Going Space – An Ambitious, Necessary Agenda for European Prosperity and Security

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Summary

This think-piece reflects EuroDefense ongoing work from several national chapters with the objective to recommend a common ambitious high-level vision for European advancement in the Space Domain as it proves critical to Europe's prosperity, security and defence. Europe should define and build a space strategic culture that accentuates its strengths, minimizes its weaknesses and articulates and justifies its goals to the world and to itself. This is an important counterpoint to the various strategic documents and other proposals which have been launched. A future European Space Defence Architecture must be able to accommodate varying levels of defence cooperation and integration with neighboring and other partner states. It must feature capabilities, but also practices that result in the maximum impact within the European Defence Architecture, such as the suggestion of including space resilience in operational planning from the previous section. Clearly, it should be compatible and interoperable with the US as we strive to cooperate in crises and conflict.

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Analysis

1. Critical Enabler

Space systems have become critical enablers for a wide variety of applications which are of paramount importance to the functioning of national and regionally/globally integrated economies, as well as the operations of Armed Forces. As a result, not only has investment in their development become a priority, but also their security from natural or accidental threats (space weather, space debris), and from deliberate threats as part of military action or general counterspace efforts of a hybrid nature (information manipulation etc.). The growing capabilities of space in fields such as remote sensing, navigation, positioning and timing and communications have spawned a vast array of applications and services that have permeated European society and have become embedded in economy, security and administration. This has happened because of their role in command, control, coordination and data gathering for complex systems, whether we are talking about global logistics, integrated power grids or military operations.

It is high time for Europe to become proactive in increasing its resilience to space system disruption; it must cultivate strategic autonomy in this regard, while maintaining itself as a leading actor in a lucrative field of high technology and exerting a positive influence on the development of space security governance.

2. NewSpace Economies

Satellite services are increasingly driven by SmallSats launched by non-traditional operators (start-up companies, universities), accounting for 44% of that figure. The vast majority of new space systems are small satellite systems, under 600 kg, and belong to just two major constellations, Starlink and Oneweb, which are dedicated to communications. One could say that they distort the overall industry analysis, but, nevertheless, the greatest growth in satellite systems is in this segment and the US leads it by far. And one should also not let the low contribution of satellite manufacturing and launch industry services (5% and 2% respectively) deceive as to the vital role that these industries play in innovation and competitiveness. Of the 12.2 billion dollars in satellite manufacturing activity in 2020, the US accounts for 65%, a figure inflated by the role of SpaceX with its Starlink constellation, but this is not the only American mega-constellation on the horizon, since Meta (formerly Facebook) has also announced plans for broadband wireless communications via satellite.

The trends can be summarized as follows:

- Advances in miniaturization, thereby increasing the capability of satellites while decreasing mass;
- Advances in standardization of satellite architectures to lower costs;
- Advances in cost of launching systems, either through cheaper launches or the possibility of bundling systems;
- Advances in demand for space services, especially in communications, remote sensing, technology demonstration etc.;
- The accessibility, including through venture capital, of funding for new space companies.
- NewSpace not only encompasses satellite manufacturing but also additional elements that potentially offer enormous benefits to Europe: i.e. space tourism, space colonism (Mars missions), and space mining (Moon-based and asteroids). Particularly the latter is projected to add trillions to the space

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economy by 2050. Any advances made in this sector may therefore achieve many of the EU's goals of becoming climate neutral, resource independent and an overall more secure and efficient economy.[1]

This is a competition that Europe is undoubtedly losing and, along with it, it is losing the competition for:

- Breadth of space industry;
- The development of private space industry, including through a vibrant start-up sector;
- Resilience through redundant capacity based on large number of SmallSat services provider systems;
- The military applications of SmallSats, which are as yet underexplored.

Unfortunately, Europe is also subsequently losing the market for launching these systems, which is, in itself, a growing lucrative domain for micro launcher companies supporting a high tech and innovative aerospace sector.

3. NewSpace Finance

At the same time, Europe is falling behind in the underlying financial capacity to support the development of an innovative and competitive space sector. While there is governmental acknowledgement of the resources that must be invested into space, and the new focus is visible at EU and ESA levels, the major funding for start-up companies in space comes mostly from venture capital. Of the 1,212 unique start-up investors identified by the firm Bryce Tech in the 2000-2020 period, almost half (544) were from the United States, followed by China with 136, Japan with 107, the UK with 103 and India with 37. The notable absence of other European countries shows that there was a lost start that was only partially recovered by 2020.

