

Italy and the Challenges of Space: Between Space Economy, International Cooperation and Cybersecurity

by Karolina Muti, Ottavia Credi and Giancarlo La Rocca



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ABSTRACT

Recent developments in the space sector pose many challenges and offer just as many opportunities for a country that boasts capabilities as advanced as Italy. This paper provides an overview of the main issues that Italy's national space complex will face, starting from the increasing global competition, the strategic decisions to be taken regarding international collaborations and alliances, but also related to the sustainable growth of the Italian space economy in a historical moment characterised by a considerable injection of funds, for instance in the framework of the National Recovery and Resilience Plan and of the European Space Agency optional programmes. The analysis starts with an overview of the national space complex, between innovation and entrepreneurship. Next, the authors offer an in-depth look at the national space economy and related trends. The second part of the study is dedicated to an overview of the collaboration with the United States and to analysing recent developments in the European space governance, including the EU Space Strategy for Security and Defence. The third and final part highlights the issue of cybersecurity of space systems, considering risks and vulnerabilities, and the current national governance in this area.

Italy | Space | USA | European Union | NATO | UK

keywords

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1. Space Italy between entrepreneurship and innovation technology

by Ottavia Credi and Karolina Muti

1.1 Technologic innovation

Italy emerges as a major player in technological innovation in space, demonstrating world-class skills in the design and development of advanced technologies, and occupying the fifth place for space innovation on the international scale.¹

The emergence of new small and medium-sized enterprises (SMEs) working in the production of satellites has made the sector particularly profitable, also in terms of its contribution to the Italian space economy. This is demonstrated, for example by the ArgoMoon satellite, developed operated by the Italian company Argotec. The satellite, aboard the Artemis 1 mission of the National Aeronautics and Space Administration (NASA), the United States space agency, succeeded in taking high-definition images of the Moon.²

Important developments are also seen in the design of technologies for space exploration and utilisation. Thanks to its prolonged presence on the International Space Station, Italy completed numerous experiments in microgravity conditions, including activities in the field of biology, biotechnology, human research, and technology development and demonstration.³ In addition, in the context of the Lunar Gateway mission, several Italian companies are collaborating with the European Space Agency (ESA) on the construction of lunar infrastructures.⁴

Indeed, Italian participation in international space programmes allows the country to achieve important results in the development of advanced technologies. For example, in collaboration with NASA and ESA, the Italian Space Agency (Agenzia Spaziale Italiana – ASI) contributed to the creation of the scientific instruments used during the Cassini-Huygens mission, which studied Saturn and its system of rings and satellites.⁵

¹ Intesa Sanpaolo Research Department, *Spazio: nuova frontiera per economia e ricerca*, November 2021, <https://www.aspeninstitute.it/?p=108554>.

² ASI, *Artemis 1: ArgoMoon Captured Photos of the Earth and Moon*, 19 November 2022, <https://www.asi.it/en/?p=36541>.

³ For a complete list of experiments conducted in microgravity conditions, see the ASI website: *List of Experiments*, <https://www.asi.it/en/?p=16710>.

⁴ ASI, *The ESA Continues Its Project on the Constellation of Lunar Satellites*, 20 May 2021, <https://www.asi.it/en/?p=23449>.

⁵ ASI website: *Cassini*, <https://www.asi.it/en/?p=16533>.

One area in which Italy excels internationally in terms of innovation technology is radars.⁶ Thanks to its expertise in the production of synthetic aperture radars, the country is a leader in the field of geo-information.⁷ Italy is also one of the seven countries in the world with launch capabilities, which facilitates bringing and testing technologies in orbit, although not currently being an autonomous capability.⁸

The technological developments achieved in the space field demonstrate Italy's determination to consolidate its position as a leader in the field, also through close cooperation with other countries and agencies. This kind of commitment also reflects the continuity with which successive governments over the recent years have focused on space, ensuring the necessary attention and political will, as well as significant resources, while maintaining a position of prominence in terms of international competition. It should also be remembered that the high level of technological innovation that characterises space makes this sector cross-cutting and enabling in other areas, with positive spin-offs from biotechnology to the microprocessors' field.

1.2 A dynamic and competitive reality

The Italian space sector comprises a multitude of different players, including a national technology cluster, ten technological districts, nearly 70 university departments and research centres, and approximately 200 large companies (about 15), SMEs and micro-enterprises.⁹

The industrial sector alone is capable of providing employment for more than 7,000 people and fosters a business volume of about two billion euro annually.¹⁰ While large companies serve as prime contractors, SMEs and microenterprises also represent a key component of the national supply chain.¹¹ Also, particularly dynamic is the sector of start-ups, which often grow in prestigious academic environments and work on innovative services. As in other Italian industrial sectors, however, SMEs, micro-enterprises and start-ups experience not surprising difficulties compared to large companies, such as access to credit and to European calls for application or consortia. This is partly due to the fact that activities conducted under ESA follow the principle of industrial geo-return of the investments made by member states in joint programmes (the so-called *juste retour*), creating structural constraints that limit the outreach of SMEs.

