: European and U.S. Institutions for Outer Space*. *Astropolitics*, 20(1), pp. 105-108;

defensive and offensive tactics. These include orbital strikes, jamming, cyberattacks, and system hardening. In this context, the United States' counterspace arsenal spans a broad spectrum of capabilities, encompassing both kinetic methods—such as anti-satellite missiles—and non-kinetic tools, including directed-energy weapons, orbital interceptor satellites, cyber operations, and satellite spoofing technologies, reflecting a sophisticated and assertive effort to preserve military superiority in the space domain.

Over the past two decades, the US institutional framework for space activities has undergone a structural transformation, particularly in the launching and Low Earth Orbit (LEO) services sectors, in order to embrace the new transformation in the space sector and to maintain its strategic dominance with global adversaries (as China)[39]. In this regard, the launching sector has shifted from a procurement model dominated by cost-plus contracts with legacy aerospace contractors to a service-based regime centred on fixed-price, milestone-driven agreements. Programs such as the Commercial Orbital Transportation Services (COTS) and the Commercial Crew Program (CCP) were instrumental in institutionalizing a new procurement paradigm in the US space sector—one that strategically reallocated development risks to the private sector while offering the prospect of long-term service contracts as an incentive for innovation and capital investment. These initiatives marked a decisive departure from the traditional cost-plus contracting regime that had long characterized NASA's relationship with legacy aerospace firms. Instead, COTS and CCP embraced a milestone-based, fixed-price procurement framework that rewarded performance, aligning private financial incentives with public policy objectives[40].

The COTS program, initiated in 2006, was explicitly designed to stimulate the development of commercial cargo transport capabilities to service the International Space Station (ISS) following the retirement of the Space Shuttle. By inviting private companies to propose innovative solutions for orbital logistics and tying public funding

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[39] European Space Policy Institute (ESPI), 2020. *ESPI Report 75 – European Space Strategy in a Global Context – Full Report*. Vienna: ESPI, p. 20;

[40] Melamed, A., Rao, A., de Rohan Willner, O. and Kreps, S., 2024. Going to outer space with new space: The rise and consequences of evolving public-private partnerships. *Space Policy*, 68, p. 6;

to specific technical milestones rather than reimbursable expenditures, COTS shifted much of the technical and financial risk to participating firms. This approach enabled the emergence of SpaceX and Orbital Sciences (now part of Northrop Grumman) as viable providers of space launch services. Notably, NASA's agreement with SpaceX under COTS required only $396 million in public funding, compared to the estimated $3–4 billion it would have cost to develop a similar capability in-house under the traditional acquisition model.

Building on the success of COTS, the Commercial Crew Program (CCP), launched in 2010, further refined this approach by focusing on developing crewed orbital transportation systems. NASA also acted as an anchor tenant, guaranteeing demand while refraining from directing the technical design process. Contracts were awarded to SpaceX and Boeing under the same milestone-based structure, allowing firms significant autonomy in vehicle development while ensuring accountability through scheduled reviews and deliverables. Importantly, both COTS and CCP did not merely aim to procure services for the government. They were conceived as instruments of industrial policy intended to foster a sustainable, competitive, and innovation-driven commercial launch sector[41]. As detailed in policy assessments, these programs exemplify a shift toward what has been termed a "facilitative state" model: rather than directly providing capabilities, the state creates conditions—through funding mechanisms, regulatory pathways, and guaranteed markets—under which private actors can assume responsibility for technological development and service provision[42]. In strategic terms, this approach has enabled the United States to preserve independent access to orbit while leveraging the private sector's dynamism to increase resiliency and responsiveness. By fostering a commercially viable launch market, COTS and CCP have reduced reliance on foreign providers (e.g., Soyuz for crew launches), enhanced supply chain autonomy, and opened pathways for further

[41] Nicoli, F., Sekut, K. and Porcaro, G., 2023. *Can Europe make its space launch industry competitive?* Bruegel Policy Analysis, pp.1-2;
[42] Nicoli, F., Sekut, K. and Porcaro, G., 2023. *Can Europe make its space launch industry competitive?* Bruegel Policy Analysis, pp. 1-2;

commercializing LEO operations. These programs laid the institutional groundwork for subsequent initiatives such as the Commercial LEO Destinations (CLD) Program and the National Security Space Launch (NSSL) framework, embedding public–private collaboration as a structural feature of US space governance[43].

A defining feature of this reconfigured landscape is the vertical integration strategy adopted by companies such as SpaceX[44]. By consolidating launch vehicle design, satellite production, constellation deployment, and downstream service delivery, SpaceX has restructured the US space industrial base into a more agile and self-contained system[45]. The company's full-spectrum control—illustrated by the Falcon 9 and Starship launch systems' in-house development and the Starlink satellite constellation deployment—enables rapid iteration, cost efficiencies, and unparalleled responsiveness to governmental and commercial demands. It also positions private firms as pivotal actors in implementing public space policy[46]. In the case of SpaceX, this has created a de facto infrastructure monopoly in specific domains, granting the company substantial leverage in shaping access to orbital services[47]. Within the context of the National Security Space Launch (NSSL) program and NASA's broader launch needs, vertically integrated firms are not merely service providers but essential strategic partners in ensuring assured access to space.

Finally, the United States is also increasingly integrating commercial satellite providers and low Earth orbit (LEO) services into its national defence architecture[48]. This approach is designed to build hybrid, resilient constellations that combine governmental and commercial assets, thereby enhancing both operational capacity and agility in contested or degraded environments. As part of this strategic shift, the US is

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[43] National Aeronautics and Space Administration (NASA), 2023. *Models for Facilitating Government-Funded Activities in the Post-ISS LEO Ecosystem*. Washington, D.C.: Mary W. Jackson NASA Headquarters, pp. 28-33;
[44] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 850;
[45] Orlova, A., Nogueira, R. & Chimenti, P., 2020. *The Present and Future of the Space Sector: A Business Ecosystem Approach*. *Space Policy*, 52, p. 6;
[46] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 850-851;
[47] Melamed, A., Rao, A., de Rohan Willner, O. and Kreps, S., 2024.cGoing to outer space with new space: The rise and consequences of evolving public-private partnerships. *Space Policy*, 68, p. 6;
[48] Department of the Air Force (2024) U.S. Space Force Commercial Space Strategy, pp. 6-7;

incorporating advanced technologies such as on-orbit servicing, logistical support, and satellite manoeuvring systems—including space tugs and robotic satellite capture mechanisms—to ensure greater adaptability, redundancy, and mission continuity in space operations. Concurrently, the United States is reconfiguring its broader approach to the governance and commercialization of low Earth orbit, reflecting the growing recognition of LEO as a critical domain for economic innovation and national security. For example, with the anticipated retirement of the International Space Station by 2030, NASA has launched the Commercial LEO Destinations (CLD) Program to facilitate the transition to privately operated platforms. Rather than building a direct successor to the ISS, the US strategy envisions a modular ecosystem of commercial stations—developed by consortia such as Axiom Space, Orbital Reef (Blue Origin and partners), Starlab (Nanoracks), and Northrop Grumman—that will support a diverse array of research, manufacturing, and logistics functions[49].

However, increasing strategic reliance on commercially autonomous actors introduces significant challenges. SpaceX's unilateral management of Starlink services during the war in Ukraine—where restrictions were placed on military applications despite the system's relevance to US and allied security operations—reveals the potential for misalignment between national interests and corporate discretion. In such cases, vertically integrated firms possess technical capacities and the geopolitical agency to determine access to strategic orbital services[50].

Furthermore, the rapid expansion of commercial platforms and satellite constellations in Low Earth Orbit (LEO) generates increasingly acute sustainability concerns. In this view, the US government has begun developing an integrated framework to enhance space sustainability and mitigate orbital threats in response to these emerging risks. Central to this effort is the modernization of space situational awareness (SSA) infrastructure, transitioning from military-led operations—primarily under the US

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[49] Rausser, G. C., Choi, E. and Bayen, A. (2023) 'Public–private partnerships in fostering outer space innovations', *Proceedings of the National Academy of Sciences*, 120(43), pp. 7-9;

[50] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 847;

Space Command—to civilian oversight by the Department of Commerce. This institutional shift is intended to foster more transparent and internationally shareable data services, enabling public and private operators to improve conjunction prediction and collision avoidance capabilities[51].

1.2.2 THE EU STRATEGY

The European Union's governance of space activities rests on a complex multilevel system composed of supranational, intergovernmental, and national actors. The system's heart lies in the interplay between the European Space Agency (ESA), the European Commission, and national space agencies. ESA, founded by the ESA Convention (1975), remains a technical intergovernmental body with strong R&D, systems engineering, and satellite operations capabilities. In parallel, the European Commission has emerged as a key political and financial actor, notably since the Treaty of Lisbon (2007) incorporated space into the EU's shared competences. This shift was operationalized through Regulation (EU) 2021/696, which established the EU Space Programme for the 2021–2027 period and created the European Union Agency for the Space Programme (EUSPA), tasked with overseeing key flagship initiatives, like Galileo and Copernicus[52].

It must be highlighted that this coexistence of overlapping mandates among the European Commission, ESA, and the member states reflects a broader tension between supranational integration and intergovernmental autonomy. Each actor operates according to its institutional logic: the Commission embeds space within its strategic objectives related to digital policy, security, and economic sovereignty; ESA functions under an intergovernmental framework prioritizing technological excellence and geographical return; while member states pursue national industrial agendas, often

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[51] Shields, R., 2022. *Space sustainability as a national priority in the United States*. *Journal of Space Safety Engineering*, 9, p. 9;

[52] Brandenburg, M. & Lieberman, S., 2022. *Critical Spaces: European and U.S. Institutions for Outer Space*. *Astropolitics*, 20(1), pp. 95-101;

independently of EU-level coordination[53]. This institutional disarticulation contributes to a dispersion of efforts in key strategic sectors[54].

In recent years, the European Union has undergone a profound strategic reorientation in its approach to space, evolving from a predominantly civilian and scientific agenda into one that explicitly incorporates defence and geopolitical imperatives[55]. Traditionally, the EU framed its space policy around technological sovereignty, research excellence, and industrial competitiveness, avoiding overt militarization. However, the geopolitical rupture caused by the Russian invasion of Ukraine, the resurgence of great power rivalry, and the growing weaponization of outer space have exposed the vulnerabilities of Europe's reliance on non-EU space infrastructures. These dynamics have prompted the EU to reconceptualize outer space not merely as a technological or commercial arena, but as a contested strategic environment where autonomy, resilience, and power projection are increasingly interlinked. The adoption of the 2023 EU Space Strategy for Security and Defence marks a decisive pivot, declaring for the first time that space is a geopolitical and military domain and that access to it is essential for the Union's capacity to act independently in critical scenarios[56]. In this regard, the EU is now embarking on the unprecedented development of 'hard power' capabilities in space, which includes the enhancement of Space Domain Awareness (SDA), the conduct of space military exercises, and the involvement of the EU Single Intelligence and Analysis Capacity (SIAC) in producing classified annual space threat assessments. At the same time, considering counter space capabilities, while no EU member state has officially developed or tested destructive anti-satellite (ASAT) weapons, some—such as France—have outlined defensive space doctrines and developed non-kinetic active defence capacities. The EU positions its approach

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[53] European Space Policy Institute (ESPI), 2020. *ESPI Report 75 – European Space Strategy in a Global Context – Full Report*. Vienna, p. 4;

[54] Brandenburg, M. & Lieberman, S., 2022. *Critical Spaces: European and U.S. Institutions for Outer Space*. *Astropolitics*, 20(1), pp. 95-101;

[55] Helwig, N. and Sinkkonen, V., 2022. *Strategic Autonomy and the EU as a Global Actor: The Evolution, Debate and Theory of a Contested Term*, p. 4;

[56] European Space Policy Institute (ESPI) 2023, *High time for an EU Space Strategy for Security and Defence*, ESPI Brief No. 63, 10 March, ESPI, Vienna;

within international norms, aiming to safeguard space assets without contributing to arms races. Nevertheless, the strategy reflects an unambiguous readiness to defend European space infrastructure more assertively, notably through cooperation with NATO, the United States, and select third countries.

To finance and operationalize these ambitions, the 2023 Strategy seeks to align diverse funding streams—Horizon Europe, the European Defence Fund (EDF), and the EU Space Programme—to support the development of dual-use technologies, bolster industrial competitiveness, and address gaps in security-oriented innovation. Economic security is framed as integral to space strategy: initiatives like the Chips Act and the Critical Raw Materials Act are examples of how securing critical technologies underpins economic resilience and strategic autonomy in space. In this context, the EU acknowledges the growing overlap between economic and security considerations and emphasizes the need to coordinate actions among member states and industry actors.

At the heart of the strategy lies the objective of reinforcing European strategic autonomy, defined as "the capacity of the EU to act autonomously—that is, without being dependent on other countries—in strategically important policy areas." This includes the protection of existing flagship infrastructures such as Galileo, EGNOS and Copernicus, alongside the development of the IRIS^2 secure connectivity constellation. A key strategic goal is to ensure independent European access to outer space by revitalizing domestic launcher capabilities—such as Ariane, Vega and emerging startups—to reduce reliance on foreign providers amid intensifying global competition, particularly from dominant players like SpaceX. ESA Director Josef Aschbacher has acknowledged Europe's loss of competitiveness in the launcher market and the urgent need to reassert it. In parallel, the strategy advocates the transformation of EU space assets into dual-use systems—capable of serving both civilian and military functions—thus enabling their integration into European and national defence efforts.

The governance and industrial logic underpinning Europe's launch capabilities have historically reflected an institutional rather than a market-based model. At the heart of this architecture lies ESA's geo-return principle, which ensures that contracts are distributed among member states in proportion to their financial contributions[57]. This mechanism has long served as a tool for maintaining political cohesion and facilitating collective investment in shared infrastructure. Enabling even smaller or less experienced member states to participate in high-profile programs has fostered the distributed development of space competencies globally, enhancing industrial presence in countries without prior leadership in space technology[58]. In this view, space policy was pursued in strong relation to the integration process at the EU level, thus favouring cooperation and shared responsibility in a policy area still heavily marked by an intergovernmental logic.

Nevertheless, this model has become increasingly strained under the weight of a rapidly evolving global launch market[59]. While it promotes inclusiveness, the geo-return system often prioritizes political balance over industrial efficiency. The resulting fragmentation of supply chains complicates coordination, hampers innovation, and slows production timelines[60]. In contrast, international competitors such as SpaceX leverage vertically integrated structures and accelerated innovation cycles, allowing them to adapt quickly to market shifts and geopolitical contingencies.

This is vividly illustrated in the case of Europe's heavy-lift capabilities, long anchored by the Ariane family of launchers developed under ESA's technical leadership and operated by Arianespace. Historically, the Ariane series guaranteed Europe's autonomous access to space and reliably served institutional clients, albeit at a high cost[61]. The current flagship, Ariane 6, was conceived as a modern successor capable of

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[57] European Space Policy Institute (ESPI), 2020. *ESPI Report 75 – European Space Strategy in a Global Context – Full Report*. Vienna, p. 7;
[58] Franzoso, Marco. (2024). Navigating the Tensions: ESA, EU, the Geographical Return Principle, and Competitiveness in the European Ambit. Business Law Review. 45. 36-40;
[59] European Space Policy Institute (ESPI), 2020. *ESPI Report 75 – European Space Strategy in a Global Context – Full Report*. Vienna; pp. 38-40;
[60] Klimburg-Witjes, N., 2023. *A Rocket to Protect? Sociotechnical Imaginaries of Strategic Autonomy in Controversies About the European Rocket Program*. *Geopolitics*, 29(3), p. 835;
[61] Klimburg-Witjes, N., 2023. *A Rocket to Protect? Sociotechnical Imaginaries of Strategic Autonomy in Controversies About the European Rocket Program*. *Geopolitics*, 29(3), p. 838: In 2019, the German government decided to launch three military satellites into space with the US rocket manufacturer Space-X instead of with the European tax-financed launcher Ariane 5. While Ariane 5's manufacturer, ArianeGroup, has complained for years about how few institutional contracts there are from European governments, Germany's decision was based on lower launch costs;

addressing the challenges of the commercial market. However, its development has been marred by significant delays and budget overruns, with its geo-return-driven production structure complicating integration and limiting flexibility. The collapse of ESA-Roscosmos cooperation following Russia's invasion of Ukraine further exacerbated the situation, abruptly ending access to Soyuz launchers from Kourou and exposing the vulnerabilities of Europe's medium-lift services.

One concrete response is the 2023 launch of the Commercial Cargo Transportation Initiative (CCTI), a joint effort by ESA and the European Commission. Inspired by NASA's Commercial Orbital Transportation Services (COTS) program, CCTI aims to stimulate the private development of reusable, commercially viable cargo launchers for servicing the International Space Station and future orbital infrastructure[62]. Structured in three phases—from early design and co-financing, through full-scale development and testing, to in-orbit demonstration—the initiative represents a deliberate pivot away from legacy procurement models. Despite its promise, CCTI faces significant hurdles. Initial funding remains modest, and the lack of long-term procurement guarantees dampens its appeal to major industrial players. Unlike its American counterpart, CCTI operates within a fragmented European governance environment, where national interests, inconsistent regulations, and limited coordination dilute political momentum[63].

In parallel with these efforts in the heavy-lift segment, Europe has also turned its attention to cultivating a small launcher ecosystem tailored to the demands of the LEO market and small satellite operators. This pivot is driven by economic and security imperatives, especially the growing need for responsive launch options for Earth observation, telecommunications, and defence missions. The target capacity has converged on launchers capable of lifting below five hundred kilograms to LEO, which

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[62] Orlova, A., Nogueira, R. & Chimenti, P., 2020. *The Present and Future of the Space Sector: A Business Ecosystem Approach*. *Space Policy*, 52, pp.5-6;
[63] Nicoli, F., Sekut, K. and Porcaro, G., 2023. *Can Europe make its space launch industry competitive?* Bruegel Policy Analysis, 21/05 July, pp. 4-5;

balances cost-effectiveness and operational flexibility[64]. A wave of public-private ventures has emerged throughout Europe to meet this challenge. From Germany and France to Italy, Spain, and the Nordic countries, aerospace startups and established firms are advancing small launcher prototypes. However, fragmentation remains a structural feature of the European space sector.

Finally, the European Union's evolving approach to in-orbit space assets reflects a decisive shift from a civilian-scientific logic toward one that explicitly embraces dual-use functionality. Traditionally, EU space infrastructures such as Galileo, Copernicus, and EGNOS were conceived as civilian or scientific tools to enable navigation, Earth observation, and environmental monitoring. However, the 2023 EU Space Strategy for Security and Defence redefines these in-orbit systems as "vital assets," positioning them within the strategic autonomy and defence preparedness framework. This conceptual transformation responds directly to a deteriorating security environment marked by the weaponization of space, the vulnerability of orbital infrastructure, and the return of high-intensity conflict on the European periphery. In this regard, the strategy calls for the gradual conversion of existing and future space assets—most notably Galileo's Public Regulated Service, Copernicus' upgraded surveillance capabilities, and the forthcoming IRIS^2 constellation—into dual-use systems that serve civilian and defence functions. It also promotes enhanced resilience through Space Domain Awareness (SDA) tools, cross-sector interoperability, and the alignment of industrial policy with security imperatives[65]. While the EU continues to stress its commitment to the peaceful use of space and international norms, the emphasis on hard power, classified threat assessments, and partnerships with NATO and the US signals a growing willingness to embed orbital infrastructures within broader geopolitical and military logics. In this emerging paradigm, in-orbit assets are no longer just enablers

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[64] Air and Space Academy (AAE) and Deutsche Gesellschaft für Luft- und Raumfahrt (DGLR), 2021. *Small Launchers: A European Perspective (AAE Dossier #52 / DGLR Dossier 2021-01)*, p. 9: The mass of most individual or "equivalent" satellites of constellations (total mass per orbit plane) planned by European operators is below 500 kg, but the few having a mass between 600 kg to 900 kg together represent a significant launch mass;

[65] Fiott, D., 2020. *The European space sector as an enabler of EU strategic autonomy*. European Parliament, Policy Department for External Relations, Directorate General for External Policies, pp. 26-34;

of public policy—they are instruments of strategic projection, deterrence, and technological sovereignty.