In 2020, there were 342 investors who made 140 deals to invest in 124 start-up space companies. 211 of them were first time investors into space, signalling the attraction of the field and its maturity. 36% or 123 of these investors were American, 48 Chinese, 31 British, 21 Japanese and 17 French. However, US start-up companies accounted for 63% of total investment received in 2020, which points to another important discrepancy, access to capital, which is also registered in other technological domains.

Without a thriving, innovative and sustainable space industry, made possible by a full spectrum of financing types and actors, the EU cannot remain competitive in space, ultimately affecting strategic space autonomy. Its security will also suffer, because its space services consumption is growing significantly and this consumption, in the absence of strategic space autonomy, will be provisioned, assured and, consequently, controlled and governed by others.

4. The Defence Perspective

The new space environment features actors that seek to disrupt space systems in order to severely degrade the capabilities of the Armed Forces to achieve their mission in the context of growing reliance on space capabilities, in particular data gathering, navigation and synchronization. DIA states that China for example "continues to improve its counterspace weapons capabilities and has enacted military reforms to better integrate cyberspace, space, and EW into joint military operations". Space systems are, increasingly, an "Achilles' heel" for the Armed

[1] van Manen et al. (2021). Towards a Space Security Strategy: Action Points for Safeguarding Dutch Security and Prosperity in the Space Age. Hague Centre for Strategic Studies. http://www.jstor.org/stable/resrep32076

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Forces of Europe and, therefore, European strategic autonomy and effectiveness can only take place in the context of security of supply for space services, respecting the need for data confidentiality, integrity and availability.

The Armed Forces were among the first to utilize space capabilities and to explore issues related to security and deliberate threats to these systems. Yet, for a long time, the European strategic community in its majority believed that it was above all the economy that counted in the struggle for power and influence in the world. But the Russian aggressions in Ukraine have highlighted, that in reality, the economy, technology and military capabilities form a mutually reinforcing alliance.

Russia and China understood this earlier than the EU. They consistently use technological leap innovations to improve their economies and military power. Russia and even more so China are on par with the EU in important fields of technology and in some cases even superior - we are talking about artificial intelligence, hypersonic weapons, cyber and electronic warfare, the misuse of social media and space technologies. They understand military power as an important factor in shaping their foreign and security policy and, in combination with other non-military power factors, use it without inhibition to advance their own interests.

Here, the EU and its Member States must change their previous course in space and aim for soft and hard space capabilities to underwrite their improving positions in the market economy, security and defence. It is not only space-related diplomacy that needs to evolve, as policies in this regard have so far been entirely dependent on internal objectives of EU member states. All space capabilities sought by the EU must be pursued through a common political approach, underpinned by strengthened diplomatic relations and unity among member states. In particular, the EU and its Member States need to make full use of their superior potential for leap innovations for their own security and defence. At the same time, they need to significantly improve their own resilience.

5. Priorities and Recommendations for Europe

Against this backdrop and with view to the European documents of reference which have been published key priorities for Europe in terms of space come to mind:

- Europe must ensure accessible, affordable and sustainable access to space services for European citizens and businesses as a precondition of continuity, resilience, growth and innovation; specifically on the EU level, it would seem initially important to achieve better knowledge of how exactly each EU policy area would benefit from increased space-based connectivity so as to better scope out a full package of needs and objectives (when Galileo launched, many EU institutions/services weren't well connected or were not even connected at all, thus decreasing its total system-wide effectiveness);
- Europe must maintain itself as a leader in innovation and production in the aerospace field and must reduce the existing gap with regards to new technologies, such as reusability;
- Europe must build, maintain and protect a full spectrum of space capabilities so that it will not be reliant on those of other powers. The next project in this regard is the secure government communications satellite system, GOVSATCOM;
- Europe must achieve resilience to risks, vulnerabilities and threats deriving from its increasing reliance on space systems, both at the level of its militaries, and at the level of society and economy;

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- Europe must create the toolbox with which to pursue its interests in a free and peaceful access to space, through a combination of multilateral agreements on rules of conduct, sectoral diplomacy and the development of instruments of deterrence against attacks on its space systems;
- The European Armed Forces must have safe and secure access to space services in order to maintain their qualitative edge in an environment beset by cyber and electronic warfare threats;
- Europe must emulate other actors in developing fair and sustainable comprehensive space partnerships with third countries, whose development will rely on space and which might otherwise become unduly beholden to European systemic rivals;
- Overall, Europe must integrate space into its toolbox for internal and external governance in all fields, from environmental and economic, to the security one;
- An improved level of public outreach in order to explain to EU citizens the benefits that space holds is paramount in raising awareness and support for the EU's space component. Success in this eventually feeds back into most previous and following points relating to innovation, production and private enterprise inclusion.