⁶ Interview, 29 May 2023.

⁷ Ibid.

⁸ Interview, 29 March 2023.

⁹ Speech by Lorenzo Fontana, President of the Italian Chamber of Deputies, at the conference "Una legge italiana per lo spazio", 16 December 2022, <https://webtv.camera.it/evento/21475>.

¹⁰ Luigi Di Maio, "Quanta Italia c'è nello spazio", in *Airpress*, 24 January 2022, <https://www.esteri.it/en/?p=70454>.

¹¹ Interviews, 18 April 2023 and 29 May 2023.

The industrial dynamic at the European and global levels is at the same time cooperative and competitive. The *juste retour* and the solidity of the larger Italian industrial entities make the national supply chain more competitive against well-organised and incisive partners and competitors, such as the French counterparts, which can count on more “large system integrators”.¹²

The Italian industrial sector boasts many synergies. One example is the collaboration between Leonardo and Telespazio in the context of the European programme Copernicus and the Italian Cosmo-SkyMed programme. Several Italian industries have in fact been able to enter larger programmes, thus securing access to a larger market. Thanks to the multitude and variety of industrial players active in the national space sector, Italy can count on a complete value chain, from upstream to downstream segments. In fact, the country is able to guarantee the production of all the elements that make up the ground and space segments – including, for example, launchers, pressurised modules and space debris removal technologies.¹³ This makes the Italian space sector a part of the country’s technological sovereignty that needs to be safeguarded, and a valuable contribution to European strategic autonomy.¹⁴

Equally important in the national space framework is the role of research centres, which have enabled Italy to become “an important player at the global level and to play a major role in all application sectors of space”.¹⁵ Italy has a strong tradition of public research in the space sector and, despite the widespread financial cuts that have occurred over the past decades, the space sector could count on enough resources to continue research and development activities.¹⁶ This is partly due to connections between the public research sector and industry, the latter holding an interest in forging collaborations – and sometimes incorporating – incubators coming from academia, which work on innovative projects and services.¹⁷ The Italian academic world indeed contributes to the technology transfer to the industrial sector, and this allows for leveraging knowledge developed in Universities to the benefit of the country’s economic growth.¹⁸ In June 2023, Galaxia, a national technology transfer hub for aerospace, was established. Galaxia is promoted by, among others, the Polytechnic University of Turin and the University of Rome La

¹² Interview, 18 April 2023.

¹³ Ottavia Credi, “L’Italia protagonista europea nello spazio”, in *AffarInternazionali*, 19 December 2022, <https://www.affarinternazionali.it/?p=101867>; Luigi Di Maio, “Quanta Italia c’è nello spazio”, cit.

¹⁴ Giancarlo La Rocca, “Il pilastro della cooperazione spaziale nel Trattato del Quirinale”, in *AffarInternazionali*, 10 December 2021, <https://www.affarinternazionali.it/?p=93677>.

¹⁵ Interview with Giorgio Saccoccia by Laura Moretti, “All’Italia un ruolo sempre più importante nella sfida per lo spazio”, in *Energia, ambiente e innovazione*, No. 3/2021 (September-December 2021), p. 48, <https://doi.org/10.12910/EAI2021-084>.

¹⁶ Interview, 21 April 2023.

¹⁷ Interview, 29 May 2023.

¹⁸ Interview, 21 April 2023.

Sapienza.¹⁹

1.3 Considerations for the future

Recent years have witnessed a profound transformation of the space sector, mainly due to the emergence of commercial interests by different types of global actors.²⁰ The lowering of access barriers to space has facilitated private actors' initiative, who approach space both to create value and to help solve global challenges.²¹ Despite the widespread focus on new commercial players active in the space economy, it should be mentioned that most of the funding in the space sector in Europe, including in Italy, is allocated by civilian public actors, and to an increasing extent by military actors. There are also public entities such as Cassa Depositi e Prestiti (CDP) or the Italian Trade Agency that are playing an interesting role in the sector, with a view both to new business models, attracting capital (venture capital) and internationalisation.²² The role played by these various actors requires to reflect on how the relationship with other institutional players should unfold. This is one of the reasons behind the initiative to establish a national legislation aimed at regulating space activities.²³

Italy holds the third place in Europe both in terms of public investment in space activities as a proportion of the national gross domestic product, and in terms of contributions to the ESA budget, after Germany and France.²⁴ The National Recovery and Resilience Plan (NRRP) established in 2021 confirmed the support of national institutions to the space sector, providing investments of about 2.3 billion euro.²⁵ This flow of resources is more significant than ever, also considering the historical moment, characterised by an increasingly strong nexus between defence and space – the later recognised by NATO as an operational domain as early as 2019 – and could help develop Space Situational Awareness (SSA) capabilities, in-orbit services and counter space measures.²⁶ Italy could meet the foreign demand and

¹⁹ CDP Venture Capital, *CDP Venture Capital SGR: nasce Galaxia, il polo nazionale di trasferimento tecnologico per lo sviluppo di nuove imprese dedicate al settore dell'Aerospazio*, 6 June 2023, https://www.cdventurecapital.it/cdp-venture-capital/en/dettaglio_comunicato.page?contentId=COM3018.