1.3 GEOPOLITICAL SHOCKS

Since 2022, strategic autonomy in space has shifted from a theoretical aspiration to an operational imperative. Once primarily driven by commercial innovation and scientific exploration, the space sector has been reshaped by geopolitical shocks that revealed its deep entanglement with global power dynamics. From the war in Ukraine—where satellite communications and Earth observation are influencing the course of the conflict—to the renewed lunar competition, space has become a central arena of great-power rivalry. These developments crystallized new international dynamics, particularly the growing role of private actors in crisis scenarios and the recognition of space as the fifth domain of warfare, in addition to cementing the fragmentation of multilateral cooperation at the global level.

The war in Ukraine has marked a turning point in democratizing access to space, highlighting how the commercial space sector can empower states with limited sovereign assets to achieve forms of strategic autonomy[66]. Historically, access to advanced space-based services—such as Earth Observation (EO), Intelligence, Surveillance and Reconnaissance (ISR), and satellite communications (SATCOM)—was confined to a few global powers. However, Ukraine's swift and early adaptation, enabled by Western support and the commercial space market, demonstrates how emerging technologies reshape access to space[67]. A striking example of this lies in the Starlink satellite internet system deployment. By April 2022, over 5,000 Starlink terminals had been delivered to Ukraine, of which 73% were donated by SpaceX and the remainder financed by the U.S. Agency for International Development (USAID)[68]. SpaceX activated the service within a few hours, and additional terminals were shipped

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[66] Czajkowski, M., 2024. *Russo-Ukrainian war's impact on space security – the Western perspective*. *Politeja*, 5(92), pp.242-243;
[67] Black, J., Paille, P., Kleberg, C., Ellis, C. and Sommerfeld Antoniou, M., 2024. *Russia's war in Ukraine: emerging insights for UK and NATO joint doctrine*. Santa Monica, CA and Cambridge, UK: RAND Corporation, pp. 26-27;
[68] Ogden, T., Knack, A., Lebret, M., Black, J. & Mavroudis, V., 2024. *The Role of the Space Domain in the Russia-Ukraine War: the impact of converging space and AI technologies.* RAND Europe & The Alan Turing Institute, p. 3;

and operational within just two days, rapidly enhancing Ukraine's connectivity and communications resilience across the battlefield.

By purchasing high-resolution EO data, synthetic aperture radar (SAR), and AI-enhanced image analysis from U.S.-based private providers, Ukraine has attained levels of situational awareness that rival or surpass traditional military ISR systems[69]. However, this reliance also exposes new vulnerabilities, as seen in Elon Musk's controversial control over Starlink's military applications and Russian forces' unauthorized use of the system. Nonetheless, the widespread availability of commercial space technologies has allowed Ukraine to bypass traditional access barriers, reinforcing its capacity to act autonomously in both military and informational domains. In this context, the case of Ukraine illustrates how commercial actors are not merely service providers but enablers of state resilience and strategic autonomy in the evolving geopolitics of space[70].

At the same time, Ukraine's reliance on space-based assets to defend against and counterattack the Russian invasion has underscored the indispensability of outer space as a warfighting domain. While both policymakers and scholars had already acknowledged the strategic value of space for military operations, and despite the use of space capabilities in warfare dating back to the Gulf War in 1991, the scale and critical importance demonstrated during the conflict in Ukraine is unprecedented. The war has revealed how space-based systems are no longer auxiliary tools but central pillars of modern defence strategies[71]. This has led to a new configuration of in-orbit strategic positioning, with some orbits acquiring newfound strategic significance. Low Earth Orbit (LEO) has emerged as the most dynamic and tactically vital regime due to its proximity to Earth, enabling low-latency communications, high-resolution imaging,

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[69] Bojor, L., Petrache, T. and Cristescu, C., 2024. *Emerging technologies in conflict: the impact of Starlink in the Russia–Ukraine war*. *Land Forces Academy Review*, 29(2[114]), p. 189;

[70] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 847;

[71] Ogden, T., Knack, A., Lebret, M., Black, J. & Mavroudis, V., 2024. *The Role of the Space Domain in the Russia-Ukraine War: the impact of converging space and AI technologies.* RAND Europe & The Alan Turing Institute, p. 4;

and precise geolocation. Satellite Communications (SATCOM) systems in LEO—such as Starlink—have become indispensable for maintaining Command and Control (C2), particularly in degraded or denied environments with compromised terrestrial infrastructure. In the Ukrainian theatre, these systems ensured real-time coordination of dispersed units, supported UAV and naval drone operations, and sustained strategic narratives through global broadcasting, influencing morale and international perception. Similarly, Positioning, Navigation, and Timing (PNT) services in MEO, notably GPS, remain foundational to modern warfare, underpinning everything from missile guidance to logistical synchronization[72]. Nevertheless, their vulnerability to electronic warfare (jamming and spoofing) has exposed strategic dependencies and cascading risks, especially in densely interconnected operating environments. Earth Observation/Intelligence, Surveillance, and Reconnaissance (EO/ISR) assets in both military and commercial LEO have proven decisive in providing real-time battlefield intelligence and verifying war crimes[73]. Companies like Maxar and Planet have supplied imagery for tactical targeting and strategic communications—countering disinformation and mobilizing diplomatic support[74]. In addition, the Finnish commercial company ICEYE further exemplifies the vital role of commercial EO providers. As of early 2025, ICEYE operated a constellation of approximately 48 SAR satellites in sun-synchronous LEO (~550 km altitude), capable of producing high-resolution radar imagery independent of weather or lighting conditions. In August 2022, access to one of these satellites was granted to Ukrainian military authorities via a purchase arranged by the Serhiy Prytula Foundation. Moreover, ICEYE allowed Ukraine tasking privileges across its broader constellation. According to multiple reports, nearly 40% of the imagery used to support Ukrainian targeting and strike

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[72] Ogden, T., Knack, A., Lebret, M., Black, J. & Mavroudis, V., 2024. *The Role of the Space Domain in the Russia-Ukraine War: the impact of converging space and AI technologies.* RAND Europe & The Alan Turing Institute, p. 4-6;

[73] Ogden, T., Knack, A., Lebret, M., Black, J. & Mavroudis, V., 2024. *The Role of the Space Domain in the Russia-Ukraine War: the impact of converging space and AI technologies.* RAND Europe & The Alan Turing Institute, p. 6;

[74] The European Union's Copernicus Programme provided crucial data through Sentinel-1 and Sentinel-2 satellites. Operating in sun-synchronous low Earth orbit (LEO), Sentinel-1's C-band synthetic aperture radar (SAR) and Sentinel-2's multispectral optical sensors enabled detailed monitoring of conflict-affected urban zones, such as Mariupol, even under cloud cover.

operations was derived from ICEYE assets, directly contributing to tactical planning and battlefield efficacy[75]. Beyond the battlefield, these assets have supported food security monitoring through programs like GEOGLAM, highlighting the dual-use character of space infrastructure[76]. Ultimately, the LEO regime has transformed from a passive enabler into a contested and congested battlespace, where commercial and military interests converge, making space power projection a critical element of strategic autonomy and crisis resilience.

Nonetheless, the increasing militarization of orbital space (particularly in LEO) has unprecedentedly elevated the risks associated with orbital dependence. Space-based assets—essential for military communications, surveillance, navigation, financial transactions, power grid synchronization, and emergency response—are now considered critical infrastructure. However, they remain inadequately protected under the existing framework of international law. The 1967 Outer Space Treaty prohibits the weaponization of space, but its enforcement mechanisms are weak, leaving significant room for state actors to operate in a legal grey zone. Russia's behaviour in recent years exemplifies this challenge. The 2021 direct-ascent anti-satellite (ASAT) test, which generated a debris field threatening both civilian and military satellites, including those of the ISS, served as a coercive signal and a stark reminder of how quickly space can become a domain of active conflict. More recently, Russia's continued development of a range of counterspace capabilities—such as kinetic interceptors, electronic warfare systems, and the rumoured pursuit of nuclear space-based weapons—represents a profound escalation with destabilizing implications[77].

Beyond direct kinetic attacks, the war in Ukraine has shown that non-kinetic weapons are both more efficient and diplomatically acceptable[78]. A dynamic highlighting the need for nations to invest in these capabilities to deter adversaries from damaging their

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[75] The Defense Post (2024) *Finnish Company Uses Space Tech to Support Ukraine's Defense*. [online] 9 July;
[76] OECD (2022) *How the war in Ukraine is affecting space activities: New challenges and opportunities*. Paris: Organisation for Economic Co-operation and Development, pp. 3-4;
[77] Black, J., Paille, P., Kleberg, C., Ellis, C. and Sommerfeld Antoniou, M., 2024. *Russia's war in Ukraine: emerging insights for UK and NATO joint doctrine*. Santa Monica, CA and Cambridge, UK: RAND Corporation, pp. 27-29;
[78] Grossfeld, E. (2025) *When Sabotage Goes Orbital: Rethinking the Russian Space Threat*. KCSI Insights, 30 June;

constellations and retaliate in case of attack. In fact, in 2021, the Secure World Foundation report identified 8 countries that were actively developing counterspace capabilities across various areas[79]. By 2025, this number had increased to 12 countries, indicating a notable expansion in the development of both destructive and non-destructive counterspace systems[80]. The war operations show that Russia is sensibly restraining from kinetic attacks on in-orbit satellites, but prefers non-kinetic attacks, including signal jamming, laser dazzling, and close-proximity manoeuvres by so-called "inspector satellites." These activities blur the line between reconnaissance and sabotage and exemplify the strategic ambiguity that defines grey-zone warfare in space[81]. They also highlight Russia's belief in escalation management: initiating limited offensive space operations can be a controlled precursor to broader conflict and yield strategic advantages. The threat of orbital sabotage now spans from covert jamming to the catastrophic scenario of nuclear detonation in space, which could trigger the Kessler Syndrome—an irreversible cascade of orbital debris that would render entire regions of low Earth orbit unusable. However, this last scenario is unlikely because a nuclear detonation would irremediably compromise the space assets of Russia and its allies too. This risk is amplified because most commercial satellite systems, which are deeply integrated into state military architectures, lack the resilience of hardened defence platforms[82]. As the boundaries between military and commercial space blur, attacks on one part of the space ecosystem can ripple across national security, economic stability, and civilian life. The 2022 cyberattack on the KA-SAT network—impacting military units and European civilian infrastructure—demonstrated the far-reaching consequences of even non-kinetic disruptions[83].

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[79] **Secure World Foundation** (2021) *Global Counterspace Capabilities: An Open Source Assessment*. Edited by Victoria Samson and Brian Weeden. Published 1 April 2021;

[80] **Secure World Foundation** (2025) *Global Counterspace Capabilities: An Open Source Assessment*. Edited by Victoria Samson (Chief Director, Space Security & Stability) with contributions from Dr. Laetitia Cesari. Published 12 June 2025;

[81] Grossfeld, E. (2025) *When Sabotage Goes Orbital: Rethinking the Russian Space Threat*. KCSI Insights, 30 June;

[82] Czajkowski, M., 2024. *Russo-Ukrainian war's impact on space security – the Western perspective*. *Politeja*, 5(92), pp.243-244;

[83] OECD (2022) *How the war in Ukraine is affecting space activities: New challenges and opportunities*. Paris: Organisation for Economic Co-operation and Development, p. 4;

In response, actors like the United States are adapting their strategies, shifting toward resilient constellations such as the Proliferated Warfighter Space Architecture, a distributed mesh network of hundreds of satellites designed to reduce the vulnerability of critical functions to single-point failures or targeted strikes[84]. As such, mega constellations of satellites in LEO have been considered the preferred way to deal with redundancy and modularity challenges. This is also reflected by Starlink in Ukraine. Musk's mega constellation was severely hit many times by non-kinetic attacks by Russian forces aimed at disabling its services. Nonetheless, the number of satellites forming this constellation has provided prolonged access and greater redundancy to overcome these sabotage attempts[85]. In this fashion, mega constellations of satellites are being created and enlarged at the global level, thus posing a great danger concerning orbital debris and orbital congestion in LEO. As illustrative examples of the rapid expansion of satellite megaconstellations, Starlink had deployed approximately 2,000 satellites by February 2022. By mid-2025, this number had surpassed 6,000 operational units, with projections aiming toward 12,000 satellites under its first-generation license and a potential expansion to 42,000 satellites as authorized by the U.S. Federal Communications Commission (FCC) for its second-generation system. In Europe, the OneWeb Phase 1 constellation reached full deployment in October 2024, comprising approximately 648 operational satellites. In China, the GuoWang project foresees the launch of 12,992 satellites, with 6,080 intended for orbits between 500 and 600 kilometres and the remaining 6,912 positioned at approximately 1,145 kilometres[86].

In this evolving security environment, outer space is no longer a sanctuary but a contested domain where offensive operations may increasingly precede or accompany terrestrial hostilities. As geopolitical dynamics increasingly project themselves into the orbital domain, the war in Ukraine has emerged as a pivotal geopolitical shock, accelerating the fragmentation of the already fragile framework of global space

[84] Grossfeld, E. (2025) *When Sabotage Goes Orbital: Rethinking the Russian Space Threat*. KCSI Insights, 30 June;
[85] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 858-859;
[86] Abels, J., 2024. *Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine*. *European Journal of International Relations*, 30(4), pp. 858-859;

governance. This conflict has disrupted traditional geopolitical alignments in space and reinforced bloc-based cooperation, deepening the divide between competing visions of international collaboration in outer space. Nowhere is this more visible than in the disruption of European-Russian cooperation on space launchers, most notably through the Soyuz program. Managed through the joint ventures Starsem and Arianespace, the Soyuz launcher historically served as a cornerstone of European access to space. Yet, Russia's unilateral decision to halt Soyuz launches from the Guiana Space Centre following the onset of hostilities has introduced significant vulnerabilities into Europe's launcher infrastructure, effectively severing one of its most reliable launch pathways. Beyond the Soyuz program, the ongoing war has exposed other critical weaknesses in Europe's space access capabilities[87]. The Vega launcher, one of Europe's mainstay launch systems, has been particularly affected. Its terminal stage propulsion system relies on components manufactured by the Ukrainian company Yuzhnoye in Dnipro—an area that has been under siege and unlikely to resume stable production in the near future. Furthermore, the Zefiro solid rocket motors used in Vega incorporate carbon inserts in their nozzle necks, which are also sourced from Ukraine[88].

These developments brought from the war in Ukraine, contributed to affirm and further accentuate a broader shift from multilateral cooperation toward selective, often exclusive, and bloc-based forms of space cooperation. As such, space governance is no longer defined solely by shared scientific goals but by political, economic, military, and technological (PemT) competition[89]; States leverage space to assert sovereignty, project power, and secure technological independence[90]. The danger lies in the potential escalation from competition to confrontation, as international governance structures struggle to keep pace with shifting power dynamics and mounting

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[87] Nicoli, F., Sekut, K. and Porcaro, G., 2023. *Can Europe make its space launch industry competitive?* Bruegel Policy Analysis, pp. 1-2; Nicoli, F., Sekut, K. and Porcaro, G., 2023. *Can Europe make its space launch industry competitive?* Bruegel Policy Analysis, pp. 1-2;
[88] OECD (2022) *How the war in Ukraine is affecting space activities: New challenges and opportunities*. Paris: Organisation for Economic Co-operation and Development, p. 4-8;
[89] Pankova, L.V., 2021, February. Competition in Space: Opportunities, Consequences and Risks to International Security;
[90] Lewis, J., 2014. Space Exploration in a Changing International Environment. A Report of the CSIS Strategic Technologies Program. Center for Strategic and International Studies (CSIS), pp. 5-7;

geostrategic tension[91]. This systemic bifurcation is most visible in the competing governance architectures led by the United States and China.

The U.S.-initiated Artemis Accords, launched in 2020, promote transparency, interoperability, and peaceful exploration. With 33 signatories—including France, Japan, the UK, and more recently India—the framework represents an effort to formalize a coalition of like-minded states under U.S. leadership. However, critics, particularly from China and Russia, have dismissed the Accords as instruments of American legal hegemony, given their alignment with NASA's Artemis Program and their exclusion of rival actors[92].

In direct response, China and Russia have reinforced bilateral space cooperation. A key milestone came in March 2021 with the signing of a memorandum to build the International Lunar Research Station (ILRS), an alternative multilateral initiative based on equality and openness to third-party partners (Roscosmos, 2021). The ILRS envisions a permanent presence near the Moon's South Pole, with several robotic missions planned by 2025 to lay the groundwork (Strekopytov, 2021). Alongside the ILRS, Russia is developing ROSS, and China has completed its own Tiangong space station, further signalling a shift toward autonomous national infrastructures[93].

The strategic divergence between the Artemis and ILRS frameworks reflects more than technological preferences—it illustrates the broader reordering of space governance along geopolitical lines. In 2023, India's accession to the Artemis Accords was swiftly followed by Pakistan's formal entry into the ILRS initiative. These moves, far from symbolic, underscore the extent to which space partnerships are becoming aligned with terrestrial alliances. China has also launched the China–CELAC Space Cooperation Forum, targeting Latin American states traditionally within the U.S. sphere of influence, and continues to expand the ILRS network to include states like Azerbaijan,

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[91] Shen, Yi, 2020. Security and Interdependence: How to Avoid Negative Spillover Effect of Sino-U.S. Tech Competition. Valdai Discussion Club;
[92] Pankova, L.V., Gusarova, O.V. and Stefanovich, D.V. (2021) 'International Cooperation in Space Activities amid Great Power Competition', *Russia in Global Affairs*, 19(4), pp. 97–117;
[93] Bilal, M. (2024) 'The Advent of Astropolitical Alliances', *SpaceNews*, 8 January;

Belarus, and South Africa. Although the Artemis and ILRS initiatives claim to uphold principles of peaceful cooperation and multilateralism, they are rooted in distinct strategic logics. U.S.–China collaboration remains legally constrained by the 2011 Wolf Amendment, which prohibits NASA from direct bilateral engagement with Chinese counterparts. This legislative barrier starkly contrasts with the cooperative narrative promoted by the United States. While NASA Administrator Bill Nelson has publicly emphasized the inclusivity of the Artemis framework, he has simultaneously warned of China's intent to "occupy the Moon," reinforcing a non-cooperative discourse[94].

Against the backdrop of a rapidly fragmenting global space order and the heightened tensions due to the war in Ukraine, the International Space Station (ISS) persists as a rare legacy institution. Few platforms so vividly encapsulate the spirit of multilateralism in orbit as the ISS, which stands as one of the most enduring and emblematic examples of international collaboration in the history of space activities. Notwithstanding this, the diverging interests and intentions of different "Space blocks" are bringing this champion of space multilateral cooperation to an end[95].

Born out of the post–Cold War thaw, the ISS was conceived as a diplomatic and technological milestone. In December 1993, the United States invited Russia to participate in a new international space station initiative. This overture marked one of the earliest and most significant expressions of post-conflict cooperation between former adversaries. In 1996, Russia had been fully integrated into the program, and the station was formally launched in 1998. From its inception, the ISS was designed as an interdependent infrastructure: sixteen pressurized modules were distributed among key spacefaring nations—six operated by Russia, eight by the United States, and one by Japan and Europe. Russia assumed responsibility for navigation and propulsion, while the United States contributed the primary habitation and power systems. This carefully

[94] Bilal, M. (2024) 'The Advent of Astropolitical Alliances', *SpaceNews*, 8 January;
[95] Air and Space Academy (2022) *The Academy's Position on the Future of Space Cooperation with Russia and Ukraine*;

orchestrated division of labour fostered a high degree of technical interdependence, which evolved into deep operational co-dependence, institutionalizing collaboration across governance, logistics, and daily operations[96]. Over its lifetime, the ISS has united fifteen nations and hosted more than 270 individuals from twenty-two countries, offering a rare and persistent model of inclusive global engagement. Yet, despite its achievements, the ISS now occupies a transitional and increasingly precarious position[97].