Recommendations:

- Europe should define and build a space strategic culture that accentuates its strengths, minimizes its weaknesses and articulates and justifies its goals to the world and to itself. This is an important counterpoint to the various strategic documents and other proposals which have been launched;
- While not militarizing per se, Europe should consider securitizing its space projects, starting with considering their utility for security, their impact on security and their requirements for security, in addition to the already included economic, environmental and social dimensions. The GOVSATCOM project is the first European space project with an explicit security focus, since it proposes to establish secure satellite communications for European governments. Future projects should also be selected in accordance with requirements for strategic autonomy and strategic technological autonomy, including with an overarching security focus;
- Additionally, advances should be made in the quantum computing and communications sector. Here China and the US are clearly in lead. As these technologies will revolutionise the secure communications component of governments – to include armed forces – and the private sector as well in a few years, the EU should speed up, if it does not want to fall behind too far;
- While Europe may not militarize, its individual Member States have been exploring the military dimension of space, by creating Space Force equivalents and possibly conducting research into counterspace capabilities and protection measures. The European Union should set up a Space Security Board as part of the Council on Space and working in close connection with DG-DEFIS to enable information sharing on these capabilities, it should conduct a European Space Defence Review as a part of evolving European Defence initiatives and capabilities;
- Cooperation between the EU and NATO on space should also be considered a continued priority. NATO does not have its own space assets and is reliant on information and asset sharing between MS for defence purposes. The EU's significant space asset base can be included in a way which is more difficult for the individual NATO and EU Member States acting on their own initiative. As an example, taking

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advantage militarily of Galileo receiver station compatibility with GPS can increase battlefield resilience. The EU can also prioritize polar-orbit satellites for environmental studies that can also be used to cover gaps in NATO polar space capabilities. This would add a space dimension to an already burgeoning cooperation between the EU and NATO, which includes cyber, maritime and hybrid threats dimensions;

- Europe should focus on mobilizing its private sector resources and its entrepreneurialism to act as a multiplier to state-led investment into space. Europe has far fewer private investors into space start-ups than either the US, China and the UK. Interviews with industry participants highlighted that the problem is not just lower start-up creation levels, but also lower start-up survival levels, implying a lack of state support for the advancement of ideas beyond the critical initial phase, lack of access to relevant infrastructure (often state-owned), but also (and especially) a lack of private sector appetite for risk related to space enterprise;
- A potential approach towards stimulating the involvement of the private sector into space is to copy the EU approach for the InvestEU Programme 2021-2027, which has a security dimension related to cyber and AI, among others. InvestEU targets 650 billion euros in the 2021-2027 timeframe, divided thusly: 15,2 bln from the European Commission, 38 bln from Member States, of which 11.8 bln are dedicated to research, and 9.5 bln from various partners. The rest is external contribution, meant to be attracted mostly from the private sector as a result of state and EU-led investment, with a multiplier of 13.8. Whether feasible or not in the required timeframe, the InvestEU model consciously approaches the issue of multiplying the public-sourced investment by attracting private investment, and can serve as a model for future space development;
- The European Union should aim to employ the "Brussels Effect" to delay the militarization of space and the onset of space conflict, until it has closed the capability gap with its main systemic rivals. The Brussels Effect refers to the EU's capability to set norms, rules and standards that are followed by entities outside the EU's borders, and is a key component of European soft power. However, fostering a Brussels Effect in any advanced technology domain requires that the EU itself become a (aspiring) leading player in that field, whether we are talking about AI or space. The EU should focus on preventing conflict in space, developing norms regarding the registration of space assets, norms regarding the assignment of liability for space disasters and damage done by debris, and norms/treaties regarding the prevention of cyber-attacks, jamming and spoofing;
- Provide support to Member States to organize Space Threat Response Architecture Exercises (the European variant of the French ASTER exercises) or various evaluations at national levels to increase awareness of critical dependence on space services and technologies;
- Begin developing dual-use technologies in space, including debris clean-up and mitigation technologies. One option to attain more of such dual-use technologies is to better synergise the civil, space and defence domains: how can each sector complement the other?
- The EU must focus on encouraging the development of private sources of funding, with appropriate appetite for risk, to complement state and EU investment in innovation and emerging technologies; the EU is far behind the US in this regard, when compared relative to size, population, GDP and overall economic sophistication;