²⁰ Speech by Davide Cipelletti, Chief of the Space Policy Office of the Italian Defence General Staff, at the conference "Una legge italiana per lo spazio", cit.

²¹ Ibid.; interview, 21 April 2023.

²² Interview, 18 April 2023.

²³ Antonello Salerno, "Space Economy, Urso: 'Italia protagonista, nuova legge in tempi rapidi'", in *SpacEconomy360*, 11 April 2023, <https://www.spaceeconomy360.it/?p=225581>.

²⁴ Speech by Giuseppe Cavo Dragone, Chief of Defence, at the AeroSpace Power Conference, Rome, 12 May 2023; Speech by Guido Crosetto, Italian Ministry of Defence, at the conference "Una legge italiana per lo spazio", cit.

²⁵ These funds are managed by ASI, together with ESA, and will be directed toward activities related to Earth observation, telecommunications satellites, space economy, and development and production of technological products and services. For more information on the NRRP, see the government website: *Italia Domani*, <https://www.italiadomani.gov.it/content/sogei-ng/it/en/home.html>.

²⁶ Interview, 29 May 2023.

thus facilitate a greater return on investments made by allocating more resources to dual-use products such as in-orbit services (IOS) and commercial-off-the-shelf (COTS) goods.²⁷ In general, Italy's ability to invest in innovation in the areas of artificial intelligence, high-power computing and big data analytics, which are functional to ensure technological advancement in the sector, will help maintain a relevant placement on the international space scene.²⁸

For what concerns institutions, at inter-ministerial level there is a need for a careful analysis of Italian space priorities.²⁹ But for this to happen, it will be necessary to develop a coherent and long-term Italian space strategy first, which should also – but not only – contain a Defence perspective, and should allow the country to keep up at the decision-making level, with developments in both the ESA and EU.³⁰

²⁷ IAI seminar: "La dimensione strategica dello spazio per il Sistema-Paese Italia", 22 February 2022, <https://www.iai.it/en/node/15322>.

²⁸ Interview, 29 May 2023.

²⁹ IAI seminar: "La dimensione strategica dello spazio per il Sistema-Paese Italia", cit.

³⁰ Interview, 29 May 2023.

2. Italian space economy: main trends and stakeholders

by Giancarlo La Rocca and Karolina Muti

Economy and the space sector are intertwined. On the one hand, space systems enable a yet incompletely mapped set of services and applications vital to the functioning and growth of G20 countries. On the other hand, modern economic and financial tools related to innovative business models have found fertile ground in the peculiar characteristics of the space sector. The results of this favourable conjuncture, typical of the new millennium and digital transition, testify continuous growth of the space economy. Globally, some projection syndicate that the space economy sector will reach a value of 642 billion dollars by 2030, a figure that, if confirmed, would validate the well-known JP Morgan prediction that the sector will collectively exceed one trillion dollars by 2040.³¹

2.1 The Italian space economy in the global, European and national contexts

Attention rises accordingly at the policy level, considering, for example, the establishment of a dedicated meeting within the G20, the Space Economy Leaders Meeting. The initiative launched by Saudi Arabia in 2020 was revived the following year by Italy and then made permanent in the G20 framework. In fact, ASI organised an event titled "People, Planet, Prosperity", with the goal of raising awareness on the sector's contributions to the world economy, to give full recognition to space economy in the G20 agenda.³²

This shall not be taken for granted, considering the period marked by the Covid-19 pandemic, during which the space sector indirectly demonstrated how several space applications could be used to analyse the impacts of the crisis triggered by global lockdowns, mitigate some of its effects and better prepare for the recovery phase.³³

Economic growth is distributed throughout the sector, from large system integrators to start-ups. The latter are specifically taken into account because of the expansion of the New Space concept and the emergence of many companies that are dedicated to space in all segments of the value chain, particularly in the so-called downstream, which highlights the value of data received from satellites. The term New Space is also generally used to define a new approach to space, more focused on risk-taking and aimed at leveraging innovative financial methods and

³¹ Jason Rainbow, "Buckle Up, It Could Get Bumpy: The Space Economy's Vaunted Resilience Will Be Tested in 2023", in *SpaceNews*, 24 January 2023, <https://wp.me/p5sx4f-AA9>.

³² ESA, *G20 Space Economy Leaders Meeting 2021*, October 2021, <https://space-economy.esa.int/article/114/g20-space-economy-leaders-meeting-2021>.