Initially slated for decommissioning in 2015, the ISS has seen its operational timeline extended multiple times, most recently to 2030 by the United States. However, Russia has not committed to participation beyond 2024, signalling a potential rupture in the collaborative framework. Network analysis reveals a significant transformation in the role of the International Space Station (ISS) within the broader framework of international cooperation. Prior to 2008, the ISS operated within a densely connected and low-modularity network, marked by robust interaction among a wide range of actors. Over time, however, this structure has evolved into a more modular configuration centered around blocs, with reduced cross-bloc engagement and increasing dominance by a few major space powers. Nevertheless, the ISS continues to maintain symbolic and institutional ties to earlier models of cooperation, such as those represented by the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and the Asia-Pacific Regional Space Agency Forum (APRSAF), which still serve as residual venues for inclusive dialogue and coordination[98]

This divergence reflects broader structural shifts in global space cooperation, prompting parallel and potentially competing initiatives that reinforce the narrative by which space multilateral cooperation has given way to forms of selected cooperation. The United States, for instance, is actively investing in the development of commercial

[96] Giovannini, F. and Al-Rodhan, N.R.F. (2024) ‘The Role of Norms in Cyberspace and Outer Space: A Comparative Assessment’, *Survival*, 66(1), pp. 49–66;
[97] Air and Space Academy (2022) *The Academy's Position on the Future of Space Cooperation with Russia and Ukraine*;
[98] Giovannini, F. and Al-Rodhan, N.R.F. (2024) ‘The Role of Norms in Cyberspace and Outer Space: A Comparative Assessment’, *Survival*, 66(1), pp. 49–66;

space stations. Russia, in turn, is advancing its autonomous platform—the Russian Orbital Service Station (ROSS)—to assert greater strategic and technological independence in orbit.

2. EMPIRICAL ANALYSIS OF POST-2022 TRAJECTORIES

2.1. THE COMPETITION OVER ORBITAL CONTROL

The intensifying competition over orbital control has emerged as a defining feature of the post-2022 strategic environment, reflecting more profound transformations in how space is conceptualized within global security architectures. Theoretically, this rivalry can be framed through competing international relations paradigms. From a realist perspective, space is an extension of terrestrial power politics. States pursue control over orbital infrastructures in this contested domain to secure strategic advantage, deterrence capabilities, and geopolitical influence. Liberal assumptions, by contrast, emphasize the potential for cooperative governance, collective security arrangements, and the shared management of global commons through regimes such as the Outer Space Treaty and the International Telecommunication Union (ITU)[99]. However, the empirical trajectory since 2022 reveals a marked securitization of orbital control, suggesting that even states rhetorically committed to multilateralism have increasingly embedded their space strategies within national security doctrines[100].

Globally, broader public investment patterns reflect these doctrinal and policy shifts. Government space budgets reached a record €106 billion in 2023, an 11% increase over the previous year. Crucially, defence-related spending exceeded 50% of total public space expenditure for the first time, signalling a structural shift from space as a primarily scientific or exploratory domain toward its securitization as a core strategic sector[101]. China's integrated military–civil space strategy channels approximately €12

[99] Elefteriu, G. (2024) *The role of space power in geopolitical competition*. Geopolitics Programme, No. GPPR01. London: Council on Geostrategy, p. 27;
[100] Tanveer, R. (2024) 'Space warfare between Russia and the United States: Implications for European Union security in 2023–2024', *Journal of Regional Studies Review*, 3(1), pp. 191;
[101] Liang, X., Tian, N., Lopes da Silva, D., Scarazzato, L., Karim, Z. & Guiberteau Ricard, J., 2025. *Trends in World Military Expenditure, 2024*. SIPRI Fact Sheet, April. Solna: Stockholm International Peace Research Institute (SIPRI);

billion into strategic Earth observation[102], BeiDou navigation enhancements, and rapid-launch capabilities via the Long March and Kuaizhou families. Though constrained by sanctions and economic pressures, Russia invests heavily in military satellite replenishment, counterspace capabilities, and GLONASS modernization[103].

The Russian invasion of Ukraine in 2022 prompted a decisive turning point in Europe's perception of strategic orbital control, reframing space not only as a domain of technological innovation but as a contested arena essential to sovereignty, deterrence, and resilience[104]. Until then, the EU had primarily approached space through a civilian paradigm, focusing on Earth observation, navigation, and telecommunications to support economic integration, climate governance, and scientific progress[105]. Security concerns were acknowledged but remained peripheral. The shock of the war in Ukraine disrupted this equilibrium. The deliberate targeting of satellites, cyberattacks on space-linked infrastructures such as the ViaSat hack, the GPS spoofing attempts, and the reliance of Ukrainian forces on privately provided systems like Starlink revealed both the strategic indispensability and the fragility of orbital assets in wartime[106].

The Strategic Compass, adopted in March 2022[107], just weeks after the invasion, reflects the immediate impact of this shock. For the first time in an EU security doctrine, space was identified as a critical operational domain, symbolically placing it on par with land, sea, and air. However, its treatment was still declaratory, signalling recognition of the problem without providing the tools to address it[108]. The conflict in this regard has been a decisive catalyst, compelling the European Union to advance its

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[102] Liang, X., Tian, N., Lopes da Silva, D., Scarazzato, L., Karim, Z. and Guiberteau Ricard, J. (2025) *Trends in world military expenditure, 2024*. SIPRI Fact Sheet, April. Stockholm: Stockholm International Peace Research Institute;

[103] Radin, A., Holynska, K., Tretter, C. and Van Bibber, T. (2024) *Lessons from the war in Ukraine for space: Challenges and opportunities for future conflicts*. Santa Monica, CA: RAND Corporation, p. 17;

[104] Reis, J. (2024) 'European Union defense and security strategy for space and ground-based systems against hybrid threats', *Acta Astronautica*, 225, p. 64;

[105] Reis, J. (2024) 'European Union defense and security strategy for space and ground-based systems against hybrid threats', *Acta Astronautica*, 225, p. 59;

[106] Tanveer, R., 2024. Space Warfare between Russia and the United States: Implications for European Union Security in 2023–2024. *Journal of Regional Studies Review (JRSR)*, 3(1), pp.189–199;

[107] Council of the European Union, 2022. *A Strategic Compass for Security and Defence – For a European Union that protects its citizens, values and interests and contributes to international peace and security*;

[108] Del Canto Viterale, F., 2022. The systemic approach to space governance: Between multilateralism and multi-stakeholderism. *Space Policy*, 61;

space security agenda. In this context, the EU Space Strategy for Security and Defence (SSSD), adopted in March 2023[109], marks this policy shift. The strategy designates orbital assets as critical infrastructures, identifies hostile acts "from or in space" as threats to European security, and sets out operational measures for resilience, deterrence, and response. Acknowledging that the disruption of space services could trigger cascading failures across terrestrial systems, including energy grids, transport, telecommunications, navigation, and emergency response, the EU has placed greater emphasis on preparedness as a prerequisite for achieving strategic autonomy. To this end, it has strengthened its mechanisms for addressing emerging threats in space, introducing dedicated exercises such as the Space Threat Response Architecture (STRA) 2023[110] and the PSC[111] Space Table-Top 2023[112]. In addition, the Joint White Paper on European Defence Readiness 2030 reinforces this trajectory by listing space alongside missile defence, drones, counter-UAS, and mobility as key enablers, advocating pooled procurement and industrial scaling to close capability gaps[113]. Parallel regulatory measures, such as the Critical Entities Resilience (CER) Directive[114], extend resilience law to space operators and secure ground infrastructures as part of the EU's defence perimeter. Taken together, these developments illustrate that space is no longer treated just as a civil enabler of prosperity, but aldo as a core theatre of competition and security, integral to the EU's pursuit of strategic autonomy[115].

The War in Ukraine also led the EU to advance policies to diversify and boost its orbital architectures in order to avoid single points of failure, expand autonomous European

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[109] European Commission & High Representative of the Union for Foreign Affairs and Security Policy, 2023. *EU Space Strategy for Security and Defence*. Brussels: European Union.

[110] Council of the European Union & European Commission, 2023. *Space Threat Response Architecture (STRA) 2023 exercise*. Brussels: European External Action Service (EEAS).

[111] European External Action Service (EEAS), 2023. *PSC Space Table-Top 2023 exercise* (Political and Security Committee, continuation of STRA 2023), Brussels, 15 March 2023.

[112] Reis, J., 2024. European Union defense and security strategy for space and ground-based systems against hybrid threats. *Acta Astronautica*, 225, pp.55–66

[113] European Commission and High Representative of the Union for Foreign Affairs and Security Policy (2025) *Joint White Paper for European Defence Readiness 2030;*

[114] The Critical Entities Resilience (CER) Directive is an EU legislative framework aimed at strengthening the ability of critical sectors to prevent, resist, absorb, and recover from disruptive incidents. It entered into force on 16 January 2023, replacing the 2008 European Critical Infrastructure Directive, and Member States must transpose it into national law by 17 October 2024;

[115] European Commission and High Representative of the Union for Foreign Affairs and Security Policy (2025) *Joint White Paper for European Defence Readiness 2030*, pp. 9-11;

launch capabilities to reduce dependence on non-EU providers, and integrate Space Situational Awareness (SSA) into both civilian and military frameworks[116]. In this regard, Russian invasion of Ukraine has induced the EU to consider dual use application in its space policy fundamental in order to achieve strategic autonomy. Flagship projects such as IRIS², with an estimated €2.4 billion budget and a multi-orbital LEO/MEO architecture, epitomize this dual-use and rapidly reconfigurable approach to deliver sovereign secure communications[117]. The programme also illustrates how the Ukrainian war, particularly the role a private entity like Starlink has played during the conflict, has altered the EU's approach to private-sector vulnerabilities[118]. As a public–private partnership, IRIS² contains provisions prioritizing governmental traffic, enforcing data localization, and mandating cybersecurity compliance. Beyond encrypted government and defence communications, it incorporates crisis-governance clauses enabling institutional overrides of commercial priorities. Industrial autonomy is safeguarded through sourcing rules favouring European suppliers and through ESA's development of independent launch capacity via Ariane 6, Vega-C, and forthcoming reusable systems, offsetting vulnerabilities created by the loss of Soyuz access[119].

Budgetary trajectories reflect this strategic reorientation. In 2023, European public space expenditure reached €11.9 billion, around 11% of global public spending. Civil applications dominated at 85%, but the rise in defence-related allocations was unprecedented[120]. This sharply contrasts with the pre-2022 period, when European space budgets grew steadily but remained overwhelmingly civilian-oriented. Between 2011 and 2021, ESA's budget rose from €3.99 billion to €6.49 billion, with the vast

[116] González Muñoz, R. and Portela, C. (2023) *The EU space strategy for security and defence: Towards strategic autonomy?* Non-Proliferation and Disarmament Papers, No. 83. Stockholm: EU Non-Proliferation and Disarmament Consortium, pp. 10-11;
[117] Plasma (2024) 'IRIS², la Commissione europea aggiudica il contratto di concessione al consorzio SpaceRISE', *Plasma*, 7 November;
[118] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: The case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), p. 846;
[119] González Muñoz, R. and Portela, C. (2023) *The EU space strategy for security and defence: Towards strategic autonomy?* Non-Proliferation and Disarmament Papers, No. 83. Stockholm: EU Non-Proliferation and Disarmament Consortium, p. 7;
[120] European Space Agency (2024) *ESA report on the space economy 2024*. Paris: ESA, pp. 3-9;

majority directed to science, Earth observation for environmental monitoring, and telecommunications. Defence and security-related spending during that decade remained marginal, often below 0.5% of total allocations, with only occasional peaks such as 2014, when roughly 13.9% of institutional spending was linked to military programmes[121]. In other words, security concerns were present but peripheral, subordinated to Europe's longstanding prioritization of civilian and scientific missions.

While the European Space Agency (ESA) continues to dominate the framework of intergovernmental cooperation, the competitive pressures unleashed since Russia's 2022 invasion are accelerating supranational integration in the space sector. For decades before the war, the space sector—like the defence sector—remained excluded mainly from integration dynamics that had advanced in other policy fields. Outer space governance has been predominantly shaped by intergovernmental logics that effectively blocked deeper European integration, as member states perceived space as a domain of national security where sharing sensitive information and technological capabilities was politically and strategically unacceptable[122]. The war disrupted this equilibrium. It exposed the vulnerabilities created by industrial and legislative fragmentation, while simultaneously demonstrating that only coordinated European action could enable the EU to emerge as a credible competitor in the global space sector. The considerable costs of developing and sustaining space infrastructure and the inherently transnational character of orbital activities underscore the limitations of purely national approaches. Moreover, the risk of cyber operations against EU orbital assets, illustrated by Russia's systemic targeting of Starlink's assets in LEO and by the jamming of GPS, has reinforced the awareness among Member States that strategic autonomy can be achieved only through coordinated collective action, which remains

[121] European Space Agency (2024) *ESA report on the space economy 2024*. Paris: ESA, pp. 3-9;
[122] Brandenburg, M. & Lieberman, S., 2022. *Critical Spaces: European and U.S. Institutions for Outer Space*. *Astropolitics*, 20(1), pp. 93–111;

unattainable in the absence of effective collaboration and harmonization among national space agencies[123].

This shift has been epitomized by linking defence to economic growth[124], an unprecedented move at the EU level, where defence was traditionally tied to national security rather than common economic development. Industrially, the European Defence Industrial Strategy (EDIS)[125] and the proposed European Defence Industry Programme (EDIP)[126]—politically agreed in June 2025—aim to stimulate joint production, with space capabilities identified as priority enablers in the new security order. The EU Space Act[127], formally proposed by the European Commission on 25 June 2025, establishes a unified and harmonized legal framework for European space activities, enhancing safety, resilience, and sustainability. It harmonizes national regulatory regimes, complements CER and NIS2[128], and sets binding standards for orbital and ground infrastructure operators, signalling a supranational grip over areas previously dominated by intergovernmental consensus. The outcome is an emerging European model of strategic orbital governance in which competition for orbital control drives integration as much as capability. In parallel, the European Commission has moved decisively into the strategic domain. Beyond co-authoring the SSSD, it has accelerated GOVSATCOM implementation, contracted the operational hub for secure governmental satellite communications, and advanced IRIS² as a sovereign alternative to foreign systems. In this sense, the Russian invasion of Ukraine has also functioned as a stimulus for the Commission to adopt a more decisive role in the space domain,

[123] Tanveer, R. (2024) 'Space warfare between Russia and the United States: Implications for European Union security in 2023–2024', *Journal of Regional Studies Review*, 3(1), pp. 191;

[124] European Commission and High Representative of the Union for Foreign Affairs and Security Policy (2025) *Joint White Paper for European Defence Readiness 2030;*

[125] European Commission & High Representative of the Union for Foreign Affairs and Security Policy, 2024. *Joint Communication on a New European Defence Industrial Strategy: Achieving EU readiness through a responsive and resilient European Defence Industry* (EDIS).

[126] Council of the European Union, 2025. *European Defence Industry Programme (EDIP): Council decision to open negotiations with the European Parliament*. Press release, 23 June.

[127] European Commission, 2025. *Proposal for a Regulation of the European Parliament and of the Council on the safety, resilience and sustainability of space activities in the Union (EU Space Act)*. Brussels: European Commission. Proposed 25 June 2025.

[128] NIS2 Directive, Off. J. Eur. Union (2022) 80–150;

spearheading central defence and security-related programmes and cementing its geopolitical stance[129].

On the other side of the Atlantic, the war in Ukraine has further cemented a particular narrative of orbital control rooted in a competitive realist outlook, framing space as a warfighting domain and a key battleground in great-power competition, especially with China and Russia. While space systems had already been designated as critical infrastructure in 2013[130], the war in Ukraine accelerated their securitization, with recent strategy documents[131] and defence reviews elevating orbital assets to the level of existential national interests. These systems now figure not only as enablers of military superiority—supporting command and control, missile warning, precision navigation, global communications, and ISR—but also as vital to the functioning of terrestrial critical infrastructures such as energy grids, transport networks, financial systems, and emergency response capabilities[132]. In this regard, the US doctrine increasingly frames the loss or degradation of space systems as a direct threat to national survival, thereby embedding strategic autonomy in space within a broader logic of deterrence and warfighting readiness[133]. In this view, strategic autonomy is becoming less about reducing dependence and more about ensuring uninterrupted dominance in an environment where the capacity to defend, reconstitute, and harden orbital assets is indispensable to sustaining national security in a contested international order.

A level of investment unmatched globally underpins the United States' strategic framing of space as a critical security domain. In 2023, the combined baseline US civil-military space budget exceeded US$50 billion, with US $25.3 billion allocated to NASA and US $26.3 billion to the US Space Force (USSF). When accounting for

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[129] Neuman, M., Wessel, R.A. & de Zee, T. (eds.), 2025. A Geopolitical Europe in the Making? The EU's Actorness in a (De-)Globalising World. The Hague: T.M.C. Asser Press/Springer, pp. 1-17;

[130] Davis, R., Bace, B. and Tatar, U. (2024) 'Space as a critical infrastructure: An in-depth analysis of U.S. and EU approaches', *Acta Astronautica*, 225, p. 267;

[131] Alyssa Goessler, The Private Sector's Assessment of U.S. Space Policy and Law, Center for Strategic and International Studies (July 25, 2022), pp. 1-16;

[132] Schlumberger, G. & Penent, G., 2023. *How the war in Ukraine is changing the space game.* Paris: French Institute of International Relations (Ifri), pp.7–9;

[133] MITRE Center for Data-Driven Policy, 2024. *Improving U.S. space capabilities in integrated deterrence.* McLean, VA: MITRE, July;

additional classified expenditures, notably through the National Reconnaissance Office (NRO), which operates the country's most advanced intelligence satellites, the total climbs to approximately US $73 billion, representing around 63% of all government space budgets worldwide. By comparison, in the decade preceding Russia's invasion of Ukraine, US space funding was significantly lower and less defence-oriented. NASA's budget, while steadily increasing, remained relatively stable, moving from US $22.6 billion in FY 2020 to US $24.0 billion in FY 2022, with spending concentrated on civil and scientific objectives such as lunar exploration, planetary science, and Earth observation. The Space Force, established only in late 2019, initially received US $40 million to set up operations, with its first full budget of US $15.4 billion in FY 2021 primarily directed toward institutional consolidation rather than mission-specific capabilities[134]. The contrast with the post-2022 trajectory is striking. The FY 2025 USSF budget allocates US $1.9 billion for the Next-Generation Overhead Persistent Infrared (OPIR) missile-warning constellation, US $1.3 billion for the low Earth orbit missile warning and tracking architecture, and US $1.2 billion for National Security Space Launch services designed to ensure rapid, assured access to orbit in contested environments. In parallel, programmes such as Protected Tactical SATCOM, funded at US $544 million, aim to deliver hardened, cyber-secure communications resistant to jamming and interception, while US $1.5 billion supports the Space Command and Control programme, designed to fuse orbital data into joint targeting and manoeuvre planning across the armed services. Such figures highlight not only the magnitude but also the qualitative reorientation of US space spending: whereas before 2022 budgets were primarily civil in scope with a nascent military component, after 2022 investment priorities increasingly reflect a securitized, warfighting logic in which resilience, deterrence, and multi-domain integration have become central.

Beyond government-owned satellites, the United States increasingly derives strategic advantage from its world-leading commercial sector[135]. In communications, mega-

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[134] Wilson, R.S. (2024) *FY 2025 defense space budget: Continued emphasis on proliferation under a more constrained top-line*. Center for Space Policy and Strategy, June;
[135] Dobos, B., 2022. Tortoise the Titan: Private entities as geoeconomic tools in outer space. *Space Policy*, 60, 101487;

constellations such as Starlink and ViaSat, and in remote sensing, firms including Maxar and Capella Space, deploy dual-use satellites that the Department of Defence can leverage in times of crisis. The war in Ukraine is accelerating this trend, demonstrating that commercial actors can become indispensable enablers of operational resilience, particularly when the survival of a friendly political entity is at stake[136]. The rapid deployment of Starlink terminals to sustain Ukraine's communications infrastructure reinforced the perception that private capabilities are no longer peripheral but essential in conflict environments. In this context, the US, leveraging its dominant commercial sector, is opting against developing sovereign constellations, instead embedding private systems into national security through binding contracts[137]. SpaceX, Amazon's Project Kuiper, and others are integrated into DoD and NASA frameworks, guaranteeing availability in contested environments, prioritizing military traffic, and enabling strategic reconfiguration. Classified programmes like Starshield adapt commercial platforms for secure governmental use, including hosting military payloads and encrypted communications[138]. Oversight mechanisms have tightened accordingly: the FCC and NTIA now exercise expanded authority over spectrum allocation, licensing, and debris mitigation, while the Office of Space Commerce has assumed a central role in civil SSA and traffic management. Financially, procurement mechanisms—such as SDA transport layer contracts and scaling agreements—ensure rapid mobilization of commercial orbital capacity in crises, effectively transforming the private sector into an operational reserve of US space power.

