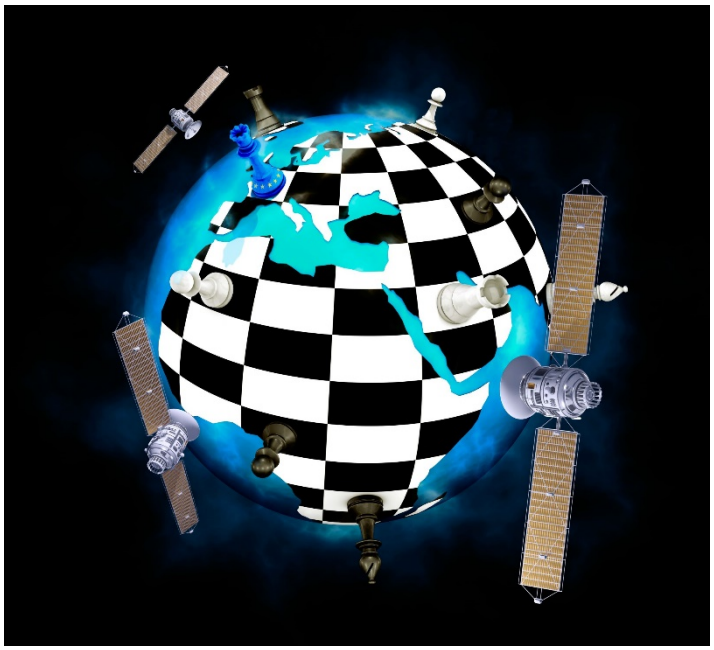
IN-DEPTH ANALYSIS

Requested by the SEDE sub-committee

European Parliament

The Strategic Compass and EU space-based defence capabilities



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ABSTRACT

The European Union relies on space for its economic sovereignty and security and defence. Without space-based capabilities, the EU could not enjoy any degree of strategic autonomy in security and defence. Since the adoption and endorsement of the Strategic Compass, space has only increased its relevance for the EU in the area of security and defence. Indeed, the Compass calls for a dedicated EU Strategy for Space and Defence. Yet space and defence is not a new avenue of policy for the EU and defence cooperation frameworks such as Permanent Structured Cooperation and the European Defence Fund already fund and advance space-relevant capability programmes. A major challenge facing the EU as it develops its space policies is how to ensure that the Union can develop a credible space and defence strategy, while also investing in the most appropriate space-defence capabilities.

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List of abbreviations

AI	Artificial Intelligence
ASAT	Anti-Satellite Weapons
ASOC	Air and Space Operations Centre
BRI	Belt and Road Initiative
C2	Command and Control
CARD	Coordinated Annual Review on Defence
CDP	Capability Development Plan
COPUOS	Committee on the Peaceful Uses of Outer Space
CSDP	Common Security and Defence Policy
EDA	European Defence Agency
EDF	European Defence Fund
EDIDP	European Defence Industrial Development Programme
EDIRPA	European Defence Industry Reinforcement through Common Procurement Act
EEAS	European External Action Service
EGNOS	European Geostationary Navigation Overlay Service
EPC	European Political Community
ESA	European Space Agency
EU	European Union
EUSATCEN	European Union Satellite Centre
EUSPA	European Union Agency for the Space Programme
EUSP	European Union Space Programme
EUSST	Framework for Space Surveillance and Tracking Support
FCAS	Future Combat Aircraft System
GNSS	Global Navigation Satellite Systems
GOVSATCOM	Government Satellite Communication
IAEA	International Agency for Atomic Energy
ICBMs	Inter-Continental Ballistic Missiles
IS	Illustrative Scenarios
ISR	Intelligence, Surveillance and Reconnaissance
ISS	International Space Station
PADR	Preparatory Action on Defence Research
PESCO	Permanent Structured Cooperation
PLASSF	People's Liberation Army Strategic Support Force

PNT	Positioning, Navigation and Timing
PRS	Public Regulated Service
MGCS	Main Ground Combat System
NATO	North Atlantic Treaty Organisation
OS	Operational Scenarios
OSCE	Organisation for Security and Cooperation in Europe
OEWG	Open Ended Working Group
SPA	Strategic Partnership Agreements
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
STM	Space Traffic Management
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
UK	United Kingdom
UN	United Nations
US	United States
USSF	United States Space Force
USSPACECOM	United States Space Command

Executive summary

The European Union (EU) increasingly sees the **importance of space from a security and defence perspective**. Ever since the adoption of the 2016 EU Space Strategy, institutions and Member States have sought to understand the security dimensions of the EU Space Programme. This has included a focus on important initiatives such as the development and use of Galileo's Public Regulated Service (PRS), the need to invest in Government Satellite Communication (GOVSATCOM) and to ensure that the Union has Space Situational Awareness (SSA) capabilities. In 2021, the EU also initiated its Space Programme (EUSP) with the ambition to modernise Galileo, Copernicus and the European Geostationary Navigation Overlay Service (EGNOS) and invest in SSA and GOVSATCOM up to 2027. Additionally, the EU has sought to ensure its secure and free access to outer space by developing its capacities for Space Traffic Management (STM).

However, despite these steps forward on space and security there is a need to think more deeply and consistently about space and defence at the EU level. Indeed, the strategic landscape is shifting in profound ways for the EU and this includes Russia's war on Ukraine and strategic competition between great powers. **Space will be affected by these undercurrents of change**, especially as the space domain is seen as enabling military power on earth. It is for this reason that the March 2022 publication of the Strategic Compass is an important moment for the EU's space and defence initiatives. Not only does the Compass underline that outer space is increasingly contested, but it sees **space as the location for rivalry between states** and growing irresponsible behaviour. In this sense, the Strategic Compass calls for scenario-based exercises on space, the development of capabilities and the publication of a dedicated EU Space and Defence Strategy.

Such a strategy is an **opportunity for the EU to be clearer about the relationship between space and defence**. Here, there is a need to look at how the EU will utilise space for its security and defence, what space-defence capabilities it should develop in the future, how it will protect space infrastructure from malicious activities and outline the ways in which mutual assistance would function in times of acute crises involving the space domain. What is more, the EU Space and Defence Strategy will play a key role in **framing the capabilities the Union should invest in for the future**. Since 2017, the EU has used tools such as the European Defence Fund (EDF) to invest over EUR 270 million in space-defence capabilities, but we should expect larger financial investments in the future. Under Permanent Structured Cooperation (PESCO) no less than five projects focus on space-defence. Thus, there is a need to ensure coherence in the Union's approach to space-defence capabilities.

This **in-depth analysis** looks at the space-based threats currently facing the EU, and it outlines how an era of strategic competition – as referred to in the Strategic Compass – could fuel the misuse of space by adversaries, rivals and even partners. The in-depth analysis also looks at the steps taken, thus far, by the EU in the **development of space-defence capabilities** – here, a specific focus is placed on PESCO and the EDF. It also volunteers some reflections on the challenges facing the production of the first-ever **EU Strategy on Space and Defence**. Overall, the in-depth analysis recommends that the EU prioritise the protection of Galileo and Copernicus from malicious activities, ensure the coherence of EU bodies and institutions dedicated to space and defence issues, invest in its geospatial intelligence capabilities, scope and invest in next-generation space-defence capabilities, regularly conduct space exercises and investigate how the Mutual Assistance clause would apply in the case of space-based threats or attacks.

1 Introduction

Space is increasingly recognised as a strategic domain that is having a profound impact on geopolitics and defence. For many years and decades, outer space has been seen as a benign element of the global commons, even if it played a major role during the Cold War. Even if space can be viewed as a **deceptively peaceful arena** by some, the reality is that it is a strategic domain that already plays a major role in military force. From air and missile defence to battlefield communications, **space-based infrastructure supports the proper functioning of militaries on earth**. Indeed, without satellites and sensors it would be extremely difficult – if impossible – to manage and support the positioning, navigation and timing of military units and troops. In this era of network-centric warfare, it is i**mpossible to sustain military power without unfettered and secure access to space**. At a time when space is becoming increasingly utilised by governments and commercial operators, it is an increasingly dense and congested domain where malicious or accidental events on key space-defence infrastructure can occur.

Just as the balance of power is shifting on earth, however, so too is space becoming increasingly implicated in strategic reflections and considerations. The rise of China and the growing menace from Russia poses difficult questions about how space can and should be used. While all countries have a legitimate right to exploit space for exploration and scientific reasons, there is often **a grey area between benign and malicious activities**. In this sense, the dominance of the West in space is being called into question. This is concerning from a European and transatlantic perspective, not least because space is an incredibly fragile environment. This means that even the slightest accident or malicious attack on space-based infrastructure could lead to major economic and security implications on earth. Hence, there is a growing need to insist upon the responsible use of space while also ensuring that space-based infrastructure remains secure.

While countries such as the United States (US), China, Russia, Japan and India are increasingly investing in their space presence and capacities, the EU has to **insure the security of its existing space-infrastructures such as Galileo and Copernicus**. Without the security of these capabilities, the Union would suffer in terms of economic and strategic health. In this regard, the Union has already started work on ensuing the further development of Galileo's PRS, which will provide a more resilient system in the face of spoofing and jamming. The EU is also working on the development of GOVSATCOM in a phased approach, but the ultimate aim is to ensure that the EU has a secure communications architecture for security and defence. Additionally, the Union has set about developing its SSA and STM capabilities with investments under the EU Space Programme. Such capabilities will allow the EU to better anticipate, avoid and respond to space-based threats.

Despite the existence of these initiatives and investments, however, 2022 marks an important year for the EU in the development of space-defence capabilities. Indeed, in March 2022 the EU adopted its **first-ever security and defence strategy** called the **Strategic Compass.** The document covers the ways which the EU will need to **act, secure, invest and partner** in order to further develop itself as a credible security and defence actor. While the Strategic Compass emphasises the importance of investing in military capabilities and strategic enablers, it does not shy away from underlining the crucial importance of developing the Union's space-defence capabilities. In this regard, the Strategic Compass calls for the EU to develop a dedicated **Strategy for Space and Defence** – the first of its kind for the EU. Until the delivery of this Strategy by the end of 2023, there is an opportunity for the EU to reflect on what precisely means by space-defence capabilities as well as to clarify what type of actor it wants to be in outer space.

The first-ever EU Strategy for Security and Defence will no doubt have to tackle how the Union can protect its existing space assets, but it will also have to outline the ways in which the EU can respond to space-based threats, risks and challenges. In this respect, we should recognise that the EU is already using the EDF and PESCO to develop space-defence capabilities. Since 2017, and under the EDF, the European Commission has **invested approximately EUR 270 million in specific space-defence capabilities** and

PESCO is home to **five specific space-defence capability projects**. Of course, for these projects to make any difference to the Union's space-defence capabilities, they need to be completed on time. Indeed, recent analysis by the European Defence Agency (EDA) shows that 20 out of 60 PESCO projects are set to be delivered by 2025, but that 21 projects are falling behind or are delayed[1]. At present, it is unclear whether the five ongoing space-defence specific capabilities are included in the list of delayed projects.

Nevertheless, collectively these capabilities and investments could lead to more effective early warning and interception capabilities, Artificial Intelligence (AI)-enabled space imagery and geospatial intelligence, secure radio and satellite communications and the development of microsatellites for the purposes of SSA and STM. Such investments show that the EU is moving in the correct direction in terms of selecting projects that fill existing capability gaps, but the Strategy on Space and Defence can help provide greater guidance for future capability needs. Such a Strategy could also provide greater coherence between EDF and PESCO space-relevant projects, especially in order to avoid any unnecessary duplication and ensure coherence between investments.

This **in-depth analysis** looks at the space-based threats currently facing the EU and it analyses the current role of the EDF and PESCO in helping the Union develop space-defence capabilities. In this respect, the analysis is guided by a number of questions, including:

1. What are the current space-based threats, risks and challenges facing the EU?
2. What role have the EDF and PESCO played in helping to develop EU space-defence capabilities?
3. In what ways could the forthcoming EU Space and Defence Strategy influence the development of space-defence capabilities at the EU level?
4. How can the Union's partnerships help with the development of a coherent EU approach to space and defence?