³³ European Space Policy Institute (ESPI), "COVID-19 and the European Space Sector", in *ESPI Special Reports*, July 2020, <https://www.espi.or.at/?p=1137>.

instruments, as well as to indicate the rise of private actors and capital, alongside traditional public and state actors and capital. Although the sector is experiencing a particular revolution in the United States, with the emergence of new private champions competing with each other and being assigned important public contracts, the space economy is also growing in Europe, both in its traditional and start-up-related aspects. Some data analysed from 2020, at the height of the pandemic, and then confirmed in subsequent years, have so far identified a positive trend of investment in space.³⁴ Above all, the data show the growth of private investment in European space start-ups in the order of half a billion euro.

In Europe, the European Commission has launched the Cassini initiative to facilitate access to funding and create opportunities for business acceleration, with a 1 billion euro endowment. The European Union Agency for the Space Programme (EUSPA) is key from an operational perspective. The Agency was established in 2021 to expand the institutional competencies to the entire EU space programme, not only pertaining to security aspects but also to entrepreneurship and market development downstream related to space application segments. Looking forward, the Commission and EUSPA could continue to strengthen these initiatives by making the governance of the financial instruments available in the sector clearer, also taking into consideration the current competencies of the European Investment Bank and the European Investment Fund.

The European picture is completed by the ESA, which in the 2022 Ministerial Council obtained subscriptions from member states totalling 17 billion euro, a budget that is higher compared to 2019 and significant, considering the current context, which is economically complex. The pandemic first and the war unleashed by Russia against Ukraine then, have certainly contributed to demonstrate in an indirect way the need to continue investing in space, and being competitive in a global context of growth in the space sector. Already in the ESA Agenda 2025, published in May 2021, ESA and its director general Josef Aschbacher emphasised the economic aspects and the commercialisation of the sector, building on initiatives already in place, such as the ESA's Business Incubator Centres (BICs), but projecting an innovative approach with regards to the market and to business risks.³⁵ During 2023, a third ESA BIC, after those in Rome and Turin, was announced in Veneto at the Officine Stellari company. Italy has significantly increased its subscription since the ESA Seville Ministerial Council in 2019, from 2 billion 282 million to 3 billion and 83 million euro subscribed in Paris in 2022. Rome's budget increase accounts for more than a third of the overall growth in ESA's budget between 2019 and 2022, positioning Italy as the first state in ESA in terms of subscriptions to optional programmes.

³⁴ Sebastien Moranta et al., "Space Venture Europe 2020", in *ESPI Reports*, No. 78 (May 2021), <https://www.espi.or.at/?p=1129>; Sebastien Moranta et al., "Space Venture Europe 2021", in *ESPI Reports*, No. 83 (June 2022), <https://www.espi.or.at/?p=2541>.

³⁵ Giancarlo La Rocca, "Agenda 2025: il futuro prossimo ed il futuro remoto dello spazio europeo", in *Astrospace*, 4 May 2021, <https://www.astrospace.it/?p=9777>.

Thanks to its industrial supply chain in the space sector, Italy ensures the production of all components of the ground and space segments and is therefore one of the few countries in the world that boasts a complete value chain. The national industrial base is made up of ten technological districts, one national technological cluster, 200 large, small and medium-sized enterprises, as well as 70 research departments, research centres and universities.³⁶ From university excellence in the space sector, various university spin-offs have also sprung up in the form of start-ups, which are also the result of the high quality of Italian universities' research activities in the field of space.³⁷ Figures 1, 2 and 3 show how the companies and their facilities are distributed across the country, divided according to the size of the company (large, SME or start-up), while Figure 4 shows companies divided by business sub-sectors (so-called "application domains").³⁸ Three industry associations represent the interests of companies in the space sector: the Association of Italian Space Enterprises (AIPAS), the Federation of Italian companies for aerospace, defence and security (AIAD) and the Association for Space-based Application and Services (ASAS).³⁹