Before Russia invaded Ukraine in 2022, the United States had already begun to define outer space as a domain of great-power competition. However, its pursuit of strategic autonomy was still rooted in unilateral primacy complemented by selective partnerships. Initiatives such as the Artemis program and early Space Domain

[136] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: The case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), p. 846;
[137] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: The case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), p. 846;
[138] Dobos, B., 2022. Tortoise the Titan: Private entities as geoeconomic tools in outer space. *Space Policy*, 60, pp. 4-5;

Awareness (SDA) arrangements with Five Eyes allies and NATO states demonstrated a willingness to cooperate[139]. Nevertheless, these frameworks were structured to reinforce US leadership rather than share control. Artemis, for instance, was presented as a cooperative platform for lunar exploration. However, its architecture—from ESA's provision of the Orion Service Module to JAXA's and Canada's roles in the Lunar Gateway—was designed to consolidate advanced capabilities within a U.S.-led ecosystem governed by the Artemis Accords[140]. This governance framework promoted interoperability among allies while excluding (not explicitly) strategic rivals, leaving Russia and China to pursue parallel ecosystems anchored in the Angara and Long March programs[141]. The invasion of Ukraine marked a decisive turning point, sharpening great-power rivalry and accelerating the fragmentation of space governance along geopolitical lines. The United States increasingly casts Russia and China as competitors and adversaries to be systematically excluded from cooperative frameworks. Strategic autonomy has since been embedded in bloc-based partnerships underpinned by significant multinational investments. The enhanced cooperation of SDA with Five Eyes and NATO partners has expanded global surveillance coverage by integrating allied radar and optical sensors into the Unified Data Library, transforming these partners into operational nodes within America's security framework. Unlike the earlier reliance on symbolic collaboration, this post-2022 framework embeds allied infrastructures directly into US strategy, producing a layered autonomy rooted in coalition resilience. At the same time, Washington has carefully limited deep technological integration and intelligence sharing to longstanding allies, ensuring that programmes such as Artemis function not only as exploration initiatives but as strategic instruments consolidating bloc cohesion and reinforcing exclusionary governance norms. In parallel, Russia and China have accelerated their initiatives—notably the International Lunar Research Station and Tiangong space station—thus consolidating

[139] Wilson, R.S. (2024) *FY 2025 defense space budget: Continued emphasis on proliferation under a more constrained top-line*. Center for Space Policy and Strategy, June;
[140] Bilal, M. (2024) 'The Advent of Astropolitical Alliances', *SpaceNews*, 8 January;
[141] Bilal, M. (2024) 'The Advent of Astropolitical Alliances', *SpaceNews*, 8 January;

alternative ecosystems[142]. The result is a post-2022 environment in which US strategic autonomy is pursued through exclusive alliances that lock adversaries out of critical infrastructures, entrenching a fragmented global order where access to orbital resources and data increasingly follows the fault lines of great-power rivalry.

[142] Shen, Yi, 2020. Security and Interdependence: How to Avoid Negative Spillover Effect of Sino-U.S. Tech Competition. Valdai Discussion Club;

2.2. ORBITAL CROWDING AND GEOPOLITICAL BALANCE

Since the early 2000s, outer space has been steadily transforming. At the beginning of the century, fewer than 1,000 active satellites orbited Earth, and annual launches rarely exceeded 70, almost all conducted by central spacefaring states with state-owned rockets. This relatively stable environment gradually shifted with the advent of commercial operators, the miniaturization of technology, and the rise of small satellites[143]. The period following the Russian invasion of Ukraine in 2022 represents a decisive break with previous patterns. The conflict underscored the geopolitical relevance of commercial infrastructures, above all communications constellations and Earth observation satellites, while coinciding with an unprecedented acceleration of launch activity[144]. According to the European Space Agency, catalogued objects increased from about 33,000 in early 2022 to nearly 40,000 by January 2025, with around 11,000 active payloads[145]. ESA's annual space environment report (2024) illustrates the scale of congestion: 54,000 objects larger than 10 centimetres, 1.2 million between 1 and 10 centimetres, and an estimated 130 million fragments measuring 1 millimetre to 1 centimetre. The pace of deployment has equally intensified. Global launches rose from 186 in 2022 to 221 in 2023, accompanied by a 48 per cent increase in total mass delivered to orbit. That year alone, 2,940 spacecraft were deployed, the majority belonging to commercial operators, with SpaceX's Starlink constellation accounting for nearly two-thirds of total launches[146]. By July 2025, ESA's DISCOS database recorded over 40,000 tracked objects, including over 15,000 payloads, of which roughly 12,300 were operational.

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[143] Melamed, A., Rao, A., de Rohan Willner, O. & Kreps, S. (2024) *'Going to outer space with new space: The rise and consequences of evolving public-private partnerships'*, Space Policy, 68, pp. 4-6;

[144] Radin, A., Holynska, K., Tretter, C. & Van Bibber, T. (2025) *Lessons from the War in Ukraine for Space: Challenges and Opportunities for Future Conflicts*. Research report, RAND Corporation, RR-A2950-1, pp 4-16;

[145] European Space Agency (2025) *ESA's annual space environment report*. Prepared by ESA Space Debris Office;

[146] European Space Agency (2025) *ESA's annual space environment report*. Prepared by ESA Space Debris Office;

Two qualitative developments are particularly relevant to the question of strategic autonomy. The first is the proliferation of dual-use satellites. Research by SIPRI and IISS[147] demonstrates that a growing share of commercial platforms, especially in communications, navigation, and Earth observation, possess capabilities that can be leveraged for military operations. This duality complicates governance, blurs distinctions between civilian and military assets, and raises urgent and critical challenges for autonomy in access to secure reliable space-based services. The second is the democratization of access to orbit. The diffusion of small satellites and CubeSats has enabled universities, research institutions, and emerging space nations to establish a presence in orbit. According to UNOOSA, more than 30 states have launched CubeSats since 2020, while the OECD highlights how cost reductions in launch services have lowered entry barriers. This diversification expands the range of actors but contributes to orbital congestion and the complexity of coordination mechanisms in space traffic management.

The geopolitical shocks since 2022 have sharpened this reality, highlighting a key exogeographic feature: specific orbital altitude bands function as strategic chokepoints, not unlike congested maritime straits on Earth[148]. This is more evident in low Earth orbit (LEO), particularly in the 500–600 kilometre shell, prized for its revisit frequency, spatial resolution, and manageable atmospheric drag balance. This altitude is essential for persistent intelligence, surveillance, reconnaissance (ISR) operations and high-capacity broadband services. However, the rapid concentration of satellites in this narrow band, primarily driven by commercial megaconstellations, has raised densities to levels approaching the centimetre-scale debris population[149]. The result is a mounting operational strain: collision-avoidance manoeuvres are more frequent, safe orbital slots harder to secure, and conjunction warnings increasingly saturated with false positives, complicating effective space traffic management. As one of the main

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[147] International Institute for Strategic Studies (IISS) (2025) *Space Capabilities to Support Military Operations in the European Theatre*. Research report;
[148] Tanveer, R. (2024) 'Space warfare between Russia and the United States: Implications for European Union security in 2023–2024', *Journal of Regional Studies Review*, 3(1), pp. 191;
[149] European Space Agency (2025) *ESA's annual space environment report*. Prepared by ESA Space Debris Office;

trends emerging from these shocks after 2022 due to their increased resilience and redundancy, the rapid expansion of mega-constellations has significantly limited orbital flexibility for new entrants, both technically and regulatorily, consolidating the positional advantages of early-deployed systems. Starlink, OneWeb, and China's Guowang have secured the most favourable orbital planes and inclinations, leaving few uncontested slots[150]. ESA's Space Environment Report[151] records a more than 50% increase in collision-avoidance manoeuvres in this band between 2022 and 2024, raising baseline operational friction, propellant expenditure, and scheduling delays for newcomers.

In this context, orbital congestion has shifted from an unintended consequence of technological progress to a competitive instrument in great-power rivalry. Governments are deploying LEO mega-constellations to build resilience, secure communications, strengthen ISR capabilities, and ensure service continuity in conflict conditions, even if this contributes to increased congestion of orbits and their transmission bands[152]. For Washington, Starlink's wartime role has demonstrated commercial constellations' military and political utility, particularly in Ukraine. Beijing's Guowang mirrors this model, embedding dual-use capabilities into the Belt and Road digital infrastructure strategy. For Brussels, these dynamics have driven initiatives such as IRIS² and PESCO-led space projects to secure sovereign communications, integrate Space Situational Awareness into the CSDP, and reduce dependence on non-EU operators.

A parallel dynamic is visible in geostationary orbit (GEO), where longitudinal slots above high-demand regions, especially the Asia-Pacific and Atlantic corridors, are nearing saturation. GEO's fixed positions and limited ITU-regulated slots have

[150] Jones, A., 2024. China is building on-orbit space situational awareness capabilities to navigate crowded orbits. *SpaceNews*, 9 December;
[151] European Space Agency (2025) *ESA's annual space environment report*. Prepared by ESA Space Debris Office;
[152] European Space Policy Institute (ESPI) (2023) *Space Spectrum Policy Report*. European Space Policy Institute, pp. 2-9;

intensified competition[153]. Operators now use station-keeping tolerances measured in tenths a degree to enable denser clustering. This practice increases the risk of radiofrequency interference and proximity operations with ambiguous intent[154]. According to the ESPI Space Spectrum Policy Report[155], the GEO belt is contested not only for commercial broadcasting and broadband, but also for military communications and strategic early-warning systems. Such disruptions in these slots may trigger diplomatic or military escalation, emphasizing the risks and consequences associated with the GEO belt.

In this space environment the International Telecommunication Union's (ITU) first-come, first-served system for spectrum and orbital filings reinforces the asymmetries already evident in post-2022 orbital competition. Having secured priority frequency allocations and orbital slots before the recent launch surge, early entrants can constrain later arrivals to less desirable parameters, often entailing higher latency, reduced coverage efficiency, or greater interference risk[156]. This creates a form of regulatory lock-in that mirrors the "strategic denial" mechanisms seen in maritime chokepoints, where control of key ports or sea lanes limits rivals' manoeuvrability and long-term competitiveness. Economically, this asymmetry is amplified by the vertical integration strategies of dominant operators. SpaceX, for example, owns Starlink's constellation and controls its launch capacity, enabling rapid replenishment, redeployment, and orbital adjustment at a scale inaccessible to most competitors[157]. Similarly, China's Guowang benefits from state-backed launch services, preferential access to domestic manufacturing, and a dedicated ground-segment network, shielding it from competitive displacement. Smaller actors—whether commercial or national—are thus left dependent on incumbents' terms, pricing, or spectrum-sharing arrangements.

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[153] Rice, E., 2023. *Deterrence and space strategy*. Space Power Series SP 02. London: Council on Geostrategy, pp. 40-43;
[154] European Space Policy Institute (2023). *Space spectrum policy report*. Vienna: ESPI, pp. 2-4;
[155] European Space Policy Institute (2023). *Space spectrum policy report*. Vienna: ESPI, pp. 9-13;
[156] Roberts, T. G. & Linares, R. (2022) *A Survey of International Telecommunication Union (ITU) Space Station License Applications in the Geosynchronous Orbital Regime (GEO)*. AMOS Technical Paper, Advanced Maui Optical and Space Surveillance Technologies Conference, 2022;
[157] Tanveer, R. (2024) 'Space warfare between Russia and the United States: Implications for European Union security in 2023–2024', *Journal of Regional Studies Review*, 3(1), p. 192;

Strategically, the effect is analogous to terrestrial competition over physical chokepoints, where control of access routes determines both the flow of traffic and the strategic latitude of dependent states. Just as maritime powers have historically leveraged control over straits such as Malacca or Hormuz to influence alignments and extract concessions, holders of prime orbital positions can, in times of crisis, restrict manoeuvre space, disrupt service continuity, or impose costly re-routing of orbital traffic. In the post-2022 environment of heightened great-power rivalry, such positional dominance translates directly into political leverage, making the control of key orbital corridors as consequential to global security as controlling any terrestrial transit route[158].

The geography–security nexus directly shapes the strategic calculus of actors with varying degrees of orbital dependence. For highly reliant powers, the consequences of disrupted access to key orbital chokepoints are systemic. The United States and the European Union exemplify such cases: satellite-based communications, navigation, and ISR (intelligence, surveillance, reconnaissance) underpin critical functions ranging from energy distribution to disaster management. This interdependence reveals a structural vulnerability: as orbital space grows more congested and contested, the potential for rivals to exploit geography and information as instruments of power expands. The war in Ukraine has intensified this securitization of orbital control, underscoring the necessity of safeguarding access not only against competitive encroachment on slots but also against hostile interference. In this environment, SSA emerges as both an operational enabler and a prerequisite of strategic autonomy in outer space, particularly as congestion and militarization accelerate[159].

In the United States, the transformation of space situational awareness (SSA) is reflected in the 2023 update to the National Space Policy Directive framework, which reinforced the Department of Commerce's Office of Space Commerce mandate to

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[158] Ramanathan, A. and Pareek, A., 2021. *Space as a geopolitical environment*. Takshashila Discussion Document 2021-5, V1.0, 2 September 2021. Bengaluru: Takshashila Institution, pp. 12-13;
[159] United States Government Accountability Office (GAO) (2023) *Space Situational Awareness: DOD Should Evaluate How It Can Use Commercial Data*. Report to Congressional Committees, GAO-23-105565, April;

provide open-access conjunction warnings while expanding classified SSA capabilities under U.S. Space Command (USSPACECOM)[160]. This evolution contrasts with the period prior to Russia's full-scale invasion of Ukraine in February 2022, when U.S. policy still relied heavily on Cold War–era structures, with civil and military tracking efforts proceeding in parallel and the integration of commercial data into official channels remaining limited[161]. The war in Ukraine marked a decisive break from this trajectory by demonstrating the operational indispensability of commercial space systems. Starlink terminals, rapidly deployed in their thousands across the country, ensured continuity of communications when terrestrial networks were degraded, while imagery from companies such as Maxar and Planet provided near-real-time intelligence on Russian troop movements[162]. The Viasat hack and Russia's ongoing jamming efforts against Starlink have highlighted the vulnerabilities in hybrid systems that mix public and private assets. This situation underscores the strategic importance and the fragility of commercial satellite constellations[163].

As a response, the United States accelerated efforts to institutionalize the integration of commercial capabilities into national security frameworks. The 2024 National Defence Authorisation Act allocated $130 million to incorporate commercial SSA data directly into military decision-making systems. By 2025, the U.S. Space Surveillance Network was tracking over 47,000 objects, with military-channel low-Earth orbit conjunction alerts achieving latencies of less than 1.5 seconds and predictive accuracy for most active satellites within a 100-meter positional uncertainty. This increase in precision reduces unnecessary manoeuvres, conserving fuel and extending satellite lifespans, and reflects the recognition of space as an operational domain shaped by

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[160] Center for Global Security Research (2024) *Refresh or reform: U.S. space strategy in 2025 – annotated bibliography*. Lawrence Livermore National Laboratory, 22–23 October 2024;
[161] NASA (2023) *A Post–Cold War Assessment of U.S. Space Policy*. Washington, DC: National Aeronautics and Space Administration;
[162] Ogden, T., Knack, A., Lebret, M., Black, J. & Mavroudis, V. (2024) *The role of the space domain in the Russia-Ukraine war and the impact of converging space and AI technologies.* CETaS Expert Analysis, February, p. 4;
[163] Radin, A., Holynska, K., Tretter, C. & Van Bibber, T. (2025) *Lessons from the War in Ukraine for Space: Challenges and Opportunities for Future Conflicts*. Research report, RAND Corporation, RR-A2950-1, pp. 28-30;

real-time conflict dynamics[164]. Ukraine's deployment of its "Delta" situational awareness system, which integrates satellite imagery, drone feeds, and allied intelligence, served as a model for the fusion of heterogeneous sources in support of military operations, and its success reinforced U.S. efforts to promote hybrid frameworks that blend redundancy with technological agility[165]. The U.S. approach thus embodies a doctrinal shift toward a comprehensive space domain awareness strategy, accelerated by the lessons of the war in Ukraine. It underscores the growing centrality of commercial actors in sustaining both strategic autonomy and operational resilience.

For the European Union, the development of space situational awareness (SSA) has been framed within the broader resilience doctrine, codified in the EU Space Strategy for Security and Defence (2023) and operationalized through the expansion of the EU Space Surveillance and Tracking (EUSST) framework under Decision (EU) 2022/2039. Before Russia's full-scale invasion of Ukraine, the EU's SSA posture remained relatively modest, with the EUSST initiative still in its consolidation phase and its outputs largely complementary to U.S. Space Command data[166]. The war in Ukraine, however, underscored the strategic risks of dependency on external actors by exposing the vulnerabilities of commercial satellite infrastructures to cyber and jamming attacks, and by demonstrating the decisive role of space-based services in sustaining battlefield communications and intelligence[167]. These lessons reinforced the urgency of cultivating autonomous European capabilities to provide independent situational awareness in crisis scenarios[168]. Between 2022 and 2025, the EUSST network expanded from 12 to 19 contributing sensors, extending independent tracking

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[164] Bondar, K. (2024) *Does Ukraine already have a functional CJADC2 technology?* Center for Strategic and International Studies (CSIS), 11 December;
[165] Bondar, K. (2024) *Does Ukraine already have a functional CJADC2 technology?* Center for Strategic and International Studies (CSIS), 11 December;
[166] Faucher, P., Peldszus, R. & Gravier, A. (2019) 'Operational Space Surveillance and Tracking in Europe', in *Proceedings of the 5th International Orbital Debris Conference*, Rimini, Italy;
[167] Radin, A., Holynska, K., Tretter, C. & Van Bibber, T. (2025) *Lessons from the War in Ukraine for Space: Challenges and Opportunities for Future Conflicts*. Research report, RAND Corporation, RR-A2950-1, pp. 28-30;
[168] Reis, J. (2024) 'European Union defense and security strategy for space and ground-based systems against hybrid threats', *Acta Astronautica*, 225, p. 64;

capacity to over 13,000 objects in low- and medium-Earth orbit[169]. Public data latency averages around 12 seconds, while conjunction prediction accuracy approaches a 250-meter uncertainty threshold. Although these figures still trail the more advanced U.S. military systems, they represent a significant step forward in the EU's ability to take autonomous operational decisions[170]. The 2024 inclusion of all EU spacefaring states as full EUSST members marked a turning point, enabling a distributed governance model that enhances resilience through redundancy and sensor interoperability. This evolution has been accompanied by adopting AI-driven data processing and cross-domain sensor integration, which improves predictive accuracy and shortens decision-making cycles[171].

Public–private participation has also been critical, as European satellite operators and service providers are increasingly integrated into EUSST's data-sharing and conjunction-avoidance protocols. This reflects a deliberate strategy to distribute resilience across State and industry assets, reducing vulnerability to single-point failures while strengthening Europe's capacity to act independently during geopolitical crises. In this sense, the post-Ukraine expansion of SSA capabilities illustrates not only a technical upgrade, but also a structural adjustment in the EU's approach to strategic autonomy: space governance is no longer treated merely as a cooperative domain, but as a critical component of crisis management and security policy[172].