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- Strategic space autonomy cannot take place in the absence of strong private sector contribution, in financing as well as in the start-up scene; the EU must act at multiple levels, encouraging both European financing and European innovation, otherwise the financing gap will be covered by US entities, leading to brain and technology drains and affecting EU strategic technological autonomy, which has identified these threats from the imbalance in transatlantic potential;
- Encouraging the supply side of start-ups, through state and EU support of space hubs and start-up incubators focusing on space and space-related domains. It is especially important to make the creation and liquidation of start-ups as painless as possible and to provide support for intellectual property protection, patenting, licensing and branding;
- The use of prizes, both at the frontier of technical ability and for incremental capability development, to motivate the formation of teams that can then coalesce into start-ups. European countries have a tradition of prizes driving research and development, but it has been overshadowed in the space field by US-based prizes;
- Stimulating the demand side for start-up products and services through a greater focus on and encouragement of new systems architectures and the services they provide, including through an emphasis on security and resilience through redundancy, interoperability and substitutive capacity.

6. A European Space Architecture

A future European Space Defence Architecture must be able to accommodate varying levels of defence cooperation and integration with neighboring and other partner states. It must feature capabilities, but also practices that result in the maximum impact within the European Defence Architecture, such as the suggestion of including space resilience in operational planning from the previous section. Clearly, it should be compatible and interoperable with the US as we strive to cooperate in crises and conflict.

Consequently, mirroring the US model, we propose 7+2 layers of systems that feature redundant capabilities, interoperability between each other and with systems of allies and a logistics and industrial support system capable of rapid redeployment or replacement. These layers are as follows:

- The “support layer” is supposed to enable a common, resilient ground support infrastructure in order to facilitate the space-based capabilities of the other layers to transmit, receive, process, exploit and disseminate data;
- The "transport layer" is a space-based communication system for all the other layers that is supposed to provide assured, resilient, low-latency military data and connectivity worldwide to the full range of military platforms;
- The “tracking layer” will deal with advanced missile threats and will provide global indications, warning, tracking, and targeting of advanced missile threats, including hypersonic missile systems.
- The “custody layer” will accelerate the sensor-to-shooter interaction and sense and track objects on the ground down to the size of trucks and provide target-related information directly to weapon systems;

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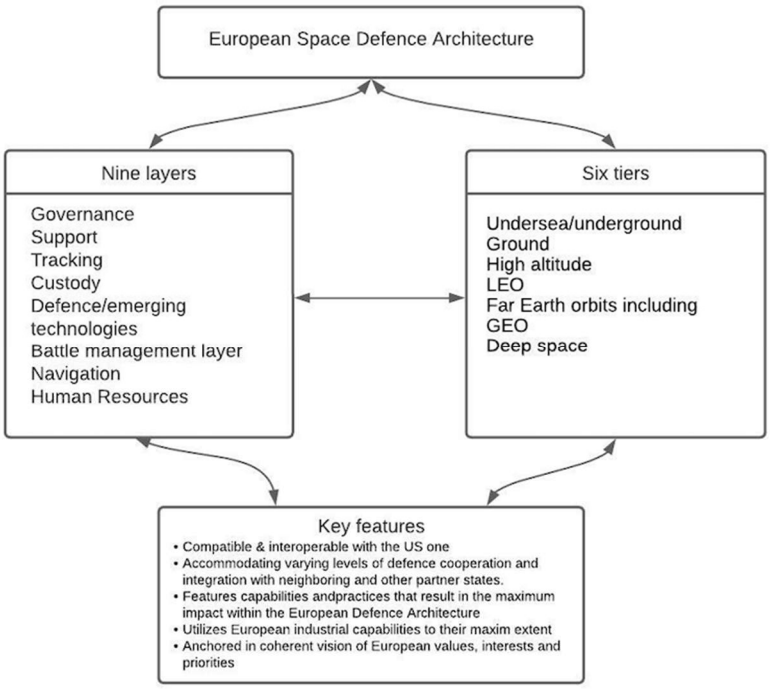