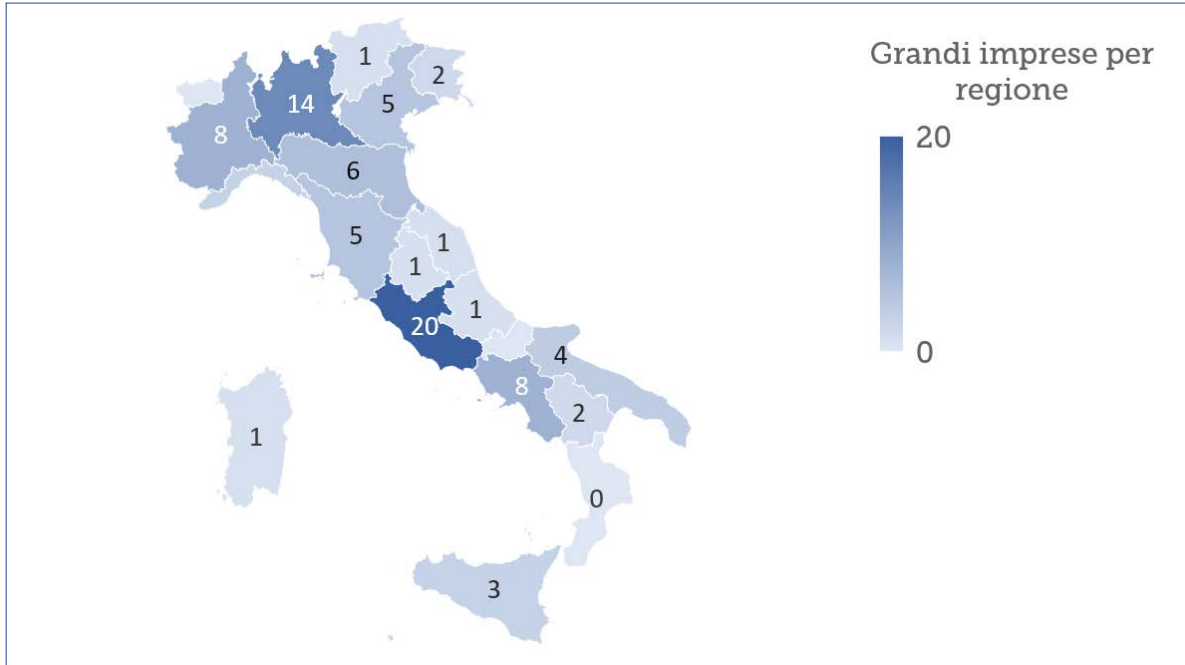
³⁶ Antonello Salerno, "Space Economy, Urso: 'Italia protagonista, nuova legge in tempi rapidi'", cit.

³⁷ Interview, 18 April 2023.

³⁸ To render the geographic distribution of the companies, Figures 1-3 were elaborated by taking into account not only the headquarters of the companies but all the establishments on the territory indicated in the online version of the *Italian Space Industry* catalogue edited by ASI. The authors are aware that this is a partial mapping that cannot fully reflect the dynamism of the Italian space economy sector, characterised by a continuous appearance of new actors, especially in the startup category. For another mapping, albeit less recent, see, "Italy's Space Industry", appendix to Silvia Ciccarelli's article, "Space Italy from Third Big to Whose Satellite?" in *Limes*, No. 12/2021, p. 205-208.

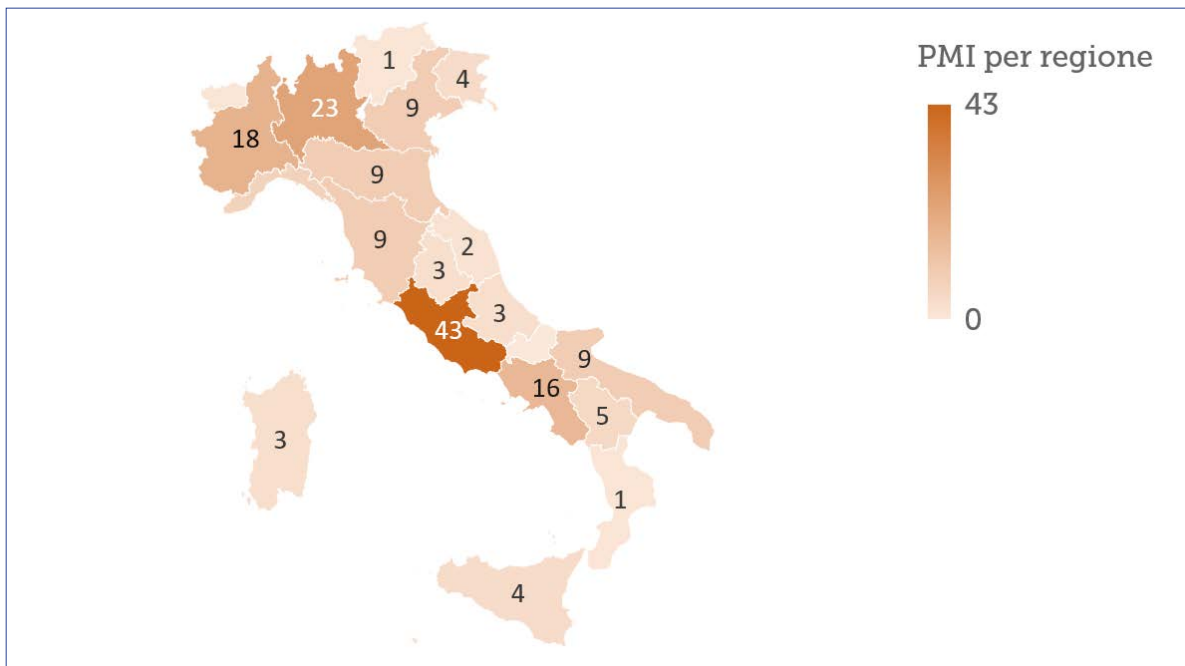
³⁹ See the official websites of AIPAS (<https://aipas.it>), AIAD (<https://aiad.it>) and ASAS (<https://www.asaspazio.it>).