China's post-2022 trajectory has equally significant shaped the global SSA trajectory. Official disclosures and external analyses indicate that Beijing has launched at least ten dedicated SSA satellites since 2022, with orbital behaviour suggesting the presence of up to eight additional unacknowledged platforms. The People's Liberation Army Strategic Support Force controls over 260 military satellites, including assets optimized for surveillance, early warning, and close-proximity operations. Ground-based SSA

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[169] European Space Agency (2024) *ESA report on the space economy 2024*. Paris: ESA, pp. 3-9;
[170] European Commission (2023) – *EU Space Surveillance and Tracking (EUSST) Partnership signs €173 million in grants to enhance capabilities*. European Commission, 30 November 2023;
[171] EUISS, 2023
[172] Küsters, A., Nolen, N. & Stockebrandt, P., 2023. *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 3-6;

capabilities have expanded through advanced radar and laser-ranging installations, including the Bohu facility in Xinjiang, supporting counterspace research. Internationally, China has leveraged the Belt and Road framework to establish 23 space cooperation agreements, including ground infrastructure components, extending its global tracking reach and securing political capital in multilateral space governance debates[173].

The strategic implications of these parallel investment trajectories are magnified by an acute risk of miscalculation in a domain where orbital congestion is sharply reducing manoeuvre margins. Narrowing spatial buffers means that close approaches, station-keeping adjustments, or on-orbit inspections, activities that might once have been interpreted as routine, now carry a far greater chance of being perceived as deliberately provocative. This is exacerbated by the inherently dual-use nature of many space systems, whose technical capabilities blur the line between civil and military purposes. In addition to the heightened competition characterizing orbital space[174].

The investment race in SSA capabilities thus mirrors the broader dynamics of great-power competition, with post-2022 figures revealing both an intensification of funding and a diversification of actor involvement. Public sector spending remains the structural backbone, underwriting capital-intensive infrastructure such as high-power radars, orbital tracking satellites, and sovereign data integration hubs. Private sector participation, by contrast, has concentrated on high-agility segments: AI-driven analytics, distributed sensor networks, and commercial service platforms that can be procured rapidly and scaled flexibly[175].

In the United States, public allocations since 2022 have prioritized the consolidation of national command over SSA infrastructure, with the FY2025 U.S. Space Force budget request of US $29.6 billion containing substantial SDA line items. The Department of

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[173] Tanveer, R. (2024) 'Space warfare between Russia and the United States: Implications for European Union security in 2023–2024', *Journal of Regional Studies Review*, 3(1), pp. 191;
[174] Hammack, K. (2021) 'International Relations in Space: The Role of Miscalculation, Militarization, and Weaponization', *Astropolitics: The International Journal of Space Politics & Policy*, 19(3), pp. 230–236.
[175] European Space Agency (2024) *ESA report on the space economy 2024*. Paris: ESA, pp. 3-9;

Commerce's Office of Space Commerce has sought US $75.6 million to operationalize the Traffic Coordination System for Space (TraCSS), blending government-collected data with commercial inputs. Private actors like LeoLabs and COMSPOC have expanded sensor coverage and real-time analytics capacity, with venture and defence contracts driving rapid capability deployment[176].

In the European Union, the EUSST Partnership signed €173 million in grants in 2023 to expand its sensor base and integrate AI processing, with around 80 per cent of the funds redistributed through subcontracting and cascading grants to European entities[177]. Companies such as GMV and Telespazio contribute software, collision-avoidance services, and sensor operations, while recent tenders have allocated over €15 million to commercial providers to supply tracking data[178]. Co-financing arrangements allow privately owned sensors to feed into public tracking networks, creating a hybrid architecture that strengthens resilience by distributing capabilities across state and industry actors.

In contrast, in China, the SSA sector remains predominantly state-run, with at least ten dedicated SSA satellites deployed since 2022 and extensive ground-based expansion. Private companies such as HEAD Aerospace contribute niche optical tracking and data services. However, their activity is strategically aligned with state priorities, reflecting a centralized model that contrasts with the pluralistic Western approach[179].

In this competitive environment, the densification of orbits and the heightened orbital competition provoked by the Russian invasion of Ukraine in 2022 have transformed congestion from a technical challenge into a strategic variable. For high-dependency actors, the imperative is to neutralize the coercive potential of congestion through informational parity or superiority. For less-dependent actors, the incentive is to exploit

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[176] Wilson, R.S. (2024) *FY 2025 defense space budget: Continued emphasis on proliferation under a more constrained top-line*. Center for Space Policy and Strategy, June;

[177] European Commission (2023) – *EU Space Surveillance and Tracking (EUSST) Partnership signs €173 million in grants to enhance capabilities*. European Commission, 30 November 2023;

[178] European Commission (2023) – *EU Space Surveillance and Tracking (EUSST) Partnership signs €173 million in grants to enhance capabilities*. European Commission, 30 November 2023;

[179] Jones, A., 2024. *China is building on-orbit space situational awareness capabilities to navigate crowded orbits*. SpaceNews, 9 April.

congestion as a cost-imposing mechanism. The interplay between these opposing imperatives defines the emerging orbital order—one in which strategic autonomy is inseparable from SSA capability, and where the ability to see, decide, and act first can determine tactical outcomes and the balance of deterrence itself.

2.3. ORBITAL GEOGRAPHY AND POWER PROJECTION ON EARTH

As competition for orbital control intensifies, outer space, particularly the most congested orbits around Earth, has become directly intertwined with terrestrial power projection. Strategic autonomy is increasingly regarded as a prerequisite and a decisive enabler of influence on Earth. Historically, however, the role of outer space was conceived in a different register: it was functional to power projection primarily as a source of international prestige and symbolic standing. Space achievements, such as the launch of satellites, human spaceflight, or planetary exploration, were seen less as operational necessities than as demonstrations of technological superiority and national power, reinforcing status within the international system[180]. Orbital infrastructure was therefore regarded as an enabling but secondary layer, supporting terrestrial operations while showcasing a state's capacity to compete in the highest frontier of modernity. The russian invasion of Ukraine changed this rhetoric: commercial and military space assets enabled real-time ISR, precision targeting, secure communications, and the coordination of multinational operations. This experience redefined orbital geography as a form of strategic high ground, whose control, or loss, directly alters the global balance of power[181].

In this post-2022 strategic landscape, space power is recognized as a pillar of national power, shaping military readiness, economic stability, diplomatic leverage, and technological influence[182]. The ability to access, control, and exploit orbital infrastructure now underwrites a state's capacity to project power globally[183]. This is reflected in the scale and distribution of resources dedicated to space: the United States accounts for over 60% of global government space spending in 2023, with defence-

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[180] Cross, M.K.D. and Pekkanen, S.M., 2023. *Space Diplomacy: The Final Frontier of Theory and Practice* (Introduction). Manuscript received 13 May 2022; revised 2 December 2022; accepted 27 February 2023, pp. 198;

[181] Tanveer, R., 2024. Space warfare between Russia and the United States: Implications for European Union security in 2023–2024. *Journal of Regional Studies Review*, 3(1), pp.189–199;

[182] Rice, S., 2022. *Deterrence and space strategy*. London: London Institute of Space Policy and Law, 37-43;

[183] Rice, S., 2022. *Deterrence and space strategy*. London: London Institute of Space Policy and Law, 37-43;

related programmes representing roughly 85% of its national space budget. China's space expenditure reached $14.5 billion in 2023, supported by more than 60 launches. Despite sanctions and economic strain, Russia continues allocating over half its space budget to military and dual-use systems[184]. The European Union's investments, led by programmes such as IRIS², explicitly link orbital capabilities to secure communications and strategic autonomy. These allocations are not merely technological but deliberate political choices to embed space within national power strategies, confirming that orbital control has become a decisive factor in shaping crisis outcomes, sustaining expeditionary operations, and exerting influence beyond national borders[185].

The maritime analogy, long used to conceptualize the strategic value of orbital control, has gained renewed analytical weight since 2022. Just as control of maritime chokepoints historically enabled the projection of naval power and the regulation of global trade flows, mastery of orbital lines of communication, particularly in LEO and GEO, now underpins a state's ability to project military force, maintain economic stability, and shape geopolitical outcomes[186]. The parallels extend beyond the notion of "sea lanes in space" to encompass the legal, infrastructural, and logistical dimensions of power: orbital slots and frequency allocations function as strategic real estate; launch corridors act as vital supply lines; and ground station networks resemble dispersed naval bases, anchoring a state's global operational reach.

In this regard, the conflict in eastern Europe has demonstrated that deterrence in orbit is no longer an abstract concern but a core operational requirement for ensuring credibility, reach, and tempo in joint force planning. Protecting orbital infrastructure has become indispensable to maintaining ISR coverage, secure communications, and reliable navigation, functions without which modern expeditionary and high-intensity operations would falter. This recognition is driving a parallel investment race in Space

[184] Tanveer, R., 2024. *Space warfare between Russia and the United States: Implications for European Union security in 2023–2024*. *Journal of Regional Studies Review*, 3(1), pp.189–199.
[185] Bahney, B. (ed.), 2020. *Space strategy at a crossroads: Opportunities and challenges for 21st century competition*. Livermore, CA: Center for Global Security Research, Lawrence Livermore National Laboratory, pp. 7-16;
[186] Ramanathan, A. and Pareek, A., 2021. *Space as a Geopolitical Environment*. Takshashila Discussion Document 2021–5 V1.0, 02 September 2021, pp. 15-16;

Situational Awareness (SSA), as Brussels and Washington increasingly view the protection of space assets from deliberate attacks and accidental hazards as a foundation of credible deterrence (see paragraph 2.2).

The core pillars of deterrence (denial, punishment, and entanglement) remain conceptually intact. However, in the contemporary post-2022 strategic environment, they have been explicitly reframed as mechanisms for safeguarding the uninterrupted flow of space-enabled capabilities that underpin terrestrial military operations[187]. Deterrence by punishment—whether through demonstrated counterspace capabilities, covert readiness, or the credible threat of proportionate multi-domain retaliation, explicitly targets the adversary's cost-benefit calculus, raising the price of an attack to levels that would compromise their overarching strategic aims. Deterrence by entanglement, increasingly salient in the commercialized and multinational space ecosystem, embeds critical infrastructure in transnational and public-private constellations. This ensures that hostile action risks cascading diplomatic, economic, and military consequences[188].

On the other hand, deterrence by denial has emerged as the preferred strategy, reflecting the recognition that in a congested, contested, and competitive orbital domain, the most credible path to dissuading aggression is to make hostile actions infeasible or prohibitively costly in operational terms. Recent scholarship defines denial in space as relying on asymmetric approaches and optimized postures that reduce incentives for early attack by deploying diverse, resilient, redundant constellations; enhancing defensive measures; and ensuring rapid recovery from disruption through reconstitution capabilities[189]. In practice, this post-2022 operationalization of denial is visible in integrating resilient multi-orbit architectures, rapid-launch reconstitution capacity, and advanced hardening against kinetic and non-

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[187] Moltz, J.C., 2023. The role of space power in geopolitical competition. *Georgetown Public Policy Review*, 28(1), pp.35–43;

[188] Moltz, J.C., 2023. The role of space power in geopolitical competition. *Georgetown Public Policy Review*, 28(1), pp.35–43;

[189] Rice, S., 2022. *Deterrence and space strategy*. London: London Institute of Space Policy and Law, pp. 12-15;

kinetic interference[190]. These measures ensure that space-based ISR, navigation, and communications systems remain operational under sustained attack, enabling terrestrial commanders to maintain operational tempo, coordinate dispersed forces, and execute precision strikes even in contested environments. Notable examples include the European Union's IRIS² programme, which will field approximately 290 satellites in a multi-orbit LEO–MEO configuration by 2027, supported by a €6 billion 12-year concession; orbital filings specify altitudes from 500 to 23,222 km and up to 899 orbital planes, providing disaggregation and redundancy. In parallel, the U.S. Space Development Agency's Proliferated Warfighter Space Architecture (PWSA) Tranche 1 Transport Layer will deploy 126 optically-interconnected satellites across 10 orbital planes, each equipped to sustain at least four simultaneous laser cross-links, allowing real-time rerouting around jammed or compromised RF channels[191]. Complementing architectural resilience, rapid-launch reconstitution has been operationally validated by the U.S. Space Force's Tactically Responsive Space (Victus Nox) mission, which progressed from launch order to liftoff in 27 hours and achieved full activation in 57 hours, meeting the ≤ 60-hour benchmark for restoring degraded space capabilities. In the launcher sector, the EU is still lagging sensibly behind[192]. Even though the successful launch of the Ariane 6 in 2025 has allowed the EU to have independent heavy launch capabilities, the development of light capabilities (essential for proliferated and redundant launches in LEO), particularly by Vega C, is still underway. In addition, Sweden's state-owned SSC inaugurated the mainland EU's first orbital launch complex in Jan 2023; authorities note that the first orbital missions are planned from 2025, underpinning future rapid-launch options from EU soil[193].

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[190] Aliberti, M. and Lisitsyna, N., 2024. *Innovating deterrence strategies in the new space age*. European Space Policy Institute.
[191] Paravano, A., Locatelli, G. and Trucco, P., 2023. What is value in the new space economy? The end-users' perspective on satellite data and solutions. *Acta Astronautica*, 204, pp.640–654;
[192] European Space Policy Institute, 2024. *Space workshop: Annotated bibliography*. Vienna: European Space Policy Institute;
[193] Swedish Space Corporation (SSC), 2023. *Spaceport Esrange inaugurated: mainland EU's first orbital launch complex*;

This fusion of deterrence with power projection has redefined the strategic value of orbital geography. Control of key orbital vantage points no longer merely supports terrestrial operations; it ensures the uninterrupted delivery of capabilities without which those operations cannot succeed. Without credible deterrence, adversaries could neutralize or degrade space-based systems, forcing states to operate "blind" or "deaf" and stripping them of the ability to coordinate large-scale or distant operations. With credible deterrence, space assets remain intact and operational, enabling sustained reach, precision, and tempo in global military and political engagements.

The U.S. approach to space deterrence has undergone a marked transformation after 2022. For much of the post–Cold War era, American space strategy rested on the assumption of uncontested orbital superiority[194]. Deterrence in this period was largely implicit, grounded in overwhelming technological dominance and the absence of peer competitors capable of threatening U.S. assets. Space was framed primarily as a sanctuary and enabler of terrestrial military operations, rather than as a domain in which deterrence dynamics had to be explicitly cultivated. The return of great-power competition, crystallized by Russia's war in Ukraine and China's rapid military build-up, has forced a reconceptualization of deterrence in space. Contemporary U.S. doctrine recognizes that orbital systems are prime targets in any conflict and that deterrence must operate across multiple levels: denial (through resilience and redundancy), punishment (through credible counter-space capabilities), and signalling resolve in crisis scenarios[195]. Integrated deterrence explicitly extends this logic into the space domain, aligning it with cyber, nuclear, and conventional deterrence in a unified framework designed to complicate adversary decision-making. Programs like Missile Warning/Missile Tracking (MW/MT), Protected Tactical SATCOM, and proliferated LEO constellations used for missile tracking and communications embody what the Pentagon calls "resilience by architecture." This strategy disperses capabilities across

[194] Rice, D.M., 2023. *Deterrence and space strategy: a framework from the study of history and theory*. Schriever Paper No. 2. Maxwell Air Force Base, AL: Air University Press, pp. 40-42
[195] Rice, D.M., 2023. *Deterrence and space strategy: a framework from the study of history and theory*. Schriever Paper No. 2. Maxwell Air Force Base, AL: Air University Press, pp. 24-26;

redundant and diversified platforms to deny adversaries the benefits of a first strike[196]. At the same time, the U.S. maintains the option of retaliatory counter-space operations, ensuring that adversaries risk escalation if they attempt to degrade American space assets[197]. This shift reflects a broader strategic recalibration: the recognition that without assured space access, U.S. forces would lose the global reach, precision, and tempo that underpin their expeditionary credibility[198]. As a result, resilience, redundancy, and retaliation now form a triad of American space deterrence, tightly integrated into the multi-domain architecture of U.S. power projection.

The European Union's posture is less explicitly warfighting-oriented than the United States. However, it converges on the same strategic imperative: safeguarding space infrastructure as a prerequisite for political influence and military autonomy. Initiatives such as IRIS², the development of sovereign launch capabilities (Ariane 6, Vega-C, and future reusable systems), and the integration of Space Situational Awareness (SSA) into defence planning are all designed to secure communications, autonomous navigation, and ISR continuity in times of crisis. In EU doctrine, resilience equates to operational continuity, which underpins sustained overseas deployments and preserving diplomatic leverage. By embedding redundancy and autonomy into orbital infrastructure, the EU aims to pre-empt the coercive leverage adversaries could exert through space denial[199].

The war in Ukraine marked a decisive turning point in Europe's conception of deterrence in space. For decades, flagship programmes such as Galileo and Copernicus were primarily civilian in orientation, justified on innovation, competitiveness, and technological independence. While their dual-use potential was acknowledged, space was treated mainly as a permissive environment, detached from the logic of

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[196] Moltz, J.C., 2023. The role of space power in geopolitical competition. *Georgetown Public Policy Review*, 28(1), pp.35–43;
[197] Ramanathan, A. and Pareek, A., 2021. *Space as a geopolitical environment*. Takshashila Discussion Document 2021-5, V1.0, 2 September 2021. Bengaluru: Takshashila Institution, pp. 17-18;
[198] Salvadori, R., 2024. *Info Flash*. Finabel – The European Land Force Commanders Organisation, July. Written by Rocco Salvadori; edited by Paola Nadal; supervised by Riccardo Angelo Grassi. Brussels, p. 5;
[199] Salvadori, R., 2024. *Info Flash*. Finabel – The European Land Force Commanders Organisation, July. Written by Rocco Salvadori; edited by Paola Nadal; supervised by Riccardo Angelo Grassi. Brussels, p. 5;

confrontation and deterrence. That assumption collapsed after 2022. Russia's invasion exposed the vulnerability of orbital assets to kinetic strikes, cyber interference, and hybrid disruption, while simultaneously demonstrating their indispensable role in real-time situational awareness and allied operational coordination. Europe's reliance on U.S. and private constellations, most visibly Starlink in Ukraine, highlighted the centrality of space to modern warfare and the risks of dependence on external actors. Several strategic assessments observed that the conflict acted as a "fog-clearing moment," revealing that Europe cannot base its security on transatlantic guarantees alone[200]. Since then, the EU has reconceptualized space as an economic enabler and a strategic domain integral to deterrence. The Strategic Compass (2022) explicitly incorporated space alongside cyber and hybrid threats as part of Europe's collective security responsibilities. New initiatives, IRIS², enhanced SSA integration, and investments in sovereign launch systems reflect this shift by linking orbital resilience directly to military autonomy and political credibility. Unlike the pre-2022 era of fragmented projects with limited defence orientation, today's approach embeds space firmly within the logic of strategic autonomy: ensuring that adversaries cannot paralyze Europe's crisis response by targeting its infrastructures[201].

Finally, the war in Ukraine has reshaped a core dimension of deterrence: counterspace capabilities. These can be divided into kinetic and non-kinetic means, each carrying distinct strategic implications. Kinetic systems, such as direct-ascent anti-satellite missiles or co-orbital interceptors, are associated with deterrence by punishment, as they can irreversibly disable or destroy adversary satellites. Their power lies in imposing visible and severe costs, but their use is politically risky. The 2007 Chinese ASAT test demonstrated how orbital debris and escalation risks undermine the credibility of such tools, making them blunt instruments of deterrence[202]. By contrast,

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[200] Reis, J. (2024) 'European Union defense and security strategy for space and ground-based systems against hybrid threats', *Acta Astronautica*, 225, p. 59;
[201] Weeden, B., 2022. *Anti-satellite (ASAT) testing in outer space: A global overview and analysis*. EU Non-Proliferation and Disarmament Consortium, Space Paper No. 83;
[202] Kelso, T.S., 2007. *Analysis of the 2007 Chinese ASAT Test and the Impact of its Debris on the Space Environment*. In: AMOS Technical Conference 2007;

non-kinetic capabilities, including jamming, spoofing, cyber operations, and directed-energy weapons, align more closely with deterrence by denial. They disrupt or degrade services without necessarily destroying the asset, raising operational uncertainty for adversaries. Their reversibility and potential deniability make them effective in grey-zone operations and coercive signalling. However, technical constraints such as limited range for jamming or the challenges of penetrating cyber defences can reduce their deterrent power compared to kinetic attacks[203].