Figure 1. A high-level view of the European Space Defence Architecture

- The "deterrence/emerging technologies layer" is an enhanced space situational awareness (SSA) capability that also covers space from geostationary orbit to the region around the moon where traffic is increasing, but not well monitored yet. It is supposed to incubate new mission concepts to deter hostile action in the increasingly active region extending beyond the geosynchronous belt to lunar ranges;
- The "battle management layer" will provide autonomy, tipping and queuing, and data fusion for mission command & control to include time sensitive targeting;
- The "navigation layer" will provide alternate positioning, navigation, and timing (PNT) for Global Positioning System (GPS)-denied environments. It is intended to come up - similar to the battle management layer - with onboard processing to provide navigation and launch data to the other satellites.

With view to the US space architecture, two additional layers – framing the other seven - are envisioned:

- The "governance layer" is made up of a framework of alliances and partnerships with differing levels of resource sharing and interoperability, as well as norms, standards and contacts that drive collective action and the harmonization of security perspectives;
- The "human resources" layer addresses a critical bottleneck for space, which is related to the availability of specially trained personnel in highly technical fields, which will require far more resources than available to militaries already stretched by the requirement for cyber-warriors. As even the civilian "human resources" will require security clearances, this will prove being a further considerable hurdle

to achieve adequate quantities and qualities. Clearly, this will involve a close cooperation between private entities, academia and space-designated forces, as well as the capability to mobilize civilian capabilities and resources in case of necessity.

The number of satellites and other systems is not set, but it is rather defined by the required capabilities for a minimum acceptable capacity level and the upper bound is set by the maximum achievable inventory of systems in the context of current private or public space capability performance. For instance, the revolution in miniaturization and standardization of space systems, as well as lower cost and reusable launches, can change practically overnight the mass and the capability that a given budget can place in orbit, enabling mixed use strategies such as low-cost, high number systems in LEO for certain operations and higher costs, sensitive and bespoke systems in GEO developed by traditional contractors.

As part of the architecture, we also define six tiers of functioning – undersea/underground, ground, high altitude, LEO, far Earth orbits including GEO and deep space. Integrated space systems function across multiple planes with components located in each and with links primarily through communication but also through supplies and other types of dependencies. For instance, a simple space surveillance system for an unstable region could consist of a number of low-cost surveillance satellites strung out in orbit to provide permanent coverage; however, this is not the only component. It also features ground stations with privileged access to system functions and specific ground equipment, communication interlinks, redundant communication capabilities with the beneficiaries (for instance, through fiber optics to avoid ground jamming or ground and space based quantum key distribution distribution networks to protect highly classified information) and, in order to supplement capabilities on a short-term basis with new sensors, it could contain high altitude surveillance subsystems such as surveillance drones or high-altitude balloons.

Towards a Framework for European Prosperity, Security and Defence Via the Space Domain

There have been attempts to structure a space approach for Europe based on existing documents of reference. For example, in April 2021 the EUISS has provided a perspective on how the four “baskets” of the Strategic Compass can be intertwined with space. In fact, the Strategic Compass constitutes a real opportunity for the EU to develop a sustainable, comprehensive EU space and defence strategy that orchestrates the necessary multidomain, interdepartmental and multinational approach and their respective policies. From the EuroDefense perspective, the subsequent roadmap should guide how to approach the EUISS four pronged framework via 2030 and 2050 milestones.