To answer and engage with these questions, the in-depth analysis is divided in three main parts. The first part of the analysis outlines the nature of space-based threats, risks and challenges facing the EU today. This section not only details the types of threats facing the Union in outer space, but it provides an account of how space is quickly becoming a strategic domain where great power rivalry is being played out. The second part of the study looks in more detail at the EU and its space-defence capabilities. In this regard, the analysis looks at what dual-use and defence capabilities are currently being developed under the EDF and PESCO. This part of the analysis gives the reader an account of what these space-defence capabilities will add to the Union's overall security and defence. The third part of the analysis focuses on the Strategic Compass and the forthcoming EU Strategy for Space and Defence, and it reflects on some of the challenges and opportunities facing the EU and its partners in developing this strategy. The analysis ends with a conclusion and specific recommendations for the European Parliament to consider in relation to EU space and defence capabilities.

[1] European Defence Agency, 'Development, Delivery and Determination: PESCO Forging Ahead', https://www.pesco.europa.eu/pressmedia/development-delivery-and-determination-pesco-forging-ahead/.

2 Space, defence and strategic competition

Unquestionably, **space is a strategic domain that cannot be neglected by the EU**. It is a domain that is of growing risk of 'weaponisation' or 'instrumentalisation', and the Union's adversaries and partners are investing in new space-based capacities and strategies. While it is true that there may be some ambivalence about being a 'first mover' into the militarisation of space[2], there is substantial evidence to show that **countries are already engaged in developing military capacities in space**. There is a risk, therefore, that the increased use of space for military purposes could lead to an 'arms race' in space. This would be particularly risky at a time when space is being used by even more commercial operators and where **space congestion is already posing risks to militaries and companies**. Nevertheless, even if space is being used by more commercial operators than in the past, we should not overlook how space is being seen as but one among many strategic domains in which power politics is playing out[3]. **Space may not be the location where great power rivalries are ignited**, but it can certainly shape what capabilities are made available to and used by great powers. Here, it is important to recognise the **interdependence of space with terrestrial politics**[4].

2.1 Space risks, threats and challenges

Space is the location of a number of risks, threats and challenges that can undermine the security and defence of nations and political organisations on earth. For example, a handful of countries are **capable today of fielding capabilities that can disable or disrupt satellites**. This, in turn, poses a major risk to space-to-earth communications and any disruption can cause untold damage to armed forces by hampering or stopping battlefield communication, positioning and timing. Accordingly, any disruption to space-based communications can stop armed forces from successfully detecting and deflecting incoming missiles or airborne threats and its makes military targeting and position even harder, if not impossible. In this sense, **Intelligence, Surveillance and Reconnaissance (ISR) capacities can be rendered ineffective** and whole military services plunged into operational darkness and immobility.

A major challenge facing the EU, however, is understanding that **the Union will only become more dependent on space in the coming years and decades**. Not only will this apply to the European economy at large, but specific future defence systems such as the Future Combat Aircraft System (FCAS), 'Eurodrone' and/or Main Ground Combat System (MGCS) will be entirely dependent on space for Positioning, Navigation and Timing (PNT). In this respect, **space is a strategic enabler that will be used to empower European militaries**, but vulnerabilities in space can only call into question the relevance or effectiveness of next-generation capabilities. In this respect, it is important to think of at least three general types of threats that risk impeding the EU's free and secure access to space. These three threats should also be considered and interrogated in further detail during the forthcoming space-related exercises and EU Space and Defence Strategy called for by the Strategic Compass. The three general threats are: 1) weaponisation; 2) congestion; and 3) disruption.

[2] Johnson-Freese, J., *Space Warfare in the 21st Century: Arming the Heavens* (London/New York: Routledge, 2017), p. 167.
[3] Fiott, D., 'The European Space Sector as an Enabler of EU Strategic Autonomy', *In-Depth Analysis*, PE 653.620, European Parliament, December 2020, https://www.iss.europa.eu/sites/default/files/EUISSFiles/EXPO_IDA%282020%29653620_EN.pdf.
[4] Bowen, B.E., *War in Space: Strategy, Spacepower, Geopolitics* (Edinburgh: Edinburgh University Press, 2020), p. 272.

2.1.1 Weaponisation

The combination of technological advances and more aggressive strategic behaviour largely explains the lurch towards more 'weaponisation of space'[5]. The increased development of micro and swarm satellites, advanced propulsion and targeting and next-generation robotics are contributing to the possibilities for malicious activities in space, as well as the economic and commercial benefits they may bring. For example, microsatellites – or satellites that weigh less than 10kgs (large satellites weigh upwards of 1 000 kgs, for example)[6] – could be used by adversaries for more effective loitering or proximity operations due to enhanced stealth and manoeuvrability technologies[7]. This means that adversaries could get closer to European-owned commercial and military satellites. Swarm satellites – or multiple microsatellites that are brought together into a system of satellites – could be used to enhance the tracking of missiles, especially as current technology allows for the detection of launches but not in-flight trajectories[8]. Such developments are giving rise to fears about what greater numbers of satellites in space will mean from a strategic perspective, with one active duty member of the US Air Force stating that it could incentivise the use of high altitude nuclear detonations to disable satellites[9]. Such theories can be coupled with existing ideas about how electromagnetic pulse weapons could be used to disable space infrastructure[10].

We already know that states such as the US, China, Russia and India are at various stages of developing and fielding Anti-Satellite Weapons (ASATs) such as jammers, directed energy, chemical sprays and hit-to-kill vehicles[11]. Documents such as the US 2020 Defense Space Strategy and the French 2019 Space Defence Strategy have already **documented cases of ASATs being used against French and American space infrastructure**[12]. Such strategies have also noted that rivals and adversaries such as Russia have spent considerable effort in loitering near French or US satellites for the purposes of intimidation and reconnaissance. As the November 2021 case of Russia destroying one of its old satellites (the Soviet-era Cosmos 1408 satellite) in orbit attests, the debris caused by the use of ASATs can have considerable, untold knock-on security implications. For example, Russia's ASAT operation led to the creation of an estimated 1 500 pieces of space debris and the International Space Station (ISS) even had to make an emergency manoeuvre to avoid being hit[13].

[5] Fiott, D., 'Securing the Heavens: How can Space Support the EU's Strategic Compass?', *EUISS Brief*, no. 9, April 2021, https://www.iss.europa.eu/content/securing-heavens.
[6] European Space Agency, 'Technology CubeSats', undated, https://www.esa.int/Enabling_Support/Space_Engineering_Technology/Technology_CubeSats.
[7] Borowitz, M., 'The Military Use of Small Satellites in Orbit', *Briefings de l'IFRI*, 4 March 2022, https://www.ifri.org/sites/default/files/atoms/files/m._borowitz_military_use_small_satellites_in_orbit_03.2022.pdf and Nayak, M., 'CubeSat proximity operations: The natural evolution of defensive space control into a deterrence initiative', *The Space Review*, 18 January 2016, https://www.thespacereview.com/article/2902/1.
[8] Miller, A., 'How the SDA's Satellite Swarm Will Track Hypersonic Missiles Where Others Can't', *Air & Space Forces Magazine*, 12 January 2022, https://www.airandspaceforces.com/how-the-sdas-satellite-swarm-will-track-hypersonic-missiles-where-others-cant/.
[9] Vincent, R., 'Getting Serious about the Threat of High Altitude Nuclear Detonations', *War on the Rocks*, 23 September 2022, https://warontherocks.com/2022/09/getting-serious-about-the-threat-of-high-altitude-nuclear-detonations/.
[10] Conca, J., 'China has "First-Strike" Capability to Melt U.S. Power Grid with Electromagnetic Pulse Weapon', *Forbes*, 25 June 2020, https://www.forbes.com/sites/jamesconca/2020/06/25/china-develops-first-strike-capability-with-electromagnetic-pulse/?sh=3deba36e1908.
[11] United States Defense Intelligence Agency, 'Challenges to Security in Space', January 2019, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.
[12] See, US Department of Defense, 'Defense Space Strategy Summary', June 2020, https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF and French Ministry of the Armed Forces, 'Space Defence Strategy', 2019, https://www.gouvernement.fr/sites/default/files/locale/piece-jointe/2020/08/france_-_space_defence_strategy_2019.pdf.
[13] Malik, T., 'International Space Station dodges orbital debris from Russian anti-satellite test', *Space.com*, 19 June 2022, https://www.space.com/space-station-dodges-russian-satellite-debris.

2.1.2 Congestion

The increased use of space by commercial and public actors is contributing to greater congestion in space. The risk posed by increased space traffic is that there is an enhanced possibility of space collisions, which in turn may lead to the creation of space debris and further damage. For example, one source estimates that **in January 2021 there were 4 500 satellites in orbit** with more than 2 800 owned by the US, 467 by China, 349 by the United Kingdom (UK), 168 by Russia, 93 by Japan, 61 by India, 57 by Canada and 47 by Germany (the highest ranking EU country, with France owning 31)[14]. One of the major issues at play in dealing with space congestion, however, is the **difficulties involved in tracking space debris and infrastructure**. It should go without saying that space is vast and existing SST and SSA capacities cannot monitor all areas of space at the same time. While it is true that AI is being increasingly used to help monitor space objects, the reality is that existing capabilities cannot effectively engage in multi-object tracking[15].

2.1.3 Disruption

In addition to the risk of the 'weaponisation of space', there is a need to consider the role of disruption to space infrastructure. The main risk here presents itself in the form of cyber intrusions of space- and ground-based infrastructure such as ground stations and satellites. There is evidence to suggest that jamming and spoofing technologies are already being employed to disrupt earth-to-space communications signals and links. For example, Russian cyber-attacks on the 'KA-SAT'[16] satellite system in February 2022 led to the disruption of communications for Ukraine's armed forces in advance of Russia's invasion of Ukraine. The attack also led to significant disruption in central and eastern Europe, with approximately 5 800 wind turbines across Germany being affected too because of their reliance on ViaSat routers[17]. More recently, authorities in Iran have responded to mass protests across the country by blocking foreign media satellite transmissions into the country – in September 2022, Iran was suspected of jamming two Eutelsat satellites[18].

Worryingly, **cyber intrusions can also lead to the hacking and control of telecommand and telemetric systems**, which can be used to create errors in PNT, and there is a growing risk that commercial satellites could be hacked and transformed into 'suicide satellites' that crash into other space infrastructure[19]. We **should not neglect the importance of ground-based infrastructures** or the vulnerabilities they can suffer from cyber-attacks. Consider, for example, that the Union's existing SST capacities are composed of a sensor network of 12 radars and 34 telescopes located in places such as Argentina, Australia, Japan and South Africa[20].

[14] Dewesoft, 'Every Satellite Orbiting Earth and Who Owns Them', January 18, 2022, https://dewesoft.com/daq/every-satellite-orbiting-earth-and-who-owns-them.
[15] Jones, B.A., 'Challenges of Multi-Target Tracking for Space Situational Awareness', 18th International Conference on Information Fusion, Washington, DC, 2015, pp. 1278-1285, https://ieeexplore.ieee.org/abstract/document/7266704?casa_token=hDYG7n1xjjUAAAAA:tvPYPJVM2haIHa8RqWp_Px_DiDlIUJtntJk_kzoSci0a3Vl0VAixIASTVEGzmyMBzLlGUoTlxHJxTA.
[16] 'KA-SAT' is owned by ViaSat.
[17] Page, C., 'US, UK and EU blame Russia for "unacceptable" Viasat cyberattack', *TechCrunch*, 10 May 2022, https://techcrunch.com/2022/05/10/russia-viasat-cyberattack/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAJDW4LhFFycLO4Kf6w9aANBjavE2KdMpONeW5-DQ8DHRu0Usz0srzOj1sANTYibhW0KupLlxzYA7pYG9rzc3ezZrccBeWrWwaIOOXP5tOmh1bEEdyEu7HTEJXzR_Dkrug7ZFfZTGV_mi3gsLcSIXoWQFuOC3A3_uEUvNibjbp4Ir.
[18] Rainbow, J., 'Eutelsat says satellite jammers within Iran are disrupting foreign channels', *Space News*, 7 October 2022, https://spacenews.com/eutelsat-says-satellite-jammers-within-iran-are-disrupting-foreign-channels/.
[19] Op.Cit., 'Securing the Heavens'.
[20] Faucher, P. and Becker, M., 'European Space Surveillance and Tracking', September 4, 2020, https://www.eusst.eu/wp-content/uploads/2020/05/EUSST_SMI2020_20200904.pdf.