The strategic calculus lies in balancing these two approaches. Kinetic means demonstrate resolve and impose high costs but risk collateral damage and escalation. Non-kinetic methods offer flexibility, reversibility, and plausible deniability, though with less decisive outcomes. For this reason, states often pursue a combination of both, blending the punitive weight of kinetic systems with the coercive utility of non-kinetic measures.

The Russian invasion of Ukraine marked a watershed moment as the first conflict in which orbital assets were directly contested and targeted[204]. Since the early 2000s, the U.S. has invested across the counterspace spectrum but consistently emphasized non-kinetic capabilities. According to the Secure World Fundation (SWF) Global Counterspace Capabilities 2025 report[205], Washington sustains mature programs in electronic warfare, cyber, and directed energy, with key initiatives such as the Space Force's Space Electromagnetic Warfare (SEW) program and the Counter Communications System (CCS) family. While the U.S. experimented with destructive ASAT systems during the Cold War and early 2000s, these were progressively deprioritized after 2008, culminating in the 2022 moratorium on destructive ASAT

[203] Ramanathan, A. and Pareek, A., 2021. *Space as a geopolitical environment*. Takshashila Discussion Document 2021-5, V1.0, 2 September 2021. Bengaluru: Takshashila Institution, pp. 15-17;
[204] Radin, A., Holynska, K., Tretter, C. and Van Bibber, T. (2024) *Lessons from the war in Ukraine for space: Challenges and opportunities for future conflicts*. Santa Monica, CA: RAND Corporation, pp. 8-12;
[205] Secure World Foundation (SWF), 2025. *Global Counterspace Capabilities Report: An Open-Source Assessment (2025 Edition)*. Edited by Victoria Samson and Laetitia Cesari. Washington, DC: Secure World Foundation;

testing[206]. This reflects a doctrinal shift toward non-kinetic, reversible means of denial, supported by a broader emphasis on resilience and redundancy.

The European Union, by contrast, has never fielded kinetic ASATs. As the SWF 2025[207] report underlines, European efforts have centred on space situational awareness (SSA/SST), electronic protection, and resilience, funded through the EU Space Programme and the European Defence Fund. Flagship initiatives include EU-SST, NAVGUARD for Galileo resilience against jamming and spoofing, and expanded SSA and space protection funding lines. These programs illustrate a Union-wide strategy prioritizing deterrence by denial, maintaining the continuity of services rather than threatening destruction.

The Ukraine conflict has reinforced these trajectories. The extensive use of jamming, spoofing, and cyberattacks against GPS and satellite communications demonstrated the operational centrality of non-kinetic counterspace tools. The SWF 2025 analysis confirms that these capabilities are now indispensable in modern warfare, prompting Washington and Brussels to accelerate related investments. For the U.S., this has meant continued modernization of SEW and CCS and expanded research in cyber and directed-energy systems. For the EU, the 2023 Space Strategy for Security and Defence explicitly linked the war to the need for stronger SSA, interference detection, and rapid-response measures, backed by new EDF calls and the creation of an EU Space-ISAC[208].

In comparative perspective, the U.S. still retains a full-spectrum portfolio, including latent kinetic capacity, but doctrinally relies on non-kinetic, reversible systems as its primary deterrent tool. The EU has adopted a more structurally defensive, resilience-oriented posture, firmly anchored in non-kinetic capabilities and governance frameworks. In both cases, the war in Ukraine has accelerated the shift toward

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[206] White House (United States), 2022. *Fact sheet: Vice President Harris announces voluntary U.S. moratorium on destructive, direct-ascent anti-satellite (ASAT) missile testing*, 18 April;

[207] Secure World Foundation (SWF), 2025. *Global Counterspace Capabilities Report: An Open-Source Assessment (2025 Edition)*. Edited by Victoria Samson and Laetitia Cesari. Washington, DC: Secure World Foundation;

[208] The EU Space Information Sharing and Analysis Centre (EU Space ISAC) is a network-based platform, jointly established by the European Commission and the European Union Agency for the Space Programme (EUSPA), with the aim to enhance resilience and security across Europe's space sector;

deterrence by denial, consolidating investment priorities around non-kinetic counterspace capabilities as the most credible and politically sustainable means of safeguarding space security[209]. This can also be regarded as a natural corollary of orbital space. As governments worldwide become increasingly dependent on orbital assets, kinetic attacks result in counterproductive outcomes as they tend to create large fleets of debris. In this view, the Russian strategic choices during the conflict are telling. As Starlink gave fresh air to the Ukrainian Army, Russia has avoided on-orbit kinetic attacks, but has instead relied on jamming and spoofing.

In both the U.S. and the EU, deterrence postures have thus become inseparable from the logic of space dominance, reflecting the wartime realization that assured control of key orbital vantage points directly determines terrestrial operations' tempo, reach, and credibility. The U.S. has evolved towards a forward-leaning deterrence model by denial and punishment, blending rapid-reconstitution architectures, proliferated LEO constellations, and integrated Space Domain Awareness (SDA) networks to impose costs and deny operational benefits to adversaries. The EU approach, by contrast, centres on resilience as deterrence, embedding redundancy, sovereignty, and secure access in the design of its space infrastructure. Despite institutional and rhetorical differences, both models converge on a strategic consensus: in the post-2022 environment, space control is no longer a supporting function; it is the central enabler of deterrence, crisis management, and sustained military advantage.

[209] Salvadori, R., 2024. *Info Flash*. Finabel – The European Land Force Commanders Organisation, July. Written by Rocco Salvadori; edited by Paola Nadal; supervised by Riccardo Angelo Grassi. Brussels;

3. CAUSAL MECHANISMS OF POLICY CHANGE

In the first chapter, it was demonstrated that strategic autonomy in outer space pertains to the capacity of political entities to independently access and operate critical space infrastructures, especially launch systems and Low Earth Orbit (LEO) services. This autonomy is not solely technical; it is shaped by global geopolitical dynamics and serves strategic, political, and security objectives. Geopolitical shocks directly affect the governance of orbital infrastructure, reshaping the scope and methods of strategic autonomy. In this context, outer space functions as a subsystem of the global order, where terrestrial rivalries extend into orbit, making strategic autonomy essential for resilience, influence, and national security in an increasingly congested and contested environment.

The second chapter provided an empirical analysis of how the Russian invasion of Ukraine transformed the space policies of the European Union and the United States. For the EU, the war marked a significant turning point: space was no longer seen mainly as a civilian and scientific sector but as a strategic environment linked to sovereignty, deterrence, and resilience. This change was reflected in doctrinal updates such as the Strategic Compass (2022) and the EU Space Strategy for Security and Defence (2023), along with tangible initiatives like IRIS² and the expansion of European Space Situational Awareness capabilities. For the United States, the conflict strengthened its already security-focused approach. Orbital infrastructures were heightened to critical national interests, with record budget allocations to the Space Force and greater integration of commercial actors. Systems like Starlink exemplified how private constellations could become essential enablers of military operations and crisis resilience.

On this basis, the present chapter turns to its central concern: identifying the causal mechanisms behind the shifts in the EU and US approaches to strategic autonomy in space. The Ukrainian war served as a critical juncture, prompting divergent internal dynamics: in the European Union, a process of securitisation that redefined orbital infrastructures as defence assets; in the United States, a process of privatised interdependence that integrated commercial capabilities within national security frameworks. Simultaneously, the conflict revealed the normative gaps and grey-zone practices in the current governance regime. Foundational principles of the Outer Space Treaty—such as the commitment to peaceful purposes and the prohibition of appropriation—proved inadequate to regulate the dual-use nature of commercial constellations, hybrid public–private roles, and the militarisation of orbital infrastructures. These shortcomings have strengthened military and defensive strategies, while expanding the scope of strategic autonomy to include private entities as essential actors.

3.1 THE SECURITIZATION OF STRATEGIC AUTONOMY

The notion of securitization, elaborated by the Copenhagen School, provides a useful analytical lens to examine the evolution of EU space policy in relation to the war in Ukraine in 2022. According to Buzan, Wæver, and de Wilde[210], securitization is the process through which political actors, by means of speech-acts, represent an issue as an existential threat to a valued referent object, thereby legitimizing extraordinary measures that transcend the realm of ordinary politics. Recent scholarship has highlighted that securitization is best conceived not as a binary outcome but as a spectrum that ranges from non-politicization to politicization and full securitization[211]. However, discourse alone cannot explain why securitisation succeeds or fails. Language does not create reality out of nothing: speech acts only gain power when they align with material infrastructures, industrial inequalities, and power relations. In the EU space sector, rhetorical framings of autonomy resonate because they correspond to vulnerabilities in launch capacity, supply chains, and institutional arrangements. As Klimburg-Witjes demonstrates[212], sociotechnical imaginaries surrounding Ariane and "European autonomy" are powerful not only as stories but because they mobilise resources, reorganise industrial foundations, and reorient procurement practices. Therefore, securitisation must be understood as a co-production of discourse and materiality, where speech acts both reflect and reshape the underlying industrial and geopolitical landscape.

Reflecting on the meaning of autonomous access before and after the war in Ukraine highlights these dynamics further. Prior to 2022, autonomy was often framed in anti-U.S. terms, with Europe relying on Soyuz launches from Kourou (active since 2011)

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210 Buzan, B., Wæver, O. and de Wilde, J. (1998) Security: A New Framework for Analysis. Boulder, CO: Lynne Rienner Publishers;

211 Blount, P. J. (2024). "The Discourse of Space Securitization." In: Pekkanen, S. M. and Blount, P. J. (eds.) The Oxford Handbook of Space Security. New York: Oxford University Press, pp. 61–75;

212 Klimburg-Witjes, N., (2023). *A Rocket to Protect? Sociotechnical Imaginaries of Strategic Autonomy in Controversies About the European Rocket Program*. *Geopolitics*, 29(3), pp. 823-824;

to reduce dependence on American providers[213]. This paradox — using Russian rockets to strengthen European sovereignty — shows how material arrangements shaped discourse. After the invasion of Ukraine, this approach was reversed: Soyuz launches were halted[214], ESA–Roscosmos cooperation collapsed, and autonomy was redefined in anti-Russian terms[215]. In the short term, Europe turned to U.S. assets to fill gaps: SpaceX Falcon 9 was contracted to launch ESA missions such as Euclid in 2023, while U.S. commercial constellations like Starlink became critical for Ukraine, prompting several member states to test and even explore agreements for access. The resulting "launcher crisis" — worsened by Ariane 5's retirement and delays in Ariane 6 — revealed Europe's structural vulnerabilities and justified the Commission's claim that access to orbit had become an existential sovereignty issue[216].

Taken together, these dynamics reveal that securitisation in the EU space field cannot be reduced to rhetorical elevation alone. It operates at the intersection of discourses, infrastructures, and asymmetries: France's dominance through CSG and Ariane, Germany's promotion of micro-launchers, the entry of new spaceports in the UK and Norway, and ESA's evolving procurement logic all reconfigure the playing field. The net effect is a shift towards a more multipolar balance inside ESA, with France still central in heavy-lift launches but counterbalanced by new entrants and by the Commission's own framing of autonomy as a collective security imperative.

Assessing whether securitisation has occurred requires three conditions: the articulation of an existential threat, the recognition of this framing by relevant audiences, and the adoption of extraordinary measures justified on security grounds. In the EU case, all three are visible in orbital control. The first appears in the discursive construction of outer space as a matter of survival, spearheaded by Commissioner

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[213] Kuzminski, J. (2022). *Strategic autonomy and European space policy: Security, sovereignty and geopolitics in orbit*, pp. 492-494;
[214] Reuters (2022). *Russia suspends Soyuz launches from French Guiana after Ukraine sanctions.* Reuters, 26 February;
[215] European Space Agency (ESA) (2022). *ESA ends cooperation with Russia on ExoMars following invasion of Ukraine.*ESA, 17 March;
[216] Küsters, A., Nolen, N. & Stockebrandt, P., (2023). *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 6-8;

Thierry Breton, central to the Union's strategic autonomy agenda in defence, digital sovereignty, and space governance. In the wake of the Russian invasion of Ukraine and the ensuing "launcher crisis," Breton repeatedly stressed that sovereignty in access to space is an existential prerequisite for Europe[217]. At the 16th Conference in January 2024 he called sovereignty in access to space "imperative if Europe is to remain a credible space power," and later, in presenting the forthcoming EU Space Law, he stressed that "in the current geopolitical context, the protection of our space system from systemic security risks is a must"[218]. This narrative has been codified in major policy acts: the *Strategic Compass* (2022) defined autonomous access as essential to "Europe's freedom of action and the protection of our citizens"; the Secure Connectivity Programme establishing IRIS² presented the constellation as a response to "challenges of security, safety and resilience," designed to "strengthen Europe's autonomy and sovereignty in space"; and the *Space Strategy for Security and Defence* (SSSD, 2023) amplified this logic[219]. As Josep Borrell stated when introducing it, "space has become a key enabler not only for our European societies and economies, but also for security and defence. Without security, there can be no future in space"[220]. Finally, the forthcoming EU Space Law is likewise justified in security terms, with Commission documents emphasising harmonisation of the internal market and reinforcement of the EU's capacity to "act as a global space power." This narrative recognises both Europe's growing dependence on space assets and the need, in a geopolitical context marked by the war in Ukraine, for the EU to assume a greater role[221]. Strategic autonomy thus becomes directly linked to the very existence of the EU as a credible geopolitical actor.

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[217] Küsters, A., Nolen, N. & Stockebrandt, P., (2023). *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 6-8;

[218] Küsters, A., Nolen, N. & Stockebrandt, P., (2023). *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 6-8;

[219] Genini, D. (2025) 'How the war in Ukraine has transformed the EU's Common Foreign and Security Policy', *Yearbook of European Law*, 2025, pp. 1–43;

[220] Küsters, A., Nolen, N. and Stockebrandt, P. (2024) *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*, cepInput, No. 4 (20 February). Berlin: Centre for European Policy Studies (CEPS), pp. 6-8;

[221] European Space Policy Institute (ESPI) (2025) *Bold Words, Blurred Lines: A Reflective Look at the EU Space Act*, ESPI Brief, published 1 August. Vienna: ESPI;

The second criterion, audience acceptance, is demonstrated by the unprecedented political convergence that followed the Commission's securitizing moves. The self-styled "geopolitical Commission" of Ursula von der Leyen was the key initiator of this process, embedding strategic autonomy into the EU's broader political agenda and reframing space policy as an instrument of sovereignty rather than a technocratic field[222]. This political orientation enabled member states and EU institutions to align around a security-driven vision of outer space. The European Parliament consistently endorsed space as essential for competitiveness and autonomy. At the same time, the Council, in its Conclusions on the EU Space Strategy for Security and Defence (March 2023)[223], explicitly welcomed the strategy, endorsed its objectives, and affirmed that "space is a strategic domain for the Union's security and defence."

Audience acceptance of the Commission's securitizing discourse has been significant, yet far from absolute. The most visible resistance at the member state level stems from diverging national industrial strategies, particularly between France and Germany. Paris has consistently defended the Ariane heavy-lift programme as a symbol of autonomy and as the backbone of Europe's independent access to space, while Berlin has channelled political and financial capital into fostering a new ecosystem of small and micro-launchers. These contrasting visions, rooted in different strategic cultures and industrial priorities, have prevented consensus on a unified launcher policy and have undermined the Commission's attempt to translate the language of "existential sovereignty" into concrete industrial integration[224]. A second line of contestation lies in the persistence of the *juste retour* principle[225]. Defended by smaller member states, this procurement rule ensures that contracts are geographically distributed in proportion to budgetary contributions. Although widely criticised by the Commission and industry actors as inefficient and ill-suited to the urgency of a securitized policy

[222] Håkansson, C. (2024) *Von der Leyen's Geopolitical Commission: Vindicated by Events?*, European Policy Analysis, No. 2024:7epa, Swedish Institute for European Policy Studies (SIEPS), March;
[223] European Council (2025) *European Council conclusions on European defence*, Special meeting, 6 March, Brussels;
[224] Küsters, A., Nolen, N. & Stockebrandt, P., (2023). *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 10-12;
[225] See chapter 1.2;

field, *juste retour* remains politically salient. Its defence reflects a reluctance to accept the Commission's framing of centralisation as a security imperative, thereby constraining the institutional uptake of the securitizing move[226]. Opposition has also surfaced within the European Parliament, where scepticism about the militarisation of space persists. The Greens/EFA and Left groups, in particular, have consistently warned against the diversion of civilian budgets into defence-oriented dual-use programmes and have resisted the Commission's portrayal of space as primarily a security domain. Even the Socialists & Democrats, while supportive of enhanced European capabilities, have voiced concerns about the erosion of the EU's civilian ethos and the risk of a Commission "take-over" of intelligence-related competences[227].

The third criterion—extraordinary measures—is reflected in the unprecedented expansion of EU resources for dual-use space applications, marking a clear departure from the Union's long-standing emphasis on space as a civilian and scientific domain. In this regard, the new framing of outer space as a strategic domain for great power competition and the convergence of political consensus on a security-oriented space agenda are the fundamental prerequisites to implement measures that, before the war, were deemed as outside the scope of the EU competencies, namely security and defence. The EU Space Programme 2021–2027 already foreshadowed this change by explicitly linking "access to space" not only to competitiveness and innovation but also to security and Europe's presence on the global stage. Since 2022, this reorientation has deepened through significant investments in programmes with a defence dimension[228], including secure governmental communications, Galileo's Public Regulated Service (PRS), and especially space situational awareness (SSA). Financial instruments consolidate this trajectory. IRIS², with over €10 billion in joint financing, provides secure communications with commercial and military applications, while the

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226 Küsters, A., Nolen, N. & Stockebrandt, P., (2023). *Strategic Autonomy in EU Space Policy: Securing Europe's Final Frontier Through Launches, Laws, and Space Mining*. cepInput No. 4, pp. 13-14;

227 European Space Policy Institute (ESPI) (2025) *Bold Words, Blurred Lines: A Reflective Look at the EU Space Act*, ESPI Brief, published 1 August. Vienna: ESPI;

228 Neuman, M., Wessel, R. A. and de Zee, T. (eds) (2025) *A Geopolitical Europe in the Making? The EU's Actorness in a (De-)Globalising World*, Global Europe: Legal and Policy Issues of the EU's External Action, Vol. 5. The Hague: T.M.C. Asser Press, pp. 4-7;

European Defence Fund and Horizon Europe increasingly prioritize projects with dual-use potential. What emerges is not simply higher spending, but a qualitative transformation in EU space policy: a deliberate embrace of dual-use technologies as the foundation of strategic autonomy.

One of the clearest manifestations of the Commission's securitization logic has been its stance on secure satellite communications. In this domain, vertically integrated firms such as SpaceX, through Starlink, have established a decisive strategic advantage through involvement in the Ukrainian theatre, prompting some member states to explore cooperation with the U.S. provider, including Italy's tests of Starlink antennas in diplomatic infrastructures and exploratory talks for broader agreements[229]. However, the Commission has firmly opposed reliance on foreign-controlled constellations, framing such dependence as incompatible with European sovereignty. As Christophe Grudler, rapporteur on IRIS², noted, bilateral deals with Starlink would "dilute European sovereignty and weaken Europe's leadership role". Instead, Brussels has promoted a collective response, presenting the development of an autonomous secure connectivity system as a matter of survival for the Union. Through initiatives such as IRIS² and the forthcoming EU Space Law, the Commission has discursively elevated secure communications from an industrial concern to a strategic imperative, embedding dual-use infrastructures into the logic of security and defence.

The Russian invasion of Ukraine has constituted a critical juncture, triggering a process of orbital securitization that has redefined EU policy on outer space and its pursuit of strategic autonomy. A critical juncture, as Capoccia and Kelemen[230] define it, is "a situation in which the structural (that is, economic, cultural, ideological, organizational) influences on political action are significantly relaxed for a relatively short period, thereby creating a wider than normal range of plausible choices available to political actors, and in which their decisions have a higher probability of affecting

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[229] Lory, G. (2025) 'Govsatcom, Eutelsat, Iris²: Ukraine seeks European alternatives to Starlink', *Euronews*, 22 April;
[230] Capoccia, G. and Kelemen, R.D. (2007) 'The study of critical junctures: theory, narrative, and counterfactuals in historical institutionalism', *World Politics*, 59(3), pp. 341–369;

the outcome of interest." In other words, external shocks disrupt equilibria and open windows for institutional innovation or policy redirection, with consequences that may endure over time.