Figure 1 | Large companies in the space sector by region



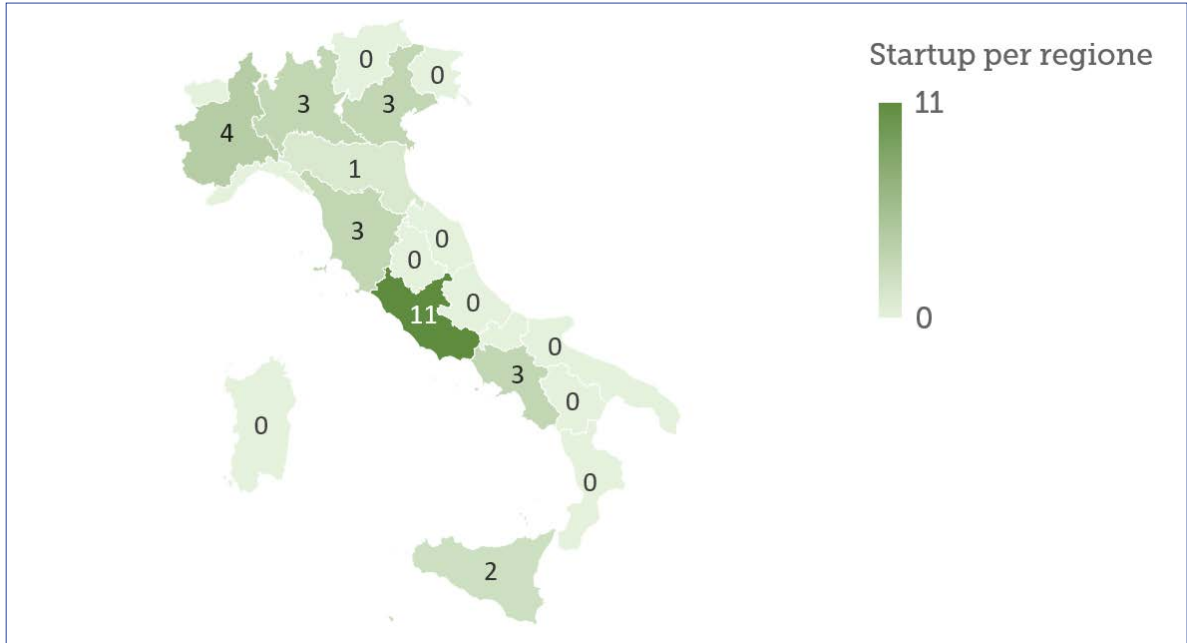
Source: Authors' elaboration based on data from the ASI *Italian Space Industry* catalogue, <https://italianspaceindustry.it/explore/?sort=a-z>.

Figure 2 | SMEs in the space sector by region



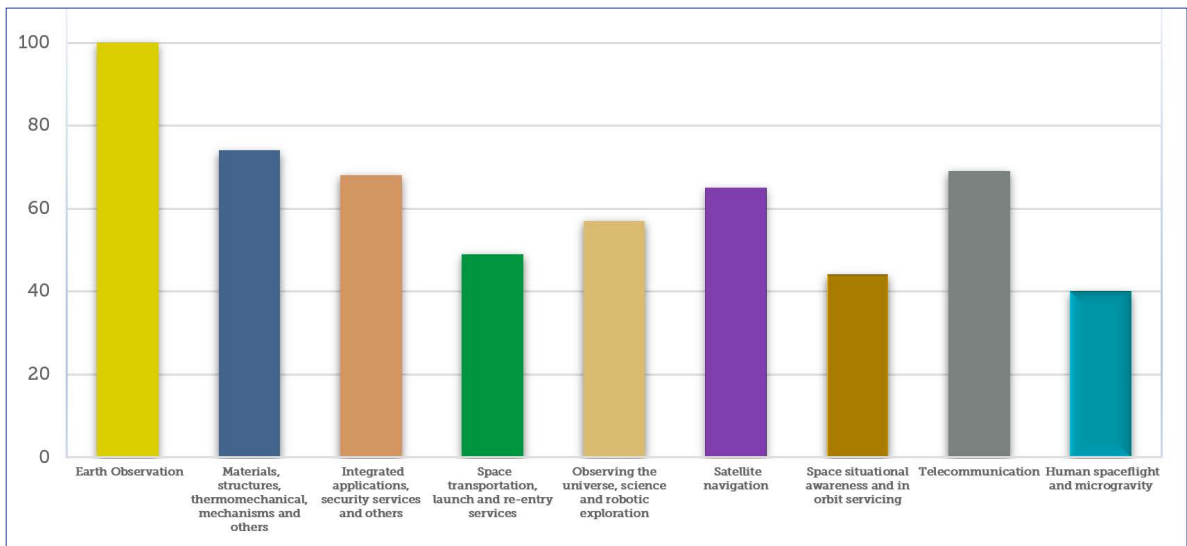
Source: Authors' elaboration based on data from the ASI *Italian Space Industry* catalogue, cit.