2.2 Space strategies and competition

We know today that a number of European and non-European states are investing in the military dimensions of their space presence and strategies. Yet, it is not just investments in space-defence capabilities that signals the rise of geopolitical competition in space. Indeed, we should also look at the ways in which **governments are leveraging the so-called 'new space' industry to advance political interests.** For example, one study from the European Space Policy Institute, shows that European public investments in space still account for more than half of all investments in 'new space' and public funding even increases when one takes into account mixed public/private financing schemes[21]. In 2019, 58 % of total funding into 'new space' came from governments – in 2020 this figure dipped to 40 % before hitting 57 % in 2021[22]. Even if there is much hype about the proliferation of new commercial operators in space, the domain is still largely dominated by states, their investments and geopolitical ambitions. Thus, as the commercial space industry grows, so too do the strategic designs of great powers.

2.2.1 United States

In the past few years, several governments have taken steps to advance their military strategies towards space. In December 2019, the US established a Space Force (USSF) so as to be able to concentrate its efforts on space security, as well as the development of military space systems, skills and military doctrine[23]. The **US government even requested a USD 24.5 billion-strong budgetary envelope for its space-defence activities in 2022**[24]. Even though the US voluntarily adopted its own moratorium on the destructive testing of ASATs[25] in 2022 under the Biden administration, the US has previously underlined that the role of the USSF and US Space Command (USSPACECOM) is to ensure that the US does not fall behind in space to competitors. As the 2020 US Defense Space Strategy states, '[s]pace, however, is not a sanctuary from attack and space systems are potential targets at all levels of conflict […] China and Russia each have weaponized space as a means to reduce U.S. and allied military effectiveness and challenge our freedom of operation in space'[26].

What is more, the 2022 US National Defense Strategy makes clear that Washington needs to defend its interests against the pacing threat of China, and, to this end, it makes clear that the US must be prepared to protect its homeland in all theatres and warfighting domains, backed up by investments in force design and capabilities[27]. The US' desire to deter harmful space-based activities dates back to at least the 1970s, when Washington developed ASATs to deter Soviet activities[28], and it indeed tested ASATs in the mid-1980s[29]. Despite the classified nature of such space programmes, there is still evidence to suggest that the US has ongoing space weapons programmes. For example, a report from August 2021 – thus, before the

[21] European Space Policy Institute, 'Towards a Slowdown of European New Space Investment?', *Executive Brief*, no. 59, August 9, 2022, https://www.espi.or.at/briefs/towards-a-slowdown-of-european-new-space-investment/.
[22] Ibid.
[23] US Air Force, 'Letter to the Force', December 20, 2019, https://www.spaceforce.mil/About-Us/Letter-to-the-Force/.
[24] Erwin, S., 'Biden's 2023 Defense Budget Adds Billions for U.S. Space Force', *Space News*, March 28, 2022, https://spacenews.com/bidens-2023-defense-budget-adds-billions-for-u-s-space-force/.
[25] Panda, A. and Silverstein, B., 'The U.S. Moratorium on Anti-Satellite Missile Tests is a Welcome Shift in Space Policy', *Carnegie Commentary*, 20 April 2022, https://carnegieendowment.org/2022/04/20/u.s.-moratorium-on-anti-satellite-missile-tests-is-welcome-shift-in-space-policy-pub-86943.
[26] US Department of Defence, 'Defense Space Strategy Summary', June 2020, p. 1, https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF.
[27] US Department of Defense, 'Fact Sheet: 2022 National Defense Strategy', March 28, 2022, https://www.defense.gov/News/Releases/Release/Article/2980584/dod-transmits-2022-national-defense-strategy/.
[28] President of the US, 'The U.S. Anti-Satellite (ASAT) Program: A Key Element in the National Strategy of Deterrence', May 1987, https://spp.fas.org/military/program/asat/reag87.html.
[29] Morgan, F.E., 'Deterrence and First-Strike Stability in Space: A Preliminary Assessment', *RAND Corporation*, 2020, https://www.rand.org/content/dam/rand/pubs/monographs/2010/RAND_MG916.pdf.

Biden administration's moratorium on ASATs – hypothesised that the US government was in possession of an ASAT that could make use of mobile lasers to blind adversary satellites or use electronic weapons to jam and disable military satellites[30].

2.2.2 Russia

Russia continues to view space as a key determinant of geopolitical power, even following its invasion of Ukraine in February 2022. Russian military doctrine already makes it clear that the **Kremlin must be able to manage air and space attacks on its infrastructure**. Russia has also made it clear that space is an enabler for its military and nuclear power and that outer space is a foundation for its conventional and nuclear defence and strike systems[31]. The Russian armed forces have within their arsenal electronic warfare (i.e. jamming and spoofing) capabilities. In addition to a reported ASAT test in July 2020[32], in November 2021 Russia conducted a direct-assent ASAT test on one of its own satellites, which resulted in the destruction of the satellite and the creation of a minimum of 1 500 pieces of space debris[33]. Additionally, we know that **Russia conducted cyber and electronic jamming actions on Ukraine** at the outset of its invasion in February, which led to the introduction of malware in thousands of ViaSat terminals – thus disrupting the communications network used by the Ukrainian armed forces[34].

Furthermore, Russia has tried to put itself on the vanguard of countries using **hypersonic missile technologies**. Such technologies differ from conventional ballistic missiles in that they do not cruise on a fixed line of travel but can manoeuvre in-flight (or 'bob and weave') to avoid detection and make it difficult for anti-missile systems to function. Hypersonic propulsion technologies are not new and existing Intercontinental Ballistic Missiles (ICBMs) use hypersonic technology, albeit for fixed trajectory targeting. What is challenging is that hypersonic glide vehicles – rockets that are attached to a rocket and released in high altitude – can operate to speeds of up to 5 600 km/h and they can 'bob and weave' at altitudes that are not extensively covered by existing SST and SSA systems[35]. Russia has reportedly invested in hypersonics, although it is unclear if these reports can be verified. For example, although the Kremlin has announced that it has used its *Kinzhal* 'hypersonic missile' several times during its war on Ukraine[36], engineers claim that the missile is a Soviet-era ballistic missile that has been fitted with a more solid rocket motor that allows it to reach the Mach 10 – a speed usually assigned to hypersonic vehicles[37]. Nevertheless, in December 2018 Russia is reported to have tested its *Avangard* hypersonic missile. This test saw the vehicle travel for 6 000 kms before hitting a target in Siberia – the Kremlin wasted no time in announcing

[30] Hitchens, T., 'Exclusive: Pentagon Poised to Unveil, Demonstrate Classified Space Weapon', *Breaking Defense*, 20 August 2021, https://breakingdefense.com/2021/08/pentagon-posed-to-unveil-classified-space-weapon/.
[31] Russian Federation, 'Basic Principles of State Policy of the Russian Federation on Nuclear Deterrence', 8 June 2020, https://www.mid.ru/en/foreign_policy/international_safety/disarmament/-/asset_publisher/rp0fiUBmANaH/content/id/4152094.
[32] Bugos, S., 'Russian ASAT Test Creates Massive Debris', *Arms Control Association*, December 2021, https://www.armscontrol.org/act/2021-12/news/russian-asat-test-creates-massive-debris.
[33] State Council of the People's Republic of China, 'White Paper on China's Space Activities in 2016', *China Daily*, 29 December 2016, http://english.www.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm.
[34] Burbach, D.T., 'Early Lessons from the Russia-Ukraine War as a Space Conflict', *Atlantic Council*, 30 August 2022, https://www.atlanticcouncil.org/content-series/airpower-after-ukraine/early-lessons-from-the-russia-ukraine-war-as-a-space-conflict/.
[35] Boyd, I., 'How hypersonic missiles work and the unique threats they pose – an aerospace engineer explains', *The Conversation*, 15 April 2022, https://theconversation.com/how-hypersonic-missiles-work-and-the-unique-threats-they-pose-an-aerospace-engineer-explains-180836.
[36] 'Russia says it has deployed Kinzhal hypersonic missile three times in Ukraine', *Reuters*, 21 August 2022, https://www.reuters.com/world/europe/russia-says-it-has-deployed-kinzhal-hypersonic-missile-three-times-ukraine-2022-08-21/.
[37] Paleja, A., 'Experts say the Russian hypersonic missile Kinzhal is not a "hypersonic weapon". Here's why', *Interesting Engineering*, 24 August 2022, https://interestingengineering.com/culture/russias-kinzhal-missile-not-hypersonic.

that had armed the *Avangard* with nuclear warheads[38]. Time will tell if Russia is able to maintain any momentum in hypersonics, as the effect of sanctions on its technology sectors makes it difficult for the country.

2.2.3 China

China is also rapidly solidifying its strategic position in space. Not only does Beijing continue to develop its Beidou Navigation System but it continues to master heavy-launcher technologies ('Long March'). Additionally, China continues to develop its so-called 'Space Silk Road' strategy in order to support its Belt and Road Initiative (BRI) and enhance its self-reliance in space innovation and capabilities[39]. **China's military doctrine makes clear that it must independently tackle space threats** and that the People's Liberation Army Strategic Support Force (PLASSF) should support space operations[40]. Reports indicate that **China is also making great strides in hypersonic missile technologies**. As we have seen, hypersonic missiles can 'bob and weave' in the earth's high atmosphere, which makes them a risk against high-value targets such as aircraft carriers or command and control bases[41], and this tests the ability of existing SST technologies to detect their in-flight trajectories. Indeed, in October 2021 the *Financial Times* reported that China had tested a nuclear-capable hypersonic missile that circled the globe before re-entering the earth's atmosphere. Although Beijing denied these reports, there have been further reports that China has tested hypersonic weapons in the South China Sea region[42]. How such technologies will effect deterrence strategies remains unclear, but the US government has already held classified meetings on the threat posed by Chinese hypersonic glide vehicles[43].