Two interconnected dynamics explain why the war in Ukraine represents such a juncture for the EU: the disruption of the space production–value chain and the need for Europe to defend itself and assume greater responsibility within NATO[231]. Together, these factors elevated orbital access from a technical or industrial concern to a securitized domain, recognized as a fundamental precondition for the Union to act as an autonomous geopolitical actor in peace and wartime. This securitization dynamic did not emerge in a vacuum. It intersected with the geopolitical ambition articulated by the von der Leyen Commission, which had already framed its mandate as that of a "geopolitical Commission." The war thus provided the external shock that transformed political rhetoric into institutional practice, aligning the EU's space policy with its broader aspiration to project strategic influence and autonomy on the global stage.

In relation to the first driver of the securitization of orbital access in the Old Continent, despite broad industrial and technological base, the conflict exposed its reliance on non-European providers for critical inputs such as EEE components, advanced materials, and specialized software[232]. Ukrainian-built Antonov freighters—essential for transporting oversized satellites—were grounded, causing immediate logistical bottlenecks. Launcher programmes were disrupted: Vega relied on Ukrainian upper stages; ESA's access to Russian Soyuz rockets for Galileo and Copernicus ended abruptly; and the Baikonur spaceport became inaccessible. These ruptures triggered cascading delays and cancellations, including the indefinite suspension of ExoMars, a flagship ESA–Roscosmos mission. More broadly, the sudden termination of joint scientific projects with Russia, from lunar exploration to the eROSITA telescope,

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[231] Undseth, M. and Jolly, C. (2022) *A new landscape for space applications: Illustrations from Russia's war of aggression against Ukraine*, OECD Science, Technology and Industry Policy Papers, No. 137, November, pp. 14-23;
[232] Undseth, M. and Jolly, C. (2022) *A new landscape for space applications: Illustrations from Russia's war of aggression against Ukraine*, OECD Science, Technology and Industry Policy Papers, No. 137, November, pp. 14-23;

illustrated how geopolitical ruptures could instantaneously sever cooperation[233]. This breakdown revealed the fragility of Europe's space industrial chain and framed autonomous access to orbit as a security imperative—a matter of industrial continuity and safeguarding strategic autonomy.

The second driver of securitization lies in the expectation that Europe assumes greater responsibility within NATO. The war in Ukraine has reconfirmed Russia as an adversary, restored Europe as a theatre of high-intensity conflict, and coincided with a U.S. pivot to the Indo-Pacific[234]. As American attention shifts toward countering China, the EU is pressed to act as a complementary security provider in its neighbourhood and emerging domains such as space and cyber. NATO's adoption of a forward-defence posture further constrains allies' flexibility, compelling the Union to ensure resilience and redundancy in critical infrastructures—including orbital ones[235]. In this light, autonomous control over space assets is no longer optional but indispensable to the EU's strategic autonomy. Trump's return to the White House reinforced this urgency by exposing Europe's vulnerability to U.S.-controlled infrastructures. Washington's suspension of Ukrainian access to Maxar imagery and restrictions on intelligence sharing illustrated how orbital assets could be instrumentalized as political leverage. For EU policymakers, this confirmed that space access is a foundational condition of sovereignty: without independent capabilities, Europe remains exposed to adversaries and the volatility of allies[236]. The broader reorientation of U.S. foreign policy magnifies these vulnerabilities. With Washington openly declaring it is no longer the primary guarantor of European security, Europe is expected to shoulder greater responsibility for its own defence. In practice, the Union cannot rely indefinitely on U.S. infrastructures and must develop autonomous

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[233] Czajkowski, M. (2024) 'Russo-Ukrainian War's Impact on Space Security – The Western Perspective', *Politeja*, 5(92), pp. 235–258;

[234] Transatlantic Task Force (2025) 'The End of an Era: What the US Retreat from European Security Means for the World', *Commentary, Geopolitics & Great Power Politics*, 17 February;

[235] Marrone, A. (2022) 'NATO's New Strategic Concept: Novelties and Priorities', *IAI Commentaries*, No. 22|30 (8 July), Istituto Affari Internazionali, Rome;

[236] Transatlantic Task Force (2025) 'The End of an Era: What the US Retreat from European Security Means for the World', *Commentary, Geopolitics & Great Power Politics*, 17 February;

capabilities to sustain military operations and geopolitical credibility. The conflict in Ukraine has made this shift tangible. Elon Musk's threats to curtail Starlink services created a strategic risk of battlefield disconnection, pushing Kyiv and Brussels to seek alternatives. The European Commission has opened channels for Ukraine to access Govsatcom, while promoting IRIS² as the long-term backbone for secure communications. Measures to reduce the gap include drawing on operators such as Eutelsat, though their capacity remains limited compared to Starlink[237]. The EU's readiness to provide such alternatives reflects more than solidarity with Ukraine: it signals recognition that Europe must be able to fill the void left by potential U.S. retrenchment in space-based defence support[238].

[237] Lory, G. (2025) 'Govsatcom, Eutelsat, Iris²: Ukraine seeks European alternatives to Starlink', *Euronews*, 22 April;
[238] Lory, G. (2025) 'Govsatcom, Eutelsat, Iris²: Ukraine seeks European alternatives to Starlink', *Euronews*, 22 April;

3.2 AMERICAN TECHNO-EXCEPTIONALISM

The underlying causal factor that explains the recent U.S. policy change concerning strategic autonomy in outer space is the enduring logic of American exceptionalism. In the academic literature, exceptionalism is defined as the conviction that the United States is qualitatively distinct from other nations, entrusted with a unique mission to lead, liberalize, and secure the international order[239]. This worldview has historically been expressed through the notion of the frontier, where expansion into new domains—territorial, technological, and economic—was framed as both a right and a responsibility.

From the nineteenth-century doctrine of manifest destiny, which legitimized continental expansion, to the Cold War race for the Moon, exceptionalism has consistently linked national identity to frontier expansion. Crucially, this exceptionalist logic is a bipartisan theme in U.S. politics. Academic studies[240] and institutional sources confirm that Democrats and Republicans invoke America's special mission to justify space and security policy leadership. Obama's 2010 National Space Policy emphasized U.S. leadership as "a vital national interest" to ensure space remains accessible[241]. Trump's 2020 Defense Space Strategy declared "freedom of action in space" indispensable for national power[242]. Biden's 2021 Interim National Security Strategic Guidance reaffirmed that the United States "must lead in the space domain to ensure it remains safe, stable, and accessible"[243]. These continuities illustrate that exceptionalism is structural: both parties agree on America's unique role, even if they diverge on how that role is enacted in the space domain.

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[239] Lipset, S.M. (1996) *American Exceptionalism: A Double-Edged Sword*. New York: W.W. Norton & Company;

[240] McCrisken, T.B. (2003). *American Exceptionalism and the Legacy of Vietnam: US Foreign Policy since 1974*. New York: Palgrave Macmillan; Restad, H.E. (2015). *American Exceptionalism: An Idea that Made a Nation and Remade the World*. New York: Routledge;

[241] Obama, B. (2010) *National Space Policy of the United States of America*. Executive Office of the President, June 28;

[242] Department of Defense (2020). *Defense Space Strategy*. Summary. Department of Defense, 17 June;

[243] The White House (2021). *Interim National Security Strategic Guidance*. Executive Office of the President, 3 March;

Where the second Trump administration marked a rupture with the precedent Administrations was in its unprecedented choice to increase the reliance on the private sector as the newfound enabler of this American exceptionalism in the space domain, transitioning to a form of techno-exceptionalism. During Donald Trump's first administration (2017–2021), U.S. space policy emphasized institutional consolidation and long-term exploration. The reestablishment of the National Space Council, the publication of the 2020 National Space Policy, and directives such as SPD-1 anchored a Moon-first strategy through Artemis, supported by state-funded infrastructures like the Space Launch System (SLS), Orion, and the Lunar Gateway[244]. At the same time, the creation of the U.S. Space Force and the 2020 Defense Space Strategy entrenched the framing of space as a contested warfighting domain[245]. Whereas Trump I built a federally driven framework prioritizing sovereign exploration capabilities, Trump II elevates private enterprise as the cornerstone of U.S. exceptionalism in space. His Second Inaugural Address (20 January 2025) cast space exploration as the continuation of America's "manifest destiny," pledging a Mars landing as the next frontier. Yet unlike the earlier reliance on government systems, he explicitly identified entrepreneurs as the vanguard of this mission, insisting that "the genius of American entrepreneurs will lead the way, not government bureaucracy."

This rhetorical shift is matched by policy. The 2025 Executive Order on "Enabling Competition in the Commercial Space Industry" reduces regulatory oversight, accelerates licensing for private launch and reentry, and expands authorization for novel missions[246]. The FY2026 NASA budget request reflects the same logic: at $18.8 billion, it phases out SLS and Orion after Artemis III, cancels U.S. Gateway contributions, and redirects funding toward commercial lunar systems and Mars-focused technologies[247]. In parallel, the Department of Defense and the Space Force

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[244] *NASA: Exploration mission integral to 2020 National Space Policy*, News Release 20-123, 9 December;

[245] U.S. Space Force (2024) *5 Years Securing Our Nation's Interests in, From, and To Space*. Arlington, VA: U.S. Department of the Air Force;

[246] The White House (2025) *Fact Sheet: President Donald J. Trump Enables Competition in the Commercial Space Industry*, 13 August;

[247] NASA (2025) *President Trump's FY 2026 Budget Revitalizes Human Space Exploration*, news release, 2 May. NASA;

are updating their strategic documents to integrate commercial infrastructures into national-security planning[248].

The divergence between the two Trump presidencies is therefore not merely institutional or budgetary, but geopolitical. Trump I sought to consolidate U.S. leadership through state-funded exploration and institutional permanence, while Trump II reorients toward deregulation and commercial empowerment, positioning private actors as strategic assets, especially for security matters.

Within this context, two dynamics have contributed to the shift towards techno-exceptionalism in the outer-space domain: the growing centrality of commercial capabilities and the intensifying imperative to preserve orbital primacy. The first dynamic concerns the role of commercial actors, whose contributions during the war in Ukraine reshaped U.S. perceptions of strategic autonomy in outer space. The rapid deployment of Starlink terminals illustrated the capacity of private firms to mobilize resources more swiftly than government bureaucracies, ensuring communications resilience despite sustained Russian cyber and kinetic disruptions[249]. Similarly, integrating commercial satellite imagery from Maxar, Planet Labs, and BlackSky into allied intelligence networks highlighted the advantages of "resilience by design," as proliferated constellations generated redundancies that complicated Russian efforts to undermine situational awareness[250]. The involvement of private cybersecurity providers such as Microsoft and Mandiant further demonstrated how commercial entities could safeguard critical infrastructures without requiring overt U.S. military intervention. Collectively, these experiences underscored how private participation enhances flexibility, resilience, and crisis responsiveness, while enabling Washington to extend meaningful support to allies and mitigate escalation risks. As global competition intensifies, such capabilities are increasingly recognized as indispensable: the United States must continue expanding its space architecture through commercial

[248] U.S. Space Force (2024) *U.S. Space Force Commercial Space Strategy*, Department of the Air Force, pp. 3-5;
[249] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), pp. 842–866;
[250] Werner, D. (2022) 'HawkEye 360 detects GPS interference in Ukraine', *SpaceNews*, 4 March;

applications to provide intelligence, surveillance, and reconnaissance (ISR), communications, and positioning, navigation, and timing (PNT) across multiple operation theatres[251].

The second dynamic recognizes that maintaining strategic advantage in space has become a prerequisite for safeguarding broader strategic autonomy[252]. Contemporary warfare relies heavily on satellite-enabled ISR, secure communications, and PNT systems, dependencies starkly revealed by the conflict in Ukraine[253]. Commercial imagery informed Western intelligence assessments, Starlink ensured battlefield connectivity, and private cybersecurity initiatives contained Russian intrusions. Together, these cases demonstrated that orbital services are no longer auxiliary but integral to operational effectiveness, reinforcing the conviction that technological superiority in space is essential to defending vital national interests. At the same time, they validated the America First 2.0 narrative, which frames the U.S. commercial ecosystem as an unparalleled strategic asset that must be mobilized to sustain leadership in an increasingly multipolar order. Crucially, strategic advantage in outer space has become inseparable from the dynamics of great-power competition intensified by the war. As Russia and China expand counterspace capabilities and deepen bilateral cooperation, America's asymmetric technological lead appears increasingly fragile—raising the prospect that orbital dominance could, paradoxically, evolve into a source of vulnerability if U.S. assets remain exposed to disruption[254].

These dynamics have reinforced the privatization of U.S. strategic functions, particularly in the military domain, producing what can be described as privatized autonomy. Under the second Trump administration, exceptionalist rhetoric is being fused with commercial mobilization, reframing strategic autonomy less as a sovereign

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[251] U.S. Space Force (2024) *U.S. Space Force Commercial Space Strategy*, Department of the Air Force, pp. 6-7;
[252] Pace, S. (2024) 'US National Security Interests in Space', in Pekkanen, S. M. and Blount, P. J. (eds), *The Oxford Handbook of Space Security*, Oxford Handbooks. New York: Oxford University Press, pp. 275–292;
[253] Transatlantic Task Force (2025) 'The End of an Era: What the US Retreat from European Security Means for the World', *Commentary, Geopolitics & Great Power Politics*, 17 February;
[254] Gichki, A. A. (2024) 'Militarization of the Final Frontier: The Growing Importance of Space Security', *Opinions*, 1 September;

prerogative than as a function increasingly entrusted to private industry. In particular, the course of operations in the war in Ukraine demonstrated that resilience, redundancy, and adaptability are best achieved through commercial infrastructures capable of rapid deployment and continuous renewal[255]. In response, U.S. space strategy has consolidated around the principle that strategic advantage in orbit rests on embedding private firms directly into intelligence, communications, and defence functions. Unlike earlier models anchored in government-owned assets, this new logic of privatized autonomy denotes a hybrid architecture in which technological superiority and strategic credibility are sustained through the systematic integration of private innovation into national security structures.

However, this integration has not diminished state authority. On the contrary, Washington has developed a repertoire of mechanisms to discipline and align corporate infrastructures with national objectives[256]. Contractual leverage has been central: programs like Starshield and the Space Development Agency's Transport and Tracking Layers integrate SpaceX constellations into U.S. defence architecture, ensuring that commercial assets are inseparable from military command-and-control systems. Financial dependency reinforces this alignment, as illustrated by Pentagon funding to sustain Starlink operations in Ukraine after SpaceX signalled its intention to withdraw support. Political and diplomatic pressure has further constrained corporate discretion, with U.S. officials intervening directly when Starlink geofenced services or imposed restrictions on Ukrainian use. In parallel, interoperability requirements have institutionalized commercial systems integration into defence networks[257]. At the same time, initiatives like the proposed Commercial Augmentation Space Reserve aim to formalize government access to private infrastructures during crises. Redundancy and competition add another layer of control: alongside SpaceX, firms like Lockheed

[255] Pace, S. (2024) 'US National Security Interests in Space', in Pekkanen, S. M. and Blount, P. J. (eds), *The Oxford Handbook of Space Security*, Oxford Handbooks. New York: Oxford University Press, pp. 275–292;
[256] Doboš, B. (2022) 'Tortoise the Titan: Private Entities as Geoeconomic Tools in Outer Space', *Space Policy*, 60, Article, pp. 6-7;
[257] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), pp. 842–866;

Martin, L3Harris, and United Launch Alliance are deliberately kept in play to prevent monopolistic leverage. Finally, regulatory authority and export controls—ranging from FCC licensing regimes to ITAR restrictions—grant Washington further oversight over the deployment and international use of private space assets[258].

By framing deregulation and commercial contracting as national imperatives—arguing that "new space-based industries, exploration capabilities, and defence systems must be pioneered in America rather than by our adversaries"[259], Trump is trying to institutionalize the principle that U.S. strategic autonomy in space would be inseparable from private-sector leadership. Deregulation in this context is not merely rhetorical but translates into systematically loosening regulatory barriers and actively incentivizing private investment across the launch, satellite, and data services sectors. Crucially, deregulation also carries a geopolitical dimension. Accelerating the expansion of private capabilities allows the United States to respond more swiftly to the growing technological advances of China and Russia, ensuring that American firms can outpace competitors in key orbital sectors[260]. Market-driven expansion gave Washington an indirect means of projecting influence abroad: U.S. dominance in launch services, satellite constellations, and space-based data infrastructures translated into de facto standards-setting power, compelling allies and partners to integrate into American-controlled supply chains[261]. In this sense, deregulation did not simply facilitate innovation. However, it institutionalized a form of digital neoliberalism, in which strategic dependence is deliberately externalized onto private infrastructures that extend American influence across borders. Allies who rely on U.S. commercial platforms for secure communications, Earth observation, or cyber defence become structurally embedded within a U.S.-centric ecosystem, making autonomy conditional

[258] Abels, J. (2024) 'Private infrastructure in geopolitical conflicts: the case of Starlink and the war in Ukraine', *European Journal of International Relations*, 30(4), pp. 842–866;
[259] The White House (2025) *Fact Sheet: President Donald J. Trump Enables Competition in the Commercial Space Industry*, 13 August;
[260] Armagno, N. M. and Harman, J. (2025) *Securing Space: A Plan for U.S. Action*, Task Force Report No. 82, Council on Foreign Relations, project directed by Esther D. Brimmer, February, pp. 4-17;
[261] Doboš, B. (2022) 'Tortoise the Titan: Private Entities as Geoeconomic Tools in Outer Space', *Space Policy*, 60, Article pp. 6-7;

on continued access to privately owned assets. In this way, deregulation transformed commercial preeminence into a strategic instrument, allowing the United States to project leadership through military superiority and by shaping the architecture of global markets and dependencies in the orbital domain.

What emerges is a reconceptualization of autonomy in space itself: no longer the exclusive prerogative of the state, but a hybrid architecture in which private firms operate as guarantors of resilience, catalysts of innovation, and vehicles through which U.S. exceptionalism is projected into an increasingly contested orbital environment. This transformation could unfold only in the United States, where a uniquely dynamic commercial space sector had already taken shape even before the war in Ukraine. By progressively adopting vertically integrated models, U.S. firms reduced costs and accelerated innovation, thereby positioning the private sector as an indispensable foundation of national strategy in space.

3.3 GREY AREAS AND FRACTURED GOVERNANCE

The governance of outer space has entered a decisive stage in its evolution, as long-standing legal ambiguities and normative grey zones increasingly reshape how states and institutions conceptualize strategic autonomy[262]. The foundational vision articulated in the 1967 Outer Space Treaty (OST), which framed outer space as a domain of peaceful cooperation and the "province of all mankind," is being eroded under the combined pressures of rapid technological innovation, intensifying geopolitical competition, and the expanding role of private actors. These pressures have destabilized the balance that the treaty sought to preserve between cooperation and restraint, revealing the fragility of its principles and the inadequacy of its enforcement mechanisms[263].

Nowhere has this erosion been more visible than in the context of the war in Ukraine, which has starkly illustrated the centrality of space infrastructures to the conduct of modern conflict[264]. As a result, the meaning of strategic autonomy in outer space has been fundamentally transformed. Once associated primarily with the pursuit of industrial and technological independence, it is now increasingly defined in militarized terms worldwide: the ability to secure and defend access to essential infrastructures, to deny adversaries the benefits of their own orbital assets, and to operate in an environment where legal protections are insufficient to prevent coercion or attack. This reconceptualization is not an incidental by-product of the conflict but a structural shift that reflects the entanglement of outer space with great-power rivalry and the normalization of counterspace strategies as instruments of statecraft.