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A Strategic Roadmap addressing European Prosperity, Security and Defence via the Space Domain	
Capabilities	
2030	**2050**
• Launch initiatives to ensure greater private participation and investment in the space sector and as multiplier of public investment; • Reduce informational asymmetries regarding capabilities of potential adversaries and systemic rivals; • Promote accessible, affordable and sustainable access to space services for all levels of European society and the business environment; • Cover gaps in start-up formation, financing and survival for the space domain, as a precondition for harnessing innovation; • Develop programs, competitions and career tracks to ensure sustainable production of human resources for the space sector; • Define voluntary standards for robust system architectures, resistant to radiation, impact and cyber threats; • Review and develop programmes for soft (low investment and low deployment effort) counterspace capabilities – cyber, jamming, spoofing, sensor blinding etc. plus sanctions capabilities;	• Ensure the existence of redundant capabilities and interoperability with major partners when it comes to securing access to space services for crisis and emergency situation management on the part of EU and MS authorities; • Have full space environmental awareness, involving space debris, space weather phenomena (including solar weather) through own assets; • Have in place financially sustainable capabilities for debris elimination and mitigation; • Define mandatory standards for robust system architectures, resistant to radiation, impact and cyber threats; • Achieve operational autonomy for space systems in line with future demands (ex: in-orbit refueling); • Develop European ASAT capabilities through key programs such as the EDF and its successors; • Develop other hard (high investment, high deployment efforts) counterspace capabilities – lasers, EMPs etc.; • Develop and mass deploy reusable space launch systems; • Achieve critical mass in EU economic presence in space, especially as relates to private economy-supporting infrastructure, thereby reducing outlays for supplies and other capabilities required in defence.
Crisis Management and Defence	
2030	**2050**
• Exercises on space defence and crisis management issues; • Include space in other EU exercises; • Develop documents of reference on space, including an EU Space Defence Strategy and a Directive on EU MS space posture; • Ensure adequate minimum level of space services access and consumption for public authorities in the field of crisis and emergency situation management across the EU; • Run exercises on space threats with key partners, including the US.	• Ensure EU space autonomy across all major capabilities and domains pertaining to space, especially in defence matters; • Have back-up plans for mitigating the damage and minimizing the disruption time of space services disruption; • Strengthen capacity at all territorial levels to deal with disruptions in space services, in accordance with local needs and challenges.
Resilience	

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2030	2050
• Perform EU and MS space dependence assessments to gauge the level of critical reliance on space systems in human, financial and strategic terms; • Perform other types of structural mapping; • Include space dependence assessments in Critical Entity security plans (or critical infrastructure operator security plans); • Introduce tiers of space system importance by user and capability provided, and mandate minimum levels of system robustness of critical societal functions; • Achieve supply chain security for current space systems; • Include critical space resilience analysis for military operations at J5 level of EU MoDs and EU military authorities.	• Plan and deploy minimum levels of substitute capacities for space services located in non-space environments (ex: ground sensors, ground monitoring stations, fiber optics, communications); • Establish a system of incentives for security conscious behaviors on the part of private actors operating space systems or reliant on space (ex: liability for damages incurred by negligence in production of space debris); • Create robust and secure supply chains by design, starting from minerals extraction to manufacturing and development for EU space activities; • Maintain capabilities and knowledge to run various backup systems, especially in a military context; • Make space resilience analysis a compulsory part in the strategic guidance for operation planning.
Partnerships	
2030	**2050**
• Establish a system of comprehensive partnerships with space-developing countries such as those in Africa, involving manufacturing, financing, training, services etc. in space to counter Russian and Chinese advances; • Support and strengthen capability sharing with countries affected by natural disasters and other crises; • Deepen partnership with US and interoperability with US space systems; • Cooperate with likeminded countries to deploy the "Brussels Effect" and maximize power of EU to create and promote norms and standards favorable to it and its values; • Establish a European multistakeholder space forum on topics related to defence and security; • Deploy defence and space attaches in EC representations abroad; • Develop a Space Commons Environmental Protection Initiative to discourage and limit the impact of hazardous space actions on the part of systemic rivals and to promote sustainable behaviors.	• Cooperation in place to prevent industrial espionage and deliberate or systemic weakening of supply chain security for space systems and space services; • Create and empower a space security community with likeminded partners, starting with collective risks such as asteroid threats, Carrington-Event level solar storms, but moving onto the deterrence of military aggression in space; • Be a part of and promote a system of sanctions for space practices and actions that are deleterious to the space environment and sustainable access to it, as a proxy for discouraging aggressive action; • Establish common and unified markets for space products and services with likeminded entities to promote common standards and super-charge investment into developing those standards to accelerate innovation (starting from the communications sector).

Table 1. A 2030 and 2050 Strategic Roadmap addressing European Prosperity, Security and Defence via the Space Domain

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Remarks: The opinions expressed in this contribution are those of the author.

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