2.2.4 India

India is also rapidly developing its space programme and, along with its nuclear programme, sees it as vital to its national security and autonomy[44]. India has been reactive to ASAT tests by Russia and China and is seeking to balance against Beijing, which it views as taking sizeable steps forward in its own military-space programme. In particular, it has been argued that India should move beyond viewing space as only a domain for reconnaissance, navigation and communications because China is using space to increase its hegemony in Asia and globally[45]. Indeed, on 27 March 2019 India became the only country after China, Russia and the US to test an ASAT – the March test was important for India, given its failed attempt in February 2019[46]. The March ASAT (dubbed 'Mission Shakti') saw India prove its capacity to launch a direct-assent missile from earth and to strike an Indian satellite located 300 kms above the earth's surface[47]. India's

[38] Stone, R., '"National pride is at stake". Russia, China, United States race to build hypersonic weapons', *Science*, 8 January 2020, https://www.science.org/content/article/national-pride-stake-russia-china-united-states-race-build-hypersonic-weapons.
[39] State Council of the People's Republic of China, 'White Paper on China's Space Activities in 2016', *China Daily*, 28 December 2016, http://english.www.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm.
[40] US Naval Institute, 'Document: China's Military Strategy', 26 May 2015, https://news.usni.org/2015/05/26/document-chinas-military-strategy.
[41] Op.Cit., 'How hypersonic missiles work and the unique threats they pose'.
[42] Sevastopulo, D. and Hille, K., 'China tests new space capability with hypersonic missile', *Financial Times*, 16 October 2021, https://www.ft.com/content/ba0a3cde-719b-4040-93cb-a486e1f843fb.
[43] Gould, J. and Albon, C., 'Russia and China's space weapon plans spur high-level Pentagon meeting', 30 August 2022, https://www.defensenews.com/pentagon/2022/08/30/russia-and-chinas-space-weapon-plans-spur-high-level-pentagon-meeting/.
[44] Rajagopalan, R.P., 'India's Emerging Space Assets and Nuclear-Weapons Capabilities', *The Nonproliferation Review*, vol. 26, no. 5-6 (2019), pp. 465-479.
[45] Bommakanti, K., 'The Enduring Significant of Space Weapons for India', *Observer Research Foundation*, 13 August 2020, https://www.orfonline.org/expert-speak/the-enduring-significance-of-space-weapons-for-india/.
[46] Panda, A., 'Exclusive: India Conducted a Failed Anti-Satellite Test in February 2019', *The Diplomat*, 30 March 2019, https://thediplomat.com/2019/04/exclusive-india-conducted-a-failed-anti-satellite-test-in-february-2019/.
[47] Set, S., 'India's Space Power: Revisiting the Anti-Satellite Test', *Carnegie India*, 6 September 2019, https://carnegieindia.org/2019/09/06/india-s-space-power-revisiting-anti-satellite-test-pub-79797.

capacity to use ASATs means it is in a league with China, Russia and the US in terms of technology and it underlines New Delhi's willingness to use such weapons in pursuit of its national defence.

2.2.5 Europe and NATO

European governments have also sought to invest in space-defence capacities. For example, France – which published a Space Defence Strategy of 2019 – has established a Space Command and an Air and Space Force, which continues to develop military-space doctrine and conduct exercises[48]. Indeed, in March 2021 **France held its first-ever military space exercise called *AsterX***, where the French Air and Space Force conducted a series of exercises where an adversary would attack French interests through espionage tactics, re-entry vehicles and ASATs[49]. In 2019, Italy produced 'Guidelines on Space and Aerospace' to deepen government-level coordination on space, security and defence matters. In November 2019, the Italian Defence General Staff created the General Space Office, a Space Operations Command was established in June 2020 and the Air Operations Command was transformed into the Aerospace Operations Command in 2020 – a move designed to emphasise the relevance of SSA and SST responsibilities under the military air chain of command[50]. Germany has also set up its own Air and Space Operations Centre (ASOC), which fuses Berlin's space intelligence, security and situational awareness capacities[51]. Finally, the United Kingdom (UK) released its Defence Space Strategy in February 2022, which presented policy initiatives such as an additional GBP 1.4 billion for space-related investments as well as a GBP 5 billion investment in its Skynet military satellite communications system. These announcements come on the back of the UK establishing its own UK Space Command and Control in April 2021[52].

[48] Ministère des armées, 'Armée de l'air et de l'Espace', September 12, 2020, https://www.defense.gouv.fr/air/dossiers/armee-de-l-air-et-de-l-espace/le-logo.
[49] Charpentreau, C., 'AsterX: France starts first military exercise in space', March 10, 2021, https://www.aerotime.aero/articles/27437-asterx-france-starts-first-military-exercise-in-space.
[50] La Rocca, G. and Marrone, A., 'Italy and Space: A Strong Position to Enhance', in Marrone, A. and Nones, M. (eds.) *The Expanding Nexus between Space and Defence*, Istituto Affari Internazionali, 2022, pp. 64-65, https://www.iai.it/sites/default/files/iai2201.pdf.
[51] Vogel, D., 'German Armed Forces Approaching Outer Space', *SWP Comment*, 2020/C 49, October 2020, https://www.swp-berlin.org/10.18449/2020C49/.
[52] UK Government, 'Defence Space Strategy: Operationalising the Space Domain', February 2022, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051456/20220120-UK_Defence_Space_Strategy_Feb_22.pdf and Suess, J., 'The UK Defence Space Strategy', *RUSI Commentary*, 11 February 2022, https://rusi.org/explore-our-research/publications/commentary/uk-defence-space-strategy.

Figure 1 – EU Member State space and defence strategies

Country	Year	Space-Defence Strategy	Space Strategy
Austria	2021		Yes, non-defence specific
Cyprus	2022 (draft)		Yes, non-defence specific
Czechia	2020		Yes, non-defence specific
Denmark	2021		Yes, partially refers to defence
Finland	2018		Yes, non-defence specific
France	2019	Yes	
Germany	2019		Yes, non-defence specific
Hungary	2021		Yes, non-defence specific
Ireland	2019		Yes, non-defence specific
Italy	2019		Yes, comprehensively deals with defence
Latvia	2020		Yes, partially refers to defence
Luxembourg	2022	Yes	
Malta	2022		Yes, non-defence specific
Poland	2017		Yes, non-defence specific
Portugal	2018		Yes, non-defence specific
Slovakia	2019		Yes, partially refers to defence
Spain	2019		Yes, comprehensively deals with defence
Sweden	2019		Yes, non-defence specific

Source: various.

As Figure 1 shows, several European countries have invested time and effort into developing space strategies. These efforts have lent weight to NATO's own engagement with space, which began in 2019 when **the alliance recognised space as an operational domain**. The first-ever 2019 NATO Space Policy stated that space should be treated as the fifth operational domain alongside land, sea, air and cyber because of its relevance for defence and deterrence[53]. On the basis of NATO's Space Policy, the alliance created a Space Centre based at Allied Air Command in Ramstein, Germany, in October 2020[54]. In January 2021, NATO also decided to open a Centre of Excellence for Space in Toulouse, France, which will support the alliance develop doctrine, training, exercises and analysis on space as a strategic domain[55]. Finally, at the Brussels Summit on June 2021 leaders agreed that 'attacks to, from, or within space present a clear challenge to the security of the Alliance, the impact of which could threaten national and Euro-Atlantic prosperity, security and stability, and could be as harmful to modern societies as a conventional attack.

[53] Brunner, K-H., 'Space and Security – NATO's Role', *Special Report*, NATO Parliamentary Assembly, p. 12, https://www.nato-pa.int/download-file?filename=/sites/default/files/2021-12/025%20STC%2021%20E%20rev.%202%20fin%20-%20SPACE%20AND%20SECURITY%20-%20BRUNNER.pdf.

[54] See: Paulauskas, K., 'Space: NATO's Latest Frontier', *NATO Review*, 13 March 2020, https://www.nato.int/docu/review/articles/2020/03/13/space-natos-latest-frontier/index.html; NATO, 'Space is essential to NATO's defence and deterrence', 14 October 2019, https://www.nato.int/cps/en/natolive/news_169643.htm?selectedLocale=en; and 'NATO's Approach to Space', NATO, 23 October 2020, https://www.nato.int/cps/en/natohq/topics_175419.htm.

[55] French Ministry for Europe and Foreign Affairs, 'Defence – Establishment of the NATO space centre of excellence in Toulouse', *Communiqué*, 5 February 2021, https://www.diplomatie.gouv.fr/en/french-foreign-policy/security-disarmament-and-non-proliferation/news/article/defence-establishment-of-the-nato-space-centre-of-excellence-in-toulouse.

Such attacks could lead to the invocation of Article 5'[56]. This point about the potential invocation of Article 5 of the Washington Treaty because of attacks to, from or within space was underlined in the NATO 2022 Strategic Concept, which was released on 29 June 2022[57].

2.3 Observations

Overall, we can clearly see that there are risks, threats and challenges developing in space for Europe through greater weaponisation, congestion and disruption. We are living in an era of increasing strategic competition and major powers are investing in and adapting to a more hostile environment in outer space. **New technologies, command structures, doctrine and strategies are a reflection of the importance of space to great powers**. In recent years, many European governments have augmented their air forces to include the space dimension and many actual or potential adversaries are already fielding ASATs in space. This should be worrying for the EU, as it has important space infrastructure such as Galileo and Copernicus that could be at risk from accidental and malicious activities in space. Even though the EU has used its Space Strategy and tools such as EDF and PESCO to enhance SSA and STM, the reality is that **no single power has the ability to monitor or avoid every space event**. This, in its own right, puts a greater emphasis on the security of space systems and ensuring that the EU has a capacity to replace vital space services in case of crises. Finally, we have also seen that there is a need to focus on the resilience of space systems and securing them from space congestion and cyber threats. These are some of the main considerations that should be at the forefront of strategic thinking as the EU invests in space-defence capabilities.

[56] NATO, 'Brussel Summit Communiqué', 14 June 2021, https://www.nato.int/cps/en/natohq/news_185000.htm.
[57] NATO, 'NATO 2022 Strategic Concept', 29 June 2022, https://www.nato.int/strategic-concept/.

3 EU space and defence capabilities

It is necessary to now reflect on the space-defence capabilities the Union is developing to mitigate the space-based threats, risks and challenges detailed in the previous chapter. To be sure, ensuring security in space implies more than just investing in space-defence capabilities, and the **EU will surely continue to develop its space diplomacy and support multilateral solutions to space governance**. One can certainly argue that EU space diplomacy is a capability in its own right, as diplomatic efforts can help contribute to safer behaviour in space and the development of standards and norms that can ensure free and unfettered access to space. In this in-depth analysis, we look at 'capabilities' in more specific manner that includes a focus on the **physical space-defence assets** being developed by the EU and the dual-use technologies used to develop space systems. Additionally, this section understands 'capabilities' to mean the **human intelligence and partnerships** that are critical to enhancing the Union's strategic autonomy in the space domain[58].

3.1 Space-defence capabilities

The EU is already making headway on the space-defence capabilities it needs in the future. The EDA Capability Development Plan (CDP) already designated earth observation, PNT, SSA, satellite communication, information superiority and management, ISR and cyber defence as key space-defence capability priority areas in 2018[59]. We should also note that the EDA's Coordinated Annual Review on Defence (CARD) has also identified defence applications in space as a one out of six capability areas that would benefit from more intense EU cooperation[60]. We should note that the EDF and PESCO have been the principle frameworks through which EU Member States, the European Commission and the EDA have sought to organise European cooperation on space-defence capabilities. Nevertheless, we should recognise that there are a number of other initiatives that fall outside of PESCO and the EDF that have a bearing on space-defence capability development. In the sections that follow, we look briefly at the key EU space-defence capability initiatives currently in play. We detail efforts to develop Galileo PRS and GOVSATCOM and, after looking specifically at the EDF and PESCO, we touch upon the importance of geospatial intelligence as a key EU capability.

3.1.1 Galileo Public Regulated Service (PRS)

Galileo's PRS remains one of the key dual-use features of the Union's space-defence capabilities. The PRS component of Galileo is suitably geared to supporting EU security and defence. Indeed, with more secure and accurate PNT services the **PRS can become a core feature of EU missions and operations under the Common Security and Defence Policy** (CSDP). Here, the emphasis on high accuracy and encryption is crucial. This is particularly important given that the Strategic Compass states that the EU needs to be ready to engage militarily in hostile and high intensity threat environments. Indeed, the Compass underlines that both conventional defence and crisis management operations will require capabilities that can function properly, even in non-permissive military contexts[61]. Consider, for example, that without secure PNT capacities it would be almost impossible to detect air and missile threats or conduct air-to-air refuelling missions.

[58] Op. Cit., 'The European Space Sector as an Enabler of EU Strategic Autonomy'.
[59] European Defence Agency, 'Space', 21 September 2018, https://www.eda.europa.eu/docs/default-source/documents/eda-information-sheet-on-space.pdf.
[60] European Defence Agency, '2020 CARD Report – Executive Summary', 2020, https://eda.europa.eu/docs/default-source/reports/card-2020-executive-summary-report.pdf.
[61] European External Action Service, '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', 2022, p. 30, https://www.eeas.europa.eu/sites/default/files/documents/strategic_compass_en3_web.pdf.