Figure 3 | Startups in the space sector by region



Source: Authors' elaboration based on data from the ASI *Italian Space Industry* catalogue, cit.

Figure 4 | Companies in the space industry by application domain



Source: Authors' elaboration based on data from ASI, *Italian Space Industry. Edition 2021-2022*, September 2021, p. 10-21, https://www.asi.it/wp-content/uploads/2021/09/Catalogo-ASI_160921_LOW.pdf.

2.2 Space economy and venture capital

Primo Space, the first Italian venture capital fund dedicated to the space economy, as well as the first established in the EU, has developed a series of activities aimed at supporting and expanding the potential of the sector.⁴⁰ Primo Space has signed a collaboration agreement with ESA for the growth of start-ups in the commercial Earth observation (EO) sector, with the coordination of the Φ -lab. The later manages the co-funding InCubed programme of 100 million euro. The fund also launched the Quasar initiative to create a dedicated pathway for start-ups in the sector, facilitate access to the market and the maturation of technologies together with the related business model.

As a whole, after just one year of activities Primo Space has reached a volume of 85 million euro in 2021, by concluding six investments worth more than 8 million and fostering a virtuous ecosystem through the involvement of and collaboration with other players, who are potentially central to sustaining the positive trends in the sector, such as CDP Venture Capital. Subsequently, the fund invested 5 million euro in Apogeo Space, an Italian company engaged in the design and production of nano-satellites for a constellation of more than 20 satellites for Internet of Things (IoT) services. Recently, Primo Space has announced three new investments in Italian space companies, including Irreo and Eoliann, specialised respectively in software for precision agriculture and in forecasting and assessing the impact of natural disasters.

These are important results that place Italy among the most dynamic countries in Europe, although Rome is by the weakness of the Italian venture capital sector that places the country behind partners such as Germany, France or Spain.⁴¹ These early results include the creation of seed and pre-seed accelerators⁴² as well as ESA-related startup accelerators,⁴³ and they need to be supported in order to let new, sound, industrial and commercial entities emerge, not only at the national level. Such commitment and interest in the sector will necessarily have to build on a dynamic ecosystem of public and private investors, leveraging both on traditional as well as innovative tools. In this regard, the E. Amaldi Foundation, an ASI spin-off created in 2017 to promote research and technology transfer in collaboration with the New Space sector, is also active in Italy.

⁴⁰ See the official website: <https://www.primo.vc/it/primospace>.

⁴¹ Interview, 21 March 2023.

⁴² These terms refer to the life cycle of a startup, which includes the following stages: "bootstrap" or "pre-seed", "seed", "early stage", "growth", and "scale up". For further discussion see Salvatore Viola, "Gli step nel ciclo di vita di una startup", in *StartUp News*, 19 January 2023, <https://www.startup-news.co.uk/?p=13298>.

⁴³ Interview, 21 March 2023.

2.3 The National Recovery and Resilience Plan (NRRP) and IRIDE

The space economy in Italy is experiencing significant changes, which are facilitated by a reorganisation of the national space governance started in 2018 and driven decisively by the implementation of the NRRP, the introduction of more than two billion euro in funding, and new programmes. This positive contingency presents considerable opportunities for strengthening the national space value chain, as well as the Italian role in the European and global context. However, the introduction of such a vast plan presents clearly management and sustainability challenges in the medium and long term (particularly after the NRRP ends in 2026). Such challenges are related, among other things, with industry's ability to find sufficient resources to sustain growth over time, concerning, for example, investments made in new plants, but also in maintaining a higher employment level. It is therefore essential on the one hand to support the industry in finding business opportunities, on the other hand anchoring the demand for space services to national and local public actors.⁴⁴

Within the NRRP, IRIDE is the standout programme, developed in collaboration with ESA and with the support of ASI. It aims at developing a constellation of over 60 satellites equipped with various types of observation and detection instruments.⁴⁵ The ambition of the programme is to consolidate Italy's position in the EO segment through investments of approximately one billion euro coming from NRRP's Mission 1 (Digitalisation), to be completed by 2026. This infrastructure would significantly increase the coverage and quality of EO over the Italian territory. IRIDE proposes innovative applications primarily for the public administration, ranging from climate change mitigation to environmental and coastal protection and critical infrastructure monitoring. It also opens up various possibilities for innovation and customisation of applications by commercial actors.⁴⁶

The development of the IRIDE satellite constellation involves the national industrial sector through specific agreements for satellites manufacturing. This engagement includes not only space traditional prime contractors, but also emerging entities within the national SME ecosystem, capable of providing cutting-edge technologies and, in the long term, consolidating their activities and expertise in the international market. Additionally, the management of data access infrastructure and services for IRIDE is key for the programme, considering the current trend of robust growth in the demand for EO satellite data. Furthermore, the gradual deployment of the satellite constellation will be entrusted to the Vega C launcher developed by Avio, thereby fulfilling the demand for services across the entire space value chain in Italy. This will create a public demand to anchor the

⁴⁴ Interview, 14 April 2023.