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262 Yuan, A. (2021) ‘Filling the Vacuum: Adapting International Space Law to Meet the Pressures Created by Private Space Enterprises’, *Denver Journal of International Law & Policy*, 49(2), pp. 27–55;

263 Gichki, A. A. (2024) ‘Militarization of the Final Frontier: The Growing Importance of Space Security’, *Opinions*, 1 September;

264 Frazão, J. N. (2022) ‘The conflict in Ukraine and space: legal aspects and the consequences for international cooperation’, *SPARC*, 29 March;

The OST enshrines fundamental principles designed to prevent precisely this outcome. Article II prohibits any claim of sovereignty over outer space or celestial bodies; Article IV restricts the placement of weapons of mass destruction in orbit and reserves celestial bodies for peaceful purposes; and Article I frames outer space as the province of all humankind, to be used for the benefit of all states. These provisions reflect the spirit of the Cold War compromise: to preserve outer space as a neutral domain, prevent its territorial division, and insulate it from the destructive logics of nuclear deterrence[265]. However, while these articles remain formally intact, their substantive meaning has been progressively diluted because the treaty confines itself to non-binding declarations and refrains from addressing the modalities of implementation. Crucially, it does not define what constitutes "peaceful use," nor does it clarify the boundary between militarization and weaponization, and it leaves unresolved the legal status of resource exploitation[266].

The ambiguity surrounding peaceful purposes has been one of the most consequential gaps. Article IV bans only nuclear weapons and other weapons of mass destruction, but remains silent on the deployment of conventional weapons in orbit or the testing of ground-based anti-satellite systems. This omission creates a doctrinal space in which states could accept the militarization of space—that is, the use of satellites for military support functions such as communications, navigation, or intelligence—while contesting only the narrower category of "weaponization."[267] However, the problem is that the line between the two concepts is increasingly blurred. Dual-use technologies—precision navigation, Earth observation, cyber operations against satellites, or kinetic kill vehicles—can serve both civilian and military purposes, making it impossible to determine with clarity whether their deployment violates the principle of peaceful use[268]. Russia's 2021 anti-satellite test illustrated this legal vacuum: it created

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[265] Von der Dunk, F. G. and Tronchetti, F. (eds.) (2015) *Handbook of Space Law*. Research Handbooks in International Law. Cheltenham and Northampton, MA: Edward Elgar Publishing;
[266] S. Marchisio, *The Law of Outer Space Activities*, Roma, 2017.
[267] Hammack, K. (2021) 'International Relations in Space: The Role of Miscalculation, Militarization, and Weaponization', *Astropolitics: The International Journal of Space Politics & Policy*, 19(3);
[268] Hammack, K. (2021) 'International Relations in Space: The Role of Miscalculation, Militarization, and Weaponization', *Astropolitics: The International Journal of Space Politics & Policy*, 19(3);

thousands of debris fragments, drew widespread condemnation, and endangered the International Space Station, yet it could not be categorically labelled as a violation of the OST because the treaty never prohibited such conventional systems[269]. What was once a safeguard against escalation has thus become a permissive framework in which each power interprets "peaceful purposes" according to its strategic needs.

Attempts to remedy these weaknesses through subsequent instruments have largely failed. The 1979 Moon Agreement sought to develop the OST's vague provisions on resource exploitation by declaring lunar resources the "common heritage of mankind" and mandating the creation of an international regime to regulate their extraction[270]. However, the redistributive implications of such a regime proved unacceptable to central spacefaring states, which refused to ratify the agreement, leaving it politically inert. Similarly, Russia and China's repeated proposals for a Prevention of the Placement of Weapons in Outer Space Treaty (PPWT) aimed at closing the loophole on conventional weapons by extending prohibitions beyond weapons of mass destruction. However, the drafts, tabled in the Conference on Disarmament, were consistently rejected by the United States and its allies, who criticised their lack of verification mechanisms and failure to address ground-based anti-satellite weapons[271]. The result has been a deadlock in arms control negotiations and a reliance instead on non-binding measures of transparency and confidence-building through COPUOS or General Assembly resolutions. These soft law initiatives—beneficial in promoting dialogue—have no enforceability and therefore cannot meaningfully constrain behaviour.

A further source of dilution lies in the treaty's silence on private actors. The OST was drafted in an era when states were the sole actors in space, and it therefore assigns

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[269] Frazão, J. N. (2022) 'The conflict in Ukraine and space: legal aspects and the consequences for international cooperation', *SPARC*, 29 March; Lauer, R. S. (2022) 'When States Test Their Anti-Satellite Weapons', *Astropolitics: The International Journal of Space Politics & Policy*, 20(1), pp. 1–26;

[270] Lambach, D. (2022) 'The Territorialization of the Global Commons: Evidence From Ocean Governance', *Politics and Governance*, 10(3), pp. 41–50;

[271] Von der Dunk, F. G. and Tronchetti, F. (eds.) (2015) *Handbook of Space Law*. Research Handbooks in International Law. Cheltenham and Northampton, MA: Edward Elgar Publishing;

responsibility for national space activities to states without anticipating the direct involvement of corporations. Today, however, the commercial sector plays a decisive role in telecommunications and Earth observation and increasingly in crisis scenarios[272]. The Ukraine war has shown how private constellations such as Starlink can provide a battlefield advantage, functioning as operational enablers of national defence. However, because private entities are not subjects of international law, they are bound only indirectly through national licensing regimes, which vary significantly across jurisdictions. This gap allows companies to shape the interpretation of international law through practice—by pursuing activities such as resource extraction or deploying mega-constellations—without being formally accountable to the principles of the OST[273]. In practice, this means that the treaty's vision of space as a domain for the benefit of all humankind is filtered through national regulatory regimes, and where those regimes are permissive, the effect is to dilute the principle's universality.

The combined effect of these shortcomings is a framework in which the OST's core provisions are acknowledged rhetorically but applied unevenly. The non-appropriation principle has been eroded by national legislation such as the U.S. Commercial Space Launch Competitiveness Act and Luxembourg's space resources law, both of which recognise rights to extracted resources[274]. The principle of peaceful purposes has been hollowed out by the acceptance of militarisation and the absence of restrictions on dual-use or conventional weapons. The principle of universality—the use of space for the benefit of all humankind—has been compromised by the centrality of private actors and the absence of a global regulatory regime. In this fragmented environment, interpretations diverge along geopolitical lines: the United States and its allies legitimise militarisation as consistent with peaceful purposes. At the same time, Russia

[272] Yuan, A. (2021) 'Filling the Vacuum: Adapting International Space Law to Meet the Pressures Created by Private Space Enterprises', *Denver Journal of International Law & Policy*, 49(2), pp. 27–55;
[273] Yuan, A. (2021) 'Filling the Vacuum: Adapting International Space Law to Meet the Pressures Created by Private Space Enterprises', *Denver Journal of International Law & Policy*, 49(2), pp. 27–55;
[274] de Zwart, M., Henderson, S. and Neumann, M. (2023) 'Space resource activities and the evolution of international space law', *Acta Astronautica*, 211, pp. 155–162;

and China advance proposals for absolute prohibitions, even as their own counterspace programmes contradict these claims. The result is not a coherent legal order but a patchwork of competing norms, in which the foundational principles of space law remain in place yet are stripped of uniform meaning.

The war in Ukraine has made the consequences of this fragmentation impossible to ignore. What the Ukrainian theatre is revealing, however, is not simply the weakness of the existing regime but also a deeper structural dynamic: in outer space, strategic advantage accrues disproportionately to those actors who act or develop first, even at the risk of undermining long-term stability. This logic of first-mover advantage is visible in the conflict's destructive and protective dimensions. On the one hand, Russia's willingness to conduct an ASAT test prior to its invasion demonstrated a calculated attempt to signal its capacity to threaten Western constellations, exploiting the lack of a binding ban to secure coercive leverage[275]. On the other hand, Ukraine's rapid integration of Starlink revealed how the early deployment of commercial constellations could decisively shape the battlefield, providing resilient communications that blunted Russian attempts at electronic warfare. In both cases, the side that moved first into the legal and strategic grey zones could gain advantages that opponents struggled to counter under existing law. In a regime defined by ambiguity and dual-use technologies, states interpret international law through strategic necessity rather than restraint, treating legal silence as an invitation to establish facts on the ground[276]. This dynamic is compounded by the role of private actors, which operate according to market logics rather than multilateral agreements, as corporations can function as "new states" in practice, shaping norms by precedent, and in Ukraine, SpaceX's willingness to provide rapid service conferred strategic benefits on Kyiv[277].

[275] Lauer, R. S. (2022) ‘When States Test Their Anti-Satellite Weapons’, *Astropolitics: The International Journal of Space Politics & Policy*, 20(1), pp. 1–26;
[276] Hammack, K. (2021) ‘International Relations in Space: The Role of Miscalculation, Militarization, and Weaponization’, *Astropolitics: The International Journal of Space Politics & Policy*, 19(3);
[277] Yuan, A. (2021) ‘Filling the Vacuum: Adapting International Space Law to Meet the Pressures Created by Private Space Enterprises’, *Denver Journal of International Law & Policy*, 49(2), pp. 27–55;

In an environment where treaty law is general and enforcement is weak, actors that exploit legal vacuums early can establish de facto control over capabilities, infrastructures, or interpretations of legality[278]. This logic deepens the militarisation of strategic autonomy and accelerates bloc formation, as states recognise that hesitation may leave them permanently disadvantaged. In this regard, the United States is seeking to consolidate its leadership through the Artemis Accords, a set of bilateral agreements with like-minded partners that reinterpret the OST by recognising property rights over extracted resources and coordinating exploration activities in ways favourable to U.S. commercial leadership[279]. By launching Artemis first, Washington effectively seized the initiative in shaping the legal environment of future lunar and deep-space activities.

Russia and China, recognising the risk of exclusion from this U.S.-led order, have sought to counter it through the International Lunar Research Station (ILRS), which presents itself as a state-driven alternative rooted in the rhetoric of sovereignty and collective benefit. The ILRS is more than a technological programme; it attempts to establish a rival normative pole that denies legitimacy to Artemis and creates a parallel centre of gravity in space governance. In this sense, Beijing and Moscow are themselves deploying a first-mover strategy—seeking to secure strategic advantage by moving early to anchor their vision of governance before Artemis can become the uncontested standard. The war in Ukraine has sharpened these divisions and accelerated the crystallization of geopolitical blocs. Trust has been eroded, cooperation ruptured, and the interpretation of space law is increasingly determined not through multilateral compromise but through the consolidation of competing blocs racing to codify their own rules first.

These divisions, together with normative ambiguities, perpetuate a spiral of space militarization that the war in Ukraine is accelerating. What Western states portray as defensive measures—securing constellations, investing in resilience, integrating

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[278] MARBOE, I. *Soft law in Outer Space: The function of non-binding norms in International Space Law*. Böhlau Verlag, 2012;

[279] Vazhapully, K. M. (2020) 'Space Law at the Crossroads: Contextualizing the Artemis Accords and the Space Resources Executive Order', *Opinio Juris*, 22 July;

private infrastructures—are perceived by Moscow and Beijing as escalatory[280]. Russia's pursuit of counterspace systems and China's rapid expansion of dual-use space capabilities reflect a mirror logic. Even the European Union, long a cautious proponent of multilateralism, has begun to frame its flagship initiatives, such as Galileo and IRIS², in explicitly security-oriented terms, describing them as critical infrastructures that must be defended against attack. Strategic autonomy, once linked to industrial independence, is thus increasingly defined through military means.

This contradictory and sometimes opposing set of views is producing what scholars have begun to conceptualise as a security trilemma, a dynamic increasingly visible in the policy shifts and investment patterns across both sides of the Atlantic and within the broader global security architecture[281]. Unlike the traditional security dilemma, which has long occupied a central place in realist international relations theory and is conventionally understood as a dyadic interaction—whereby the defensive measures of one state are interpreted as offensive by another, provoking reciprocal measures—the security trilemma introduces an additional layer of complexity. In this configuration, the actions undertaken by two competitors to secure themselves are mutually threatening and simultaneously generate insecurity for a third actor that is not directly part of the original rivalry[282].

The implications of this triangular dynamic are profound. Efforts by State A to enhance its security, through either military modernisation, alliance-building, or technological innovation, predictably trigger defensive or counter-balancing responses from State B. However, in a trilemma setting, these measures also reverberate outward, compelling State C—and potentially other actors in the system—to accelerate their military build-ups, fearing that inaction would result in strategic marginalisation. The result is a cascading effect of armament, vividly illustrated by the war in Ukraine as a critical

[280] Hammack, K. (2021) 'International Relations in Space: The Role of Miscalculation, Militarization, and Weaponization', *Astropolitics: The International Journal of Space Politics & Policy*, 19(3);
[281] West, J. and Miller, J. (2023) *Clearing the Fog: The Grey Zones of Space Governance*, CIGI Paper No. 287, Centre for International Governance Innovation, November;
[282] West, J. and Miller, J. (2023) *Clearing the Fog: The Grey Zones of Space Governance*, CIGI Paper No. 287, Centre for International Governance Innovation, November;

juncture in the post-Cold War security order. The trilemma dynamic has multiplied insecurity across the Euro-Atlantic and global system rather than producing a stable balance of power—as classical balance-of-power theorists might anticipate. Russia's invasion and subsequent military build-up have not only provoked reciprocal reinforcement of NATO's deterrence posture but also compelled other states, both within and beyond Europe, to accelerate their defence investments to avoid strategic marginalisation[283]. Each actor, in seeking to shield itself from vulnerability, has deepened the insecurity of others, locking the system into a cycle of continuous expansion of military capabilities.

One particularly revealing case is the use of commercial Earth observation imagery. Ukraine's access to high-revisit data from Western providers, including Maxar, Planet, and ICEYE, enabled near-real-time targeting and battlefield transparency[284]. Russia, in turn, signalled at the United Nations that "quasi-civilian" satellites supporting Ukraine might be considered legitimate military targets, thereby broadening the scope of potential counterspace operations[285]. This provoked a response, where States such as Japan, India, and Australia, although not directly part of the Russia–Ukraine dyad, began to reconsider the vulnerability of their commercial space assets. Japan's 2022 National Security Strategy explicitly expanded the role of its Space Operations Squadron and called for closer integration of commercial data into national defence, reflecting concerns that commercial constellations could become targets in a future conflict[286]. India, through the Defence Space Agency and the opening of its space sector to private actors under the IN-SPACe framework, has increasingly emphasised dual-use capabilities, driven by the recognition that reliance on commercial EO and communications infrastructures entails exposure to counterspace threats. Australia, for

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[283] North Atlantic Treaty Organization (NATO) (2022) *"Strategic Concept"*, NATO, adopted 29 June, Madrid;
[284] Center for Strategic and International Studies (CSIS) (2023) *Space Threat Assessment 2023*. Aerospace Security Project report, 14 April. CSIS;
[285] United Nations General Assembly (UNGA) (2022) *Statement by Konstantin Vorontsov, Russian Foreign Ministry official, warning that "quasi-civilian infrastructure may be a legitimate target for retaliation" at the United Nations*. [Oral statement] 26 October;
[286] Government of Japan (2022) *National Security Strategy of Japan*. Cabinet Secretariat, approved by the Cabinet on 16 December;

its part, launched the Defence Space Command in 2022, framing the resilience of commercial and dual-use constellations as critical for both national security and alliance commitments in the Indo-Pacific[287].

The war in Ukraine has thus crystallised the emergence of an orbital security trilemma, with profound consequences for the global conception of strategic autonomy. Measures to secure communications, enhance surveillance, or harden satellites against interference are not only interpreted as threatening by rivals, prompting countermeasures, but also compel third parties to expand their own capabilities to avoid strategic exclusion. This dynamic has reshaped strategic autonomy into an increasingly militarised paradigm, where resilience in orbit and the development of counterspace capacities are viewed as indispensable to sovereignty. The outcome is a spiral of investment in military space technologies and space situational awareness that mirrors terrestrial rearmament, embedding the cascading logic of insecurity across domains and consolidating militarization as a central pillar of strategic autonomy worldwide.

[287] Australian Department of Defence (2022) *Defence Space Command Established to Enhance Australia's Strategic Access to Space*, media release, 18 January;

CONCLUSION

Outer space is not a static domain but an environment that evolves in close connection with terrestrial dynamics, underscoring its inseparability from global political, economic, and security processes. Within this context, strategic autonomy in outer space is defined as the ability to independently access and operate critical infrastructures, above all through sovereign launch capabilities and control over Low Earth Orbit (LEO) services. The war in Ukraine did not alter this definition, but it compelled both the European Union and the United States to recalibrate their policies around it, elevating strategic autonomy from an industrial and technological objective to a central element of security strategy.

The conflict marked a decisive turning point. It demonstrated the degree to which modern warfare depends on space-based services and revealed the critical role of private actors. Ukraine's reliance on Starlink epitomized the operational advantages of commercial constellations—redundancy, flexibility, rapid deployment, and cost efficiency—when confronted with Russian cyberattacks and bombardments against terrestrial infrastructure. Yet the war also illuminated deeper structural dynamics: the intensifying competition for orbital control, the rapid congestion of LEO, and the strategic importance of orbital geography as a foundation of power projection on Earth. The concentration of mega-constellations in key orbital bands, combined with the vulnerabilities exposed by attacks on space infrastructures such as ViaSat, underscored that access to orbits is not simply a technical matter but a determinant of sovereignty, deterrence, and crisis resilience. While space assets had been used in earlier conflicts, Ukraine highlighted for the first time the unprecedented scale of military dependence on congested and contested orbital infrastructures—and the vulnerabilities this creates in the projection of terrestrial power.

The divergent responses of the EU and the U.S. can best be explained through the causal mechanisms of securitization and techno-exceptionalism. For the European

Union, securitization transformed space into a matter of existential sovereignty. By framing independent access to orbital infrastructures as essential for survival and resilience, EU institutions legitimized extraordinary measures such as the creation of the IRIS² sovereign constellation, investment in autonomous launch capacity, and the expansion of space situational awareness. Crucially, these policies were not only institutional innovations but also direct responses to the structural pressures of orbital congestion and competition. In an environment where mega-constellations risk monopolizing access and intensifying vulnerability, securitization allows the EU to reposition its fragmented governance model around defence, crisis management, and the protection of access to congested orbital "corridors" critical for terrestrial security.

In contrast, the United States relies on techno-exceptionalism, rooted in narratives of frontier expansion and American exceptionalism. Here, private industry is already an indispensable component of space power. Companies such as SpaceX and Maxar were integrated into state strategy, providing critical services to Ukraine and confirming a model of "privatized autonomy." This model rests on the assumption that private constellations can outpace orbital competition by sheer scale, operating with high launch cadence and proliferated redundancy. Yet it also introduces vulnerabilities: the monopolistic control of congested orbits by a handful of corporations, the risk of corporate discretion shaping strategic outcomes, and the fragility of deterrence in orbital regimes where collision, interference, or deliberate attacks can cascade into systemic disruption.

Both securitization and techno-exceptionalism occurred within an international legal and governance environment already vulnerable. The weakening of cooperative frameworks, the indistinct boundary between civilian and military assets, and the structural deficiencies of the Outer Space Treaty created grey zones that accelerated orbital competition and worsened congestion. In effect, the lack of enforceable norms regarding the placement and use of satellites in LEO, GEO, and beyond has made access to orbits a contested resource, heightening the risks of monopolization and escalation. For the EU, this governance gap legitimized securitization, allowing institutions to portray independent access as a sovereign necessity amid scarcity and uncertainty. For the U.S., these same ambiguities reinforced techno-exceptionalism, enabling reliance on private actors whose swift deployment and frequent launches acted as substitutes for multilateral regulation. In both cases, the legal order's structural flaws—paired with the strategic realities of orbital congestion and competition—rendered policy adaptation unavoidable.

Looking ahead, securitization and techno-exceptionalism will evolve within a governance system that is not only fragmented but also increasingly shaped by the division of the international order into competing geopolitical blocs. The lack of robust multilateral rules, combined with the shortcomings of the Outer Space Treaty, leaves orbital competition and congestion largely unregulated, creating ripe conditions for rivalries to harden along bloc lines. In this environment, the EU and the U.S. may align more closely in their approaches, framing strategic autonomy as part of a broader Western response to systemic rivals, while Russia, China, and emerging powers pursue alternative governance models focused on sovereignty, control, and militarization. Such fragmentation risks turning orbits into arenas of bloc competition, where contested infrastructures mirror broader geopolitical divisions. The future of strategic autonomy in space will thus depend not only on how Washington and Brussels redefine their policies, but also on whether the global governance vacuum continues to deepen, pushing outer space further into a landscape of rival blocs and fragmented norms.

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