Given that Galileo is a sovereign EU capability, there is a clear need to ensure that its PRS is secure and available to EU armed forces. As we will see in the following sections, the EDF and PESCO are already developing projects that can exploit and secure Galileo PRS. Aside from these defence cooperation frameworks, the European Commission and the EU Agency for the Space Programme (EUSPA) are looking at ways to support uptake of the PRS by government users. Indeed, in 2021 the EUSPA launched a public consultation that sought feedback from users for the purposes of understanding how PRS can be used in a secure and cost-effective manner. With a view to the ongoing modernisation of Galileo and the maturity of PRS, **2022 saw a major step forward in ensuring the full operational capacity of the PRS**. Indeed, the EU continues to expand and develop Galileo's ground segment in France and Spain so that sensor stations can pick up the upgraded PRS signal[62]. In this sense, and notwithstanding all of the non-defence activities supported by the system, Galileo PRS is shaping up to be a major element of the Union's security and defence efforts.

3.1.2 Government Satellite Communication (GOVSATCOM)

GOVSATCOM is also a crucial element of the Union's efforts to develop space-defence capabilities in the area of secure communications. Without secure communications it would be extremely difficult for European armed forces to communicate with each other. In an era of network-centric warfare, where a military's ability to manoeuvre and communicate en masse is vital, **GOVSATCOM provides a solution to modernising the Union's military intelligence and communications systems**. Even though GOVSATCOM began as a project in 2013, EU bodies such as the European Commission and EDA have taken steps to understand better government/military needs. Under the EUSP, an initial GOVSATCOM capacity will be financed in such a way as to plug secure communication gaps through a mixture of public and private services and assets. At this stage, the EU is using the period to 2025 to ascertain what demand exists from governments, but beyond this we could expect a more ambitious approach to create a federated network of existing secure satellite communications while also seeking to grow this network through the deployment of future satellite constellations.

3.1.3 European Defence Fund

Since the creation of the EDF in 2016, the EU and its Member States have moved rapidly to initiate space-defence capability programmes. For example, over the course of the **Preparatory Action on Defence Research (PADR)** from 2017 to 2019 the EU invested approximately EUR 3 million in basic space-defence research. Under the PADR, the European Commission invested in two innovation projects called QUANTAQUEST[63] and OPTIMISE[64]. Both of these defence research projects focused on ways in which the EU could avoid disruptions in space. For example, OPTIMISE sought to ensure that the EU would still have access to PNT services from EU satellite systems even when operating in areas where Global Navigation Satellite Systems (GNSS) were denied or disrupted. The OPTIMISE architecture would ensure that even when GNSS were denied because of hostile jamming or interference, a range of ground-based sensors and signals from communication towers, and algorithms (e.g. Kalman filters) that can memorise PNT data, could be used as replacements. QUANTAQUEST took an even more novel approach to space-defence needs by investing in quantum research. Here the idea was to **use quantum signals and computer cryptology to**

[62] Gutierrez, P. 'Fully operational Galileo PRS edges closer', *Inside GNSS*, 15 September 2022, https://insidegnss.com/fully-operational-galileo-prs-edges-closer/.
[63] Quantum Secure Communication and Navigation for European Defence (QUANTAQUEST). See: https://defence-industry-space.ec.europa.eu/quantaquest_en.
[64] Innovative Positioning System for Defence in GNSS-Denied Areas (OPTIMISE). See: https://defence-industry-space.ec.europa.eu/optimise_en.

replace the need for GNSS – quite radically, the project proceeded from the notion that quantum radars and sensing would make satellites obsolete in the future.

The European Commission also sought to invest in prototype space-defence capabilities through the **European Defence Industrial Development Programme** (EDIDP). Indeed, under the EDIDP eight specific capability projects were financially supported with a total value of EUR 87.7 million over the 2019-2020 period. In 2019, the EDIDP financed two projects worth approximately EUR 52 million. 'OPTISSE'[65] was initiated to study the possibility of developing earth observation capacities in small satellites. In this sense, the technological challenge was to ensure effective and high-resolution optics on a micro satellite. With an EU contribution of approximately EUR 43 million, 'GEODE'[66] would be one of the largest projects financed under the EDIDP and it focuses on further advancing Galileo's PRS by proving its services for defence specific needs and applications through testing and certification, as well as exercises across naval and land platforms located in multiple EU Member States. In essence, GEODE will allow the Union to test the practical relevance of Galileo PRS for military use.

In 2020, the EDIDP financed a further six projects worth some EUR 35.7 million. The 'INTEGRAL'[67] project focuses on developing an AI-supported Command and Control (C2) system that can exploit SSA data generated from military space assets. Following on in the area of SSA, the 'SAURON'[68] project focuses on creating a network of SSA ground and space-based sensors. 'ODIN'S EYE'[69] follows on from the logic of enhancing SSA capacities by developing an early-warning system to detect and track ballistic and hypersonic missile threats. The 'NEMOS'[70] project also develops SSA capacities but from the perspective of maritime surveillance and the need to anticipate and track maritime threats with space-based capabilities. Additionally, the EDIDP helped finance novel secure communications projects with 'P2P-FSO'[71] looking to develop laser-based secure signals and links as a back-up or replacement for radio frequency solutions. Finally, in support of the Union's geospatial intelligence capacities the 'PEONEER'[72] project seeks to develop a novel software system to help support analysts' capacities to identify satellite data and use AI-enabled techniques to inform the development of geospatial analysis.

Under the first-ever call of the **European Defence Fund** in 2021, the European Commission made clear that one of the important aspects of the work programme in 2021 would be developing the EU's Navigation Warfare (NAVWAR) capabilities. Although NAVWAR is not a new concept for those intimately dealing with PNT and Galileo, the Commission was keen to ensure that the EDF responded to the needs of protecting and promoting Galileo's PRS. Stressing the importance of European sovereignty, the Commission invited proposals under the 2021 work programme for projects that would 'contribute to the unlimited and uninterrupted access to the Galileo PRS worldwide […] on EU Member States territory and abroad during operations or missions'[73]. To this end, NAVWAR calls in 2021 had to ensure continuous use in contested and hostile electromagnetic environments, integrate anti-jamming and anti-spoofing

[65] Very High Resolution Optical payload for Small Satellites for Defence Applications (OPTISSE).
[66] Galileo for EU Defence (GEODE).
[67] Innovative and Interoperable Technologies for Space Global Recognition and Alert (INTEGRAL).
[68] Sensors for Advanced Usage & Reconnaissance of Outerspace Situation (SAURON).
[69] Multinational Development Initiative for a Space-based Missile Early-Warning Architecture (ODIN'S EYE).
[70] Novel Earth and Maritime Observation Satellite (NEMOS).
[71] Platform to Platform – Free Space Optical Link (P2P-FSO).
[72] Persistent Earth Observation for Actionable Intelligence, Surveillance and Reconnaissance (PEONEER).
[73] European Commission, 'Space and ground-based NAVWAR surveillance', 2021, https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/edf-2021-space-d-sgns. See also European Commission, 'Commission Implementing Decision on the Financing of the European Defence Fund and the Adoption of the Work Programme for 2021', *C(2021) 4910 final*, Brussels, 30 June 2021, https://defence-industry-space.ec.europa.eu/system/files/2021-06/edf-wp2021_en.pdf.

technologies and create secure and high-performing PRS receivers and sensors to ensure a greater federation of EU NAVWAR capabilities among Member States[74].

Within the NAVWAR call, the Commission went on to invest in nine separate projects (worth some EUR 171.3 million or approximately 15 % of the total EDF call of EUR 1.2 billion) specifically related to space-defence capabilities. Not only has the EDF continued its support for projects first initiated under the EDIDP (e.g. P2P-FSO and 'Q-SiNG'[75]), but the Fund has clearly sought to address key space-defence capability gaps. For example, the 'EU HYDEF'[76] project – which takes up the bulk of space-related financing under the EDF worth EUR 100 million – will build up the Union's capacity to track and intercept future hypersonic technologies. 'NAUCRATES'[77] is aimed to boost the Union's ability to anticipate space-based threats through enhanced SSA, specifically through the use of microsatellites for enhanced optical intelligence. To develop the Union's ground segment capacities, the EDF is also financing the 'SPRING'[78] project which will provide an integrated solution to responding to threats against military space systems.

[74] Ibid.
[75] Quantum-based Simultaneous inertial Navigator and vector Gravimeter (Q-SiNG). This project builds on the QUANTAQUEST project financed under the PADR.
[76] European Hypersonic Defence Interceptor (EU HYDEF).
[77] Innovative Positioning System for Defence in GNSS-Denied Areas (NAUCRATES).
[78] Space Response to Risk & Integration with Ground Segment (SPRING).

Figure 2 – Space-defence capabilities under the EDF

Positioning, Navigation and Timing (PNT) - *capabilities focused on optimising or replacing PNT in areas with limited or disrupted GNSS and the resilience and protection of Galileo PRS.*

Project title		EU financial contribution	Source
EPW	European Protected Waveform	EUR 25 million	EDF
Navguard	Advanced Galileo PRS resilience for EU Defence	EUR 24 million	EDF
Q-SiNG	Quantum-based Simulations inertial Navigator and vector Gravimeter	EUR 3.8 million	EDF
GEODE	Galileo for EU Defence	EUR 44 million	EDIDP
OPTIMISE	Advanced Galileo PRS resilience for EU Defence	EUR 24 million	PADR
QUANTAQUEST	Quantum-based Simulations inertial Navigator and vector Gravimeter	EUR 3.8 million	PADR

Space Communications - *capabilities focused on improving the resilience and performance of Satellite Communication services for military users and developing secure communications and data exchange.*

Project title		EU financial contribution	Source
P2P-FSO	Platform to Platform Free Space Optical Link	EUR 3.5 million	EDF
RFSHIELD	RF Interference Removal for Military Services based on Spaces Link	EUR 3.4 million	EDF

SSA and Missile Interception - *capabilities focused on detecting and tracking ballistic missiles, enhancing Space Situational Awareness capacities and/or improving geospatial intelligence data gathering and management.*

Project title		EU financial contribution	Source
HYDEF	European Hypersonic Defence Interceptor	EUR 100 million	EDF
SPRING	Space Response to Risk and Integration with Ground Segment	EUR 3.7 million	EDF
INTEGRAL	Innovative and Interoperable Technologies for Space Global Recognition and Alert	EUR 7.5 million	EDIDP
ODIN'S EYE	Multinational Development Initiative for a Space-based Missile Early Warning Architecture	EUR 7.5 million	EDIDP
PEONEER	Persistent Earth Observation for Actionable Intelligence Surveillance and Reconnaissance	EUR 7.2 million	EDIDP
SAURON	Sensors for Advanced Usage and Reconnaissance of Outerspace Situation	EUR 7.5 million	EDIDP

Microsatellites - *capabilities focused on developing microsatellites for geospatial surveillance and intelligence and/or specialised payloads for small satellites.*

Project title		EU financial contribution	Source
NAUCRATES	Microsatellite for Geostationary Orbit Surveillance and Intelligence	EUR 4 million	EDF
NEMOS	Novel Earth and Maritime Observation Satellite	EUR 3.9 million	EDIDP
OPTISSE	Very high resolution Optical payload for Small Satellites for Defence Applications	EUR 874 958	EDIDP

Sources: European Commission, 2022.

Clearly, the EU has also understood that the protection of existing EU space assets is of critical importance, and this is why the Union has invested in the 'EPW'[79], 'Navguard'[80] and 'RP SHIELD'[81] projects. These three projects are designed to ensure that satellite communications are protected (EPW and RP SHIELD) and that the Galileo PRS is secured through the development of new ground and space-based architectures (Navguard) – a key aspect of EU NAVWAR. Finally, the EDF has also sought to support important space-defence supply chains – the 'Mini-BOT'[82] project will do just this for high-performance optical receivers. For the first-ever call under the EDF, there is clear evidence that the European Commission and EU Member States have identified critical space-defence capabilities that need developing for the Union. Of course, one can argue that the financial amounts invested in each project is relatively small, and we should keep in mind that these projects are in a current state of development. They are not yet available for deployment.

3.1.4 Permanent Structured Cooperation

Under **Permanent Structured Cooperation**, EU Member States are collectively developing space-defence capabilities. To date, PESCO houses five specific projects that relate to space. The 'TWISTER'[83] project is designed to ensure that the EU can avoid and monitor threats in the air and missile domains. In particular, Twister's aim is to ensure that the EU can detect and track ballistic missiles through space-based early warning systems. The TWISTER project is linked with the EU HYDEF hypersonic defence inceptor project financed under the EDF. This certainly responds to the increased weaponisation of space and shows that the EU is aware that SSA is critical if the EU is to make a contribution to the defence of Europe. Related to the TWISTER project is the 'EU-SSA-N'[84], which takes the logic of SSA further by helping to develop a network of space surveillance assets. In this respect, EU-SSA-N builds on the recognition that the EU's autonomous SSA capabilities are far too fragmented. EU-SSA-N is also linked to the EDF-funded project called NAUCRATES, which is developing a microsatellite for geostationary orbit surveillance and intelligence, and before this it was linked to the EDIDP projects INTEGRAL and SAURON which developed microsatellite technologies.

Beyond SSA, however, PESCO has also seen the initiation of projects designed to enhance the EU's space-based communications and to ensure that Europe's armed forces can inter-operate in a secure manner. The EURAS[85] project, for example, aims to make full use of Galileo's PRS by promoting the development of a common European military PNT structure. EURAS is linked to the EDF-financed Navguard project and before this it was coupled with the EDIDP-financed GEODE project that developed elements of Galileo PRS for defence. This responds to the need **to ensure that the EU can maintain the resilience of the Galileo system**. Likewise, the DOSA[86] project seeks to ensure that EU current and future space capabilities can maintain secure manoeuvrability and resilience against potential accidental or malicious space events. Finally, PESCO is also home to the COHGI[87] project which aims – working through EU SatCen – to create a common hub in which classified governmental imagery can be exchanged at the EU level.

[79] European Protection Waveform (EPW).
[80] Advanced Galileo PRS resilience for EU Defence (Navguard).
[81] RF Interference Removal for Military Services based on Spaces Link (RP SHIELD).
[82] Miniaturized Board-mountable Optical Transceiver for high data rate Military Satellite Communications (Mini-BOT).
[83] Timely Warning and Interception with Space-based Theater Surveillance (TWISTER).
[84] European Military Space Surveillance Awareness Network (EU-SSA-N).
[85] EU Radio Navigation Solution (EURAS).
[86] Defence of Space Assets (DOSA).
[87] Common Hub for Governmental Imagery (COHGI).

Figure 3 – Space-defence capabilities under PESCO

Positioning, Navigation and Timing (PNT) - *capabilities focused on optimising or replacing PNT in areas with limited or disrupted GNSS and the resilience and protection of Galileo PRS.*

Project title		Partners	Source
EURAS	EU Radio Navigation Solution ** Linked to the EDF project and Navguard and the EDIDP project GEODE.*	FR, BE, ES, IT, PL	PESCO

SSA and Missile Interception - *capabilities focused on detecting and tracking ballistic missiles, enhancing Space Situational Awareness capacities and/or improving geospatial intelligence data gathering and management.*

Project title		Partners	Source
EU-SSA-N	European Military Space Surveillance Awareness Network ** Linked to the EDF project NAUCRATES and the EDIDP projects INTEGRAL and SAURON.*	IT, FR, DE, NL	PESCO
COHGI	Common Hub for Governmental Imagery	DE, AT, FR, LT, LU, NL, ES	PESCO
TWISTER	Timely Warning and Interception with Space-based Theater Surveillance ** Linked to the EDF project EU HYDEF.*	FR, FI, DE, IT, NL, ES	PESCO
DOSA	Defence of Space Assets	FR, AT, DE, IT, PL, PT, RO, ES	PESCO

Source: European Defence Agency and EU Military Staff, 2022.

We should also recognise that there is some degree of commonality between PESCO and EDF projects as they pertain to space-defence capabilities. For example, three are presently three EDF-PESCO space-defence capability projects underway: EU HYDEF is connected to TWISTER, NAUCRATES to EU-SSA-N and Navguard to EURAS. In this regard, one can see that the EU Member States are committed to developing tracking and detection, SSA and Galileo PRS resilience across community and intergovernmental frameworks. Indeed, when taken together **the EDF and PESCO are closely aligned to the capability priorities outlined in both the CDP and CARD**. What will, however, be a key challenge for PESCO is ensuring that future waves of projects can deepen the credibility of EU efforts in space and defence. First, there is a need to better articulate linkages between PESCO projects, especially where they can enhance the EU's ability to act in security and defence. Second, there is a need for the EU to scope out what space technology domains will be crucial for the future and then exploit them within the context of the EDF and PESCO.

3.1.5 Dual-Use Space Technologies

We should underline that **space and defence capabilities are inherently dual-use in nature**, even if the defence sector requires specific technologies with regard to secure communications and encryption. Recognising this fact, in February 2021 the European Commission released its action plan on **synergies between civil, defence and space industries**[88]. The action plan is focused on supporting technological and financing synergies between the Union's investments in civil research (e.g. Horizon, Internal Security

[88] European Commission, 'Communication for an Action Plan on Synergies between Civil, Defence and Space Industries', *COM(2021) 70 final*, Brussels, 22 February 2021, https://ec.europa.eu/info/sites/default/files/action_plan_on_synergies_en.pdf.

Fund, Connecting Europe Facility, Digital Europe, etc.), the EDF and the EUSP. Additionally, the action plan seeks to fund *spin-off* and *spin-in* technologies and research. Most crucially, however, the action plan outlines three flagship projects that should benefit from greater dual-use research and investments including: 1) EU drone technologies; 2) EU space-based global secure communications system; and 3) Space Traffic Management[89]. The Commission hopes that through a process of 'blended funding' via the Union's financing instruments, it can help develop standards for STM, build a third EU satellite system in addition to Galileo and Copernicus and invest in drone technology building blocks[90].

Successful implementation of these flagship programmes should, of course, have positive implications for a range of **civil and security sectors** including: maritime surveillance, border management, health management, renewable energies, air traffic management. However, it is also likely to assist with security of supply in the space sector and other strategic sectors. As the Commission made clear in its February 2022 roadmap on critical technologies for security and defence, security of supply is vital if the Union is to maintain its technological sovereignty[91]. Here, the Commission recognises that being able to secure critical raw materials (e.g. Magnesium, Scandium, Niobium) and technological inputs (e.g. semiconductors and microelectronics) is a vital element of any coherent space and defence strategy[92]. Overall, therefore, the Union's dual-use strategies and projects can be of great relevance to developing EU space-defence capabilities.

3.1.6 Geospatial Intelligence

The last and crucial space-defence capability outlined by this in-depth analysis is geospatial intelligence. Indeed, geospatial intelligence is a capability that fuses technological and human capital and it is already widely used in the context of the EU's CSDP. At present, the **EU SatCen is the core EU body responsible for fusing and integrating space data and imagery**. It relies on earth observation capacities such as Copernicus but it also increasingly plays a role in the Union's SSA and SST endeavours through the Framework for Space Surveillance and Tracking Support (EUSST). Furthermore, the EU SatCen works with the EEAS' Space Task Force to support the Union's space diplomacy efforts. In this regard, SatCen geospatial intelligence products are offered to international organisations such as the Organisation for Security and Cooperation in Europe (OSCE) or the International Agency for Atomic Energy (IAEA). In recent years SatCen has only become more indispensable in providing geospatial intelligence for crisis response, non-proliferation, counter-terrorism efforts, humanitarian aid delivery, international justice, etc. In 2021 alone, SatCen produced and provided 4 186 geospatial intelligence products (in 2020 this stood at 2 940 products)[93].

[89] Ibid.
[90] Ibid.
[91] European Commission, 'Communication for a Roadmap on Critical Technologies for Security and Defence', *COM(2022) 61 final*, 15 February 2022, https://ec.europa.eu/info/sites/default/files/com_2022_61_1_en_act_roadmap_security_and_defence.pdf.
[92] Bobba, S. *et al.*, 'Critical Raw Materials for Strategic Technologies and Sectors in the EU: A Foresight Study', p. 10, https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2020.pdf.
[93] EU Satellite Centre, 'Annual Report 2021', 2022, p. 29, https://www.satcen.europa.eu/keydocuments/AnnualReport_2021_2%20-%20web62a9edd9601f2a0001c84688.pdf.

4 Strategic Compass

The EU Strategic Compass embodies a paradigm shift in the way the EU sees space and defence. Indeed, the Compass explicitly states that the EU's 'freedom of action depends on safe, secure and autonomous access to the space domain'[94]. As a document, the Strategic Compass usefully puts space and defence on the EU's agenda in a way that other strategic documents have failed to achieve. This is, in part, **a recognition at the highest political level that space and defence cannot be ignored**. In fact, the Strategic Compass underlines the fact that the EU needs to enhance its access to the cyber, air, space and maritime domains. As the Compass goes on to remark, due to the Union's 'increasing dependency on space systems and services, [the EU is] more vulnerable to irresponsible and threatening behaviour by strategic competitors'[95]. In this regard, **the Strategic Compass stresses the importance of maintaining the resilience of dual-use space infrastructure such as Galileo and Copernicus**. In the future, security and resilience will need to be extended to the EU's Secure Connectivity Programme, which is a future dual-use strategic project being developed over the 2023-2027 period.

On this basis, in its deliverables the Strategic Compass stresses the fundamental importance of developing space-based capabilities, conducting space-relevant exercises and undertaking to draft a dedicated EU Space and Defence Strategy by the end of 2023. In particular, this forthcoming dedicated EU Space and Defence Strategy is a way of planning for future space-defence capabilities, signalling the EU's ambition for and use of space for defence purposes, protecting dual-use space-based infrastructure and underlining the importance of partnerships. In this chapter, we look in more detail at the forthcoming strategy and space partnerships.

4.1 Towards an EU Space and Defence Strategy

By the end of 2023, the EU should produce a Space and Defence Strategy. As the Strategic Compass highlights, the Strategy will help the EU 'build a common understanding of space-related risks and threats, develop appropriate responses and capabilities to react better and fast to crises, strengthen [the EU's] resilience and make full use of the benefits and opportunities linked to the space domain'[96]. The Compass also states that the **EU Strategy for Space and Defence should encompass political, operational, diplomatic and governance dimensions**. In this sense, it is interesting to note that the EU will set about drafting the Strategy in a phased manner that will include the validation of the Galileo threat response mechanism and the conduct of exercises that pertain to space and the Union's 'solidarity, mutual assistance and crisis response mechanisms'[97]. In particular, the Mutual Assistance clause (or Article 42.7 TEU[98]) should be one of the core features of the Space and Defence Strategy – not least because Mutual Assistance was under-represented in the Strategic Compass proper, and because space-based threats and risks have an important bearing upon European security.

The ideas of mutual assistance, solidarity and space do not sit automatically with each other. Indeed, Article 42.7 TEU speaks of a response in case of an act of 'armed aggression' on the 'territory' of a Member State. In this respect, there is less scope to argue that space can be related to sovereign territory, especially seeing that under international law outer space cannot be claimed in sovereign terms. Even if not every state – including two EU Member States – has ratified the Outer Space Treaty[99], it clearly states, 'outer space,

[94] Op.Cit., 'Strategic Compass for Security and Defence', p. 35.
[95] Ibid.
[96] Ibid., p. 36.
[97] Ibid., p. 40.
[98] Article 42.7 of the Treaty on European Union.
[99] The Outer Space Treaty has not been ratified by 59 countries including Albania, Andorra, Angola, Belize, Bhutan, Brunei Darussalam, Cambodia, Cape Verde, Chad, Comoros, Congo, Cook Islands, Costa Rica, Côte d'Ivoire, Croatia, Djibouti, Dominica,

including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means'[100]. Article 222 TFEU[101] provides more flexibility when it comes to the definition of territory, as Council Decision of 24 June 2014 states that Article 222 TFEU applies to a Member States' 'land area, internal waters, territorial sea and airspace'[102]. This would appear to offer more geographical flexibility than Article 42.7 TEU, however, the Council Decision does not specifically refer to space when referring to infrastructure. On this front, the Council Decision refers to infrastructure 'situated in the territorial sea, the exclusive economic zone or the continental shelf of a Member State'[103].

Yet, these restrictions should not stop the EU from investigating how Article 42.7 TEU and Article 222 TFEU should apply in the space domain. Indeed, the emphasis on territory under Article 42.7 TEU does not exclude action against armed aggression that is directed towards ground-based installations such as launch sites, sensor stations or communication and data processing hubs. True, even here one could point to a complication in how we define 'armed aggression', as arguably jamming and spoofing of satellites would not strictly be seen as an act of armed aggression. All of **these restrictions may appear absurd when one thinks about how much disruption can be caused by an attack on space-based installations**. In this sense, it would make sense for the EU Space and Defence Strategy to outline how the EU sees space and mutual assistance. In this respect, a good place to start is to think about how Article 42.7 TEU clearly links to Article 51 of the UN Charter. The Charter specifically underlines the right to 'collective self-defence if an attack occurs *against* a Member of the United Nations'[104]. Clearly, there is a difference between an 'armed attack *on* the territory' and an 'armed attack *against* a Member of the UN'. While the problem of defining an 'armed attack' remains, Article 51 of the UN Charter potentially offers a wider definition of the term 'territory' – especially if, as Article 42(7) states, EU actions should occur 'in accordance with Article 51 of the United Nations Charter'[105].

Beyond mutual assistance, solidarity and space, the forthcoming EU Strategy on Space and Defence will have to be mindful of a number of other challenges. First, there is a need to avoid a situation where the Strategy is published and promptly forgotten by EU Member States. For many EU countries, **space and defence is still not seen as a major issue**. In this regard, the Strategy should not just be a document but rather a process where the EU frequently conducts space-related exercises and develops operational concepts for space-related military contingencies. Here, it would seem useful to reflect on the space dimensions associated with EU advance planning and the creation of new Operational Scenarios (OS) and Illustrative Scenarios (IS).

Eritrea, Eswatini, Gabon, Georgia, Grenada, Guatemala, Guinea, Kiribati, Kyrgyzstan, Latvia, Liberia, Malawi, Maldives, Marshall Islands, Mauritania, Micronesia, Monaco, Montenegro, Mozambique, Namibia, Nauru, North Macedonia, Palau, Moldova, Saint Kitts and Nevis, Saint Lucia, Samoa, Sao Tome and Principe, Senegal, Serbia, Solomon Islands, South Sudan, Sudan, Suriname, Tajikistan, Timor-Leste, Turkmenistan, Tuvalu, Tanzania, Uzbekistan, Vanuatu and Zimbabwe. See: https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_10_0_html/AAC105_C2_2022_CRP10E.pdf.

[100] See Article II: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html.

[101] Council of the EU, 'Council Decision on the arrangements for the implementation by the Union of the solidarity clause', *2014/415/EU*, June 24, 2014, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0415&from=EN.

[102] See Article 2(1)a of the Council Decision: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014D0415&rid=8#:~:text=Pursuant%20to%20Article%20222(1,natural%20or%20man%2Dmade%20disaster.

[103] See Article 2(1)b of the Council Decision: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014D0415&rid=8#:~:text=Pursuant%20to%20Article%20222(1,natural%20or%20man%2Dmade%20disaster.

[104] See, Article 51: https://legal.un.org/repertory/art51.shtml.

[105] See, Article 42(7): https://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF.

A second challenge will be ensuring effective **institutional and intergovernmental governance**. This starts with the consideration that EU Member States manage space-related issues in different ways at the national level. Some governments have space split between different ministerial portfolios such as science and innovation, transport and defence and these ministries can be presided over by different political parties – not least in coalition governments. Thus, some patience will be required in ensuring maximum buy-in from Member State governments. The same is true of the EU, of course, where there is no clear governance structure for managing space-defence issues. Today, the issue is split between the Council of the EU, the European Commission, the European External Action Service (EEAS) and the EDA – even non-EU bodies like the European Space Agency are involved. Using the Strategy on Security and Defence to clarify roles and services would be beneficial.

However, the forthcoming Strategy should not become an exercise in bureaucracy by design. For example, it should **dedicate sufficient room to explore ways in which the EU and NATO can engage on space issues**. Thus far, the EU-NATO Joint Declarations do not touch on space, which is concerning given how far NATO and the EU have both come in developing their respective space policies. The Compass does, however, specifically refer to the need to develop EU-NATO cooperation on outer-space[106]. Today, NATO recognises space as an operational domain and it has stated that Article 5 would apply in case of space-related collective defence needs. This means that the EU, especially with regard to how it treats space and mutual assistance, is lagging behind NATO concepts and approaches. What is more, with the EU rapidly developing space-defence capabilities there is a need to ensure that European-made space capabilities can play a role in conventional defence as well as crisis management. As a core partnership for the EU, developing EU-NATO cooperation on capabilities, scenarios and crisis response will become even more relevant in a context where Europeans are being called upon to boost their own defences.

4.2 Partnerships and space

The EU maintains a number of important partnerships in the space domain and the **Strategic Compass dedicates a whole chapter to the issue of partnerships in security and defence**. The Strategic Compass looks at developing greater cooperation with partners on shared situational awareness, joint and inclusive exercises, operational coordination, early-warning and conflict prevention, information sharing and confidence-building measures. The Strategic Compass also underlines the importance of tailoring its bilateral partnerships: indeed, some partnerships may require a greater focus on capacity building, whereas others depend on closer complementarity between tools and decision-making frameworks. What is lacking in the Strategic Compass' chapter on partnerships is, however, specific reference to how space can be employed to develop deeper security and defence partnerships and help with capacity-building and multilateral/diplomatic efforts.

We should acknowledge that the EU has **undertaken diplomatic efforts to reduce space threats in multilateral settings** such as the UN. For example, in the Open Ended Working Group (OEWG) on reducing space threats the EU has consistently raised the importance of reducing irresponsible behaviour in space by generating acceptable international norms and rules and monitoring capacities[107]. In particular, at the OEWG the Union has underlined its concern about kinetic destructive testing of ASATs, but it has also called on the UN to recognise how evolving technical, economic and political developments in space are leading to 'new and emerging threats'[108]. In this respect, the EU has through its Member States striven to contribute

[106] Op.Cit., 'Strategic Compass for Security and Defence', p. 53.
[107] European Union, 'Open Ended Working Group on reducing space threats through norms, rules and principles of responsible behaviours – EU Statement', Geneva, 13 September 2022, https://www.eeas.europa.eu/delegations/un-geneva/open-ended-working-group-reducing-space-threats-through-norms-rules-and_en?s=62.
[108] Ibid.

to the work of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) on issues such as the safe access and sustainable use of outer space[109].

In addition to space diplomacy at the UN, the EU has a clear rationale for enhancing its cooperation with NATO and this is acknowledged in the Strategic Compass. In the coming months, there will be an opportunity to **develop further the Union's space-defence partnership with NATO**. This starts with the third EU-NATO Joint Declaration (due late 2022 – early 2023), which should list space as a new area of cooperation between the two partners. The two previous declarations from 2016 and 2018 did not include space as a stand-alone area of cooperation[110]. Nevertheless, a key question is how in practical terms can the EU and NATO strengthen their cooperation in space. Due to understandable security of information and technology concerns, it seems unlikely that the EDF or PESCO will involve third states in major space-defence capability projects. However, cooperation in space can begin modestly through joint participation in space exercises and a common understanding of the application of Article 5 of the Washington Treaty and Article 42.7 TEU in case of space-related acts of aggression towards NATO or the EU. The new NATO Centre of Excellence on space could play a critical role in this regard, especially if it works with EU SatCen, the EEAS Space Task Force, DG Defis and the EDA.

Another core partnership that the EU can help strengthen is the one with the **European Space Agency**, especially given how past cooperation has led to the creation of Copernicus and Galileo. Although the EU and ESA have different membership structures, and cooperation has tended to be mainly based on technical exchanges and project contracts, there is a potential to develop each organisations' situational awareness for space. For example, ESA has tended to focus on the civilian and security dimensions of space but increasingly there is a need to jointly understand space risks and to plan for security of supply in the space sector. As the EU-ESA Joint Declaration of 2016 points out, the key objectives are to 'ensure European autonomy in accessing and using space in a safe and secure environment, and in particular consolidate and protect its infrastructures, including against cyber threats'[111]. In this sense, the EU has to make good on its promise in the Strategic Compass to work with the ESA to 'protect space supply chains and invest in critical space technologies'[112].

The forthcoming EU Strategy for Space and Defence is also an opportunity to delve into more detail about how the **EU's bilateral partnerships in and diplomatic efforts for space-defence matters** can be strengthened. For example, it is important to build on the references to space cooperation in the Strategic Partnership Agreements (SPA) with **Japan** and **Canada**. So far, the SPAs stress the importance of information sharing but in time the EU could explore how best to leverage such as close partnerships for the mutual benefit of SSA and STM. Given Japan and Canada's considerable presence in space, exploring ways to expand space situational awareness would be a solid form of cooperation. The same is true of the strategic cooperation on space with **South Korea**, which, since 2010, has seen the two partners focus on cooperation on GNSS and space and crisis management[113]. Furthermore, the forthcoming EU Strategy for

[109] European Union, 'EU joint contributions to the works of the Open-Ended Working Group on Reducing Space threats through Norms, Rules and Principles of Responsible Behaviours – First part: Scoping', Geneva, 11 May 2022, https://www.eeas.europa.eu/delegations/un-geneva/eu-joint-contributions-works-open-ended-working-group-reducing-space-threats_en?s=62.

[110] Council of the EU, 'EU-NATO Cooperation', 31 August 2022, https://www.consilium.europa.eu/en/policies/defence-security/eu-nato-cooperation/.

[111] European Space Agency, 'Joint Statement on Shared Vision and Goals for the Future of Europe in Space by the EU and ESA', Brussels, 26 October 2016, https://www.esa.int/About_Us/Corporate_news/Joint_statement_on_shared_vision_and_goals_for_the_future_of_Europe_in_space_by_the_EU_and_ESA.

[112] Council of the EU, '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', *7371/22*, Brussels, 21 March 2022, p. 24, https://data.consilium.europa.eu/doc/document/ST-7371-2022-INIT/en/pdf.

[113] Chung, S-W. and Lee, J-S., 'Building the Pillars of the EU-South Korea Strategic Partnership', *Asia Europe Journal*, vol. 17 (2019), pp. 327-340.

Space and Defence could also inform the Union's level of ambition with regard to the **United States**. For example, the EU-US defence dialogue has so far failed to specifically address space, even though it has led to dialogue on cyber defence, climate change and countering hybrid threats. Once published, the EU Space and Defence Strategy could be used to deepen the defence dialogue with Washington.

Finally, the EU will likely seek to develop its security and defence cooperation with the UK. Even though the relationship is still strained because of Brexit, opportunities with the new UK government (in office since September 2022) could be exploited if and when they arise. While the UK is a member of NATO and ESA – which in itself gives opportunities for engagement –, London is no longer part of Galileo or EGNOS and the issue of whether the UK will in future participate in Copernicus, the Space Surveillance and Tracking Programme and Horizon Europe is unresolved. Since Brexit, the UK has re-emphasised its objective of working on space and defence issues via NATO, through the 'Five Eyes' arrangement and bilaterally with the US. The UK has also stated in its 2022 Defence Space Strategy that it wants to build a sovereign space presence by investing some GBP 1.4 billion in new low earth orbit satellites and space-military technologies such as sensors and an ISR constellation[114]. A question facing the UK today, however, is whether the post-summer economic crisis[115] and the need to plug a GBP 60 billion[116] deficit will leave the UK government with the financial resources it needs for space-defence capability pledges. Either way, the development of new UK space capabilities can only lead to a need for cooperation with the EU on issues such as SSA and SST – even if such cooperation is largely mediated via NATO or ESA. Finally, the newly created European Political Community (EPC) could also be an informal network through which the EU and UK can discuss space-defence matters.

[114] Op.Cit., 'Defence Space Strategy: Operationalising the Space Domain'. See also: Wilkins, A., 'UK may go it alone in orbit after Brexit shutout from EU space plans', The New Scientist, 14 June 2022, https://www.newscientist.com/article/2324165-uk-may-go-it-alone-in-orbit-after-brexit-shutout-from-eu-space-plans/.
[115] Adam, S. *et al*., 'Mini-Budget Response', Institute for Fiscal Studies, 23 September 2022, https://ifs.org.uk/articles/mini-budget-response.
[116] Atkinson, A., 'Kwarteng Told He Needs to Find GBP 60 Billion of UK Spending Cuts', *Bloomberg*, 11 October 2022, https://www.bloomberg.com/news/articles/2022-10-10/uk-urged-to-slash-spending-after-crisis-of-investor-confidence.

5 Conclusion and recommendations

This study has shown how space and defence has become an increasingly important element of the EU's overall space policy. Even though Galileo and Copernicus already prefigured essential security services, the introduction of PESCO and the EDF has altered the way the EU thinks and invests in space-defence capabilities. To date, PESCO and the EDF are helping to develop space-defence capabilities such as early-warning and interception technologies, AI-enabled satellite imagery and intelligence, secure radio navigation and satellite communication systems, microsatellites and air and missile defence capacities. So far, when the EU's investments over the EDF, PADR and EDIDP are combined, the Union has invested over EUR 270 million on space-defence capabilities. While such investments are small when compared to partners and adversaries such as the US and/or China, over the longer-term the EU's strategic ambition is becoming clearer: space is a crucial strategic domain where the Union needs to enhance its strategic presence.

5.1 Gearing up for strategic competition in space

Space will be a crucial element of broader trends in strategic competition. While the EU has a strong interest in investing and developing space-based capabilities that can benefit the CSDP and crisis management, it needs to use the forthcoming EU Space and Defence Strategy to elaborate a deeper understanding of the linkages between space and strategic competition. Indeed, many of the EU's existing and potential adversaries and partners are developing space-based capabilities and a presence in outer-space in order to enhance their power on earth. In this regard, this study recommends that the EU use the forthcoming EU Space and Defence Strategy for the following ends:

1. **Secure existing space-based assets such as Galileo and Copernicus** from manipulation from strategic competitors. The duty of any coherent and robust EU Space and Defence Strategy will be, first and foremost, to spell out how the Union will ensure the protection of key space assets from attacks and manipulation. In this sense, the Strategy has to set a roadmap with key timelines for how the EU will safeguard Galileo, Copernicus and the future EU satellite communication constellation. The EU and Member States should keep in mind that any Strategy should serve as a political deterrence and dissuade harmful actions against EU space- and ground-based infrastructure;

2. **Ensuring the coherence of the EU's approach to space and defence** requires a reflection on the most effective institutional set-up to discuss space and defence matters. The European Council could take the lead in this regard through its summits on security and defence, but the challenge is deeper for the Union. Today, competences for space and defence are split between the European Commission (with EUSPA), the EEAS (Space Task Force), EU SatCen and the EDA and other non-EU bodies like the ESA have a stake in the issue too. In this respect, the European Parliament should reflect on what more it can do to develop a more centralised bureaucratic approach to space and defence. In this respect, a more integrated bureaucratic structure (or 'chain of command') is required for crucial issues such as SST and SSA;

3. **Bolstering the Union's capacities for geospatial intelligence** by investing in the future evolution of the EU SatCen. Here, the European Parliament can continue to explore ways in which the EU budget can help support EU SatCen. This would not only contribute to ensuring the financial sustainability and longevity of the Centre, but it would also allow SatCen to invest in the human and technological capacity required to ensure that the Union is able to gather, process and utilise data from space;

4. **Think of the next generation of space-defence capabilities within the EDF**. To date, the EU has invested over EUR 270 million (since 2017) through the PADR, EDIDP and EDF on space-defence capabilities such as air and missile interception technologies, secure satellite communications, AI-

enabled geospatial technologies and more. In the future, however, the Union has to think about investments in frontier technologies such as reusable launchers, advanced robotics and propulsion, space-based logistics capacities, smart energy solutions and more. This will require more substantial and sustained investments in space by the EU through the EDF and new instruments such as the European Sovereignty Fund (see recommendation 7).

5. **Ensure that PESCO projects related to space and defence are given greater attention**. It is worrying that the PESCO Secretariat assess that approximately 35 % of the existing 60 PESCO projects are falling behind or are delayed[117]. It is not clear today whether any space-defence projects are included in these delays. While 18 PESCO projects are close to finalisation[118], there remain questions about the efficacy of PESCO to deliver on capability projects in time. What is more, the PESCO Secretariat recognise that while many factors may contribute to project delays the overall trend points to 'a lack of planning, both financial and practical in terms of project timelines'[119]. In anticipation of the fifth wave of projects in May 2023, EU Member States need to recommit to ensuring the effectiveness of PESCO otherwise in time it will become an unattractive venue in which to develop space-defence projects.

6. **Recently announced plans for European common defence procurement** should consider space-defence capabilities. While the bulk of political attention is focused on the military equipment required to support Ukraine and replenish European equipment stocks, over the longer-term it will be necessary to understand how instruments such as the European Defence Industry Reinforcement through Common Procurement Act (EDIRPA) could help procurement space-defence capabilities over the longer-term. Here, there is also a need to ensure coherence between new tools such as EDIRPA with the EDF and the EU Space Programme.

7. **Study how any future 'European Sovereignty Fund' could be leveraged for space and defence.** In the 2022 State of the Union Speech, European Commission President Ursula von der Leyen made reference to the need for a European Sovereignty Fund to 'make sure that the future of industry is made in Europe'[120]. European Commissioner Thierry Breton has already remarked how the Fund could be used to channel collective, large-scale, strategic investments into key infrastructure, advanced technologies and manufacturing production sites in Europe[121]. While it is too early to know precisely how the European Sovereignty Fund will function, it is imperative that space-defence capabilities are not to be overlooked, even if space and defence already receives funding from the EUSP and EDF.

8. **Continue to press forward with the Union's dual-use synergy policies.** It will be essential that the Union develops the capacity to benefit from research synergies between the EDF, the EUSP and civilian research (e.g. Horizon Europe). The Directorate-General for Defence and Space Industries (DG DEFIS) is well-placed to continue this work, but creating research synergies is dependent on an intimate knowledge of the space and defence sectors. The Commission therefore needs to work with research institutes and enterprises to better understand the functioning of supply chains in the space and defence sector, which have differences in terms of technology maturity and application.

[117] European Defence Agency, 'Development, Delivery and Determination: PESCO Forging Ahead', 2022, https://www.pesco.europa.eu/pressmedia/development-delivery-and-determination-pesco-forging-ahead/.
[118] Ibid.
[119] Ibid.
[120] European Commission, '2022 State of the Union Address by President von der Leyen', Strasbourg, 14 September 2022, https://ec.europa.eu/commission/presscorner/detail/ov/SPEECH_22_5493.
[121] European Commission, 'A European Sovereignty Fund for an Industry "Made in Europe" – Blog of Commissioner Thierry Breton', Brussels, 15 September 2022, https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_5543.

In addition, the Commission needs to show greater ambition for the recently announced Observatory of Critical Technologies[122]. The Observatory should not just identify critical technologies in the civil, defence and space industries, but also develop coherent sector-specific strategic plans for how the Union will gain technology leadership through the generation of skills and investment in major strategic projects.

9. **Ensuring that the EU remains on track on space and defence** is the task that flows from the Strategic Compass. Although the Compass document has already provided a strategic framing of space and defence, the Union cannot wait until 2030 before it returns to a strategic reflection about space. In this respect, steps to ensure that the Union and its Member States conduct a more frequent revision of the 'Threat Analysis' must reflect more specifically on space-based threats. Although the Threat Analysis is of a classified nature, the EEAS and European Commission must use the exercise to raise greater public attention around the strategic importance of space. A more frequent Threat Analysis that includes a more dedicated section on space would assist bodies like the EU Military Staff with concepts and advance planning. It would also greatly aid relevant EU bodies when planning for future investments in space-defence capabilities;

10. **Frequent exercises on space and defence** would assist with raising political awareness within EU bodies and between EU Member States. Under the Strategic Compass, one of the deliverables by the end of 2022 is to conduct space-relevant exercises. There is a risk, however, that such exercises will remain table-top or scenario-based gatherings that will be promptly forgotten. In this regard, exercises cannot only focus on scenarios and must include an assessment of available/missing space-defence capabilities. Officials and ambassadors should be forced to think about *how* they would respond in case, e.g., Galileo is taken off-line rather than just on specific scenarios (e.g. *what if* an adversary launches an ASAT at EU space infrastructure).

11. **Use the Space and Defence Strategy to flesh-out EU responses under the Mutual Assistance and Solidarity Clauses**. So far, the place of space-based attacks is unclear under the Mutual Assistance Clause, which specifies that a response is warranted in case of an act of armed aggression *on* the territory of an EU Member State. In particular, Article 42.7 TEU does not appear to include space in its provisions, which is a challenge when developing EU capacities to respond to space-based crises. The Strategy should be used to bring clarity to how space is treated under Article 42.7, in a similar way to how NATO has treated space under Article 5 of the Washington Treaty.

12. **Continue to develop close space partnerships with like-minded actors.** Principally, the Union should develop further the space aspects of its strategic relationships with countries such as Canada, Japan and South Korea. It should also more fully integrate space into its diplomatic efforts in regions such as the Indo-Pacific. Furthermore, the EU can study the added-value of addressing space issues within the newly created European Political Community. The EPC, for example, could be a useful venue to raise awareness about space-defence matters and allow the 44 participating governments and EU bodies the scope to provide strategic orientations for the EU, NATO and ESA on space. Although the EPC's first meeting on 6 October 2022 in Prague, Czech Republic, focused largely on the war on Ukraine, future iterations could discuss space in a larger European setting. In this regard, it would be useful to invite relevant EU representatives, NATO and ESA and use the EPC to build trust with the UK on defence and space matters.

[122] European Commission, 'Communication on the Commission Contribution to European Defence', *COM(2022) 60 final*, Brussels, 15 February 2022, https://ec.europa.eu/info/sites/default/files/com_2022_60_1_en_act_contribution_european_defence.pdf.

This study assumes that the above recommendations should be easier to achieve in a political sense because of the process of drafting a dedicated EU Space and Defence Strategy. In this respect, it is understood that all EU Member States will engage with the reflection and drafting process behind the Space and Defence Strategy in good faith. Although not every EU Member State may see an immediate need to invest in space and defence – not least because of the competing demands on defence budgets today –, this is **a unique moment for the Union to collectively assert itself in the area of space-defence capabilities.** EU leaders already missed the opportunity to discuss space and defence at previous European Council Summits on security and defence. They should organise a dedicated EU summit on space and defence in advance of the Strategy on Space and Defence.

Investments in space-defence capabilities should, of course, not undermine the EU's efforts to develop space diplomacy or dissuade it from engaging adversaries and partners in multilateral fora. Indeed, diplomacy is an important element of the Union's efforts to ensure that space remains free and secure. Nevertheless, **diplomatic efforts must not come at the expense of an appreciation of and investment in space-defence capabilities**. Indeed, it should be recognised by the EU and its Member States that an inability to protect space-based assets will lead to an erosion of the Union's credibility and, thus, its ability to support the multilateral rules-based order as it pertains to space governance.

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