⁴⁵ ESA, *IRIDE: La squadra è al completo*, 12 April 2023, https://www.esa.int/Space_in_Member_States/Italy/IRIDE_La_squadra_e_al_completo.

⁴⁶ Planetek Italia website: *IRIDE Constellation*, https://www.planetek.it/eng/projects/iride_constellation.

programme's development and technological growth in the sector.

More broadly, within the field of EO, especially concerning services and applications, the sector is increasingly opening up and intersecting with other non-traditionally space-related business sectors, ranging from banking and finance to insurance.⁴⁷ It even extends to the circular economy, creating potential new markets and growth opportunities for Italy.

IRIDE is complemented by other innovative programmes funded to strengthen national capabilities in strategically important sectors. Of particular significance is ASI's programme to carry out Italy's first in-orbit servicing mission. This mission has been assigned to a consortium of companies and aims to develop key technologies for sustainability and in-orbit manoeuvres, such as deorbiting, repositioning, refuelling and assembly of infrastructure and satellites, with a value of approximately 235 million euro.⁴⁸ Finally, ASI is advancing the Space Factory 4.0 programme in collaboration with the industrial sector, with an initial budget of 57 million euro and investments from private entities involved in a public-private partnership. This programme aims to enhance satellite production capacity in the national territory and facilitate automation and digitisation processes.⁴⁹

2.4 Conclusion

The unprecedented amount of funding, combined with commitments at national and European levels, thus sets the stage for an exceptional season for the Italian space sector. Following such fruitful period, a phase of maintaining and revitalising activities in the long term should follow. In perspective, it is important to find tools to support the growth of SMEs in the sector, promote industry scalability, create agile mechanisms for generating public demand and sharing business risks, and attract and retain human capital. Italian companies still face difficulties in finding enough specialised personnel with the technical skills required to meet the sector's expansion needs. Furthermore, there will be an increasing demand for profiles not traditionally associated with the space sector, including those with cross-functional skills (e.g., project management). This demand will depend on the convergence of the space economy with other business sectors and the impact of technological innovation on the entire space industry, from using big data analysis and artificial intelligence to process and integrate satellite data (and more), to machine learning

⁴⁷ Jules Varma and Rodolfo Zontini, "The Global Space Economy: Definition, Evolution and Forecasts", in Fabrizio Botti and Ettore Greco (eds), *The Geopolitics of Space*, Rome, IAI, June 2023, p. 18-38, <https://www.iai.it/en/node/17132>; IAI seminar on "The Geopolitics of Space - The Economy of Space: Evolution and Forecast", 22 November 2022, <https://www.iai.it/en/node/16226>.

⁴⁸ Thales Alenia Space, *A Consortium of Companies Led by Thales Alenia Space Signs Contract with Italian Space Agency for an In-Orbit Servicing Demonstration Mission*, 15 May 2023, <https://www.thalesaleniaspace.com/en/press-releases/consortium-companies-led-thales-alenia-space-signs-contract-italian-space-agency>.

⁴⁹ ASI, *Grazie ai fondi del PNRR l'Agenzia Spaziale Italiana affida a diversi contraenti la realizzazione della Space Factory*, 30 March 2023, <https://www.asi.it/?p=40243>.

and quantum computing.

An update of the national Strategic Space Economy Plan, originally launched in 2016 and updated for the first time two years later may complement the needs outlined above. The document should be revised in light of new contexts and challenges faced by the Italian space sector, in order to define priorities, strategic objectives and tools for the future. Another crucial step that should help provide clarity in this regard is the definition of a space law announced by the Minister for Enterprises and Made in Italy, with responsibility for space, Adolfo Urso. The law, scheduled on the legislative agenda for January and February 2024, would have the task of “framing the areas of activity of private actors in space”,⁵⁰ regulating other areas such as data security and environmental sustainability in space. This context also includes the dimension of security, especially in view of a renewed push for New Space activities, which do not necessarily adhere to pre-established security requirements, despite a relatively greater focus on adopting systems that are secure by design. In this sense, the definition of a regulation, also in light of an impulse from the EU Space Strategy for Security and Defence, could ensure that private and commercial activities do not compromise space sustainability, safety and security.

⁵⁰ Antonello Salerno, “Space Economy, Urso: ‘Italia protagonista, nuova legge in tempi rapidi’”, cit.

3. Cooperation with the United States

by Giancarlo La Rocca

The cooperation between Italy and the United States in space has a long history of more than sixty years, formally beginning in 1962 with a memorandum of understanding. The document signed in Rome by the then-Vice President Lyndon Johnson marked the agreement with Washington on the San Marco programme, which would lead to the launch of Italy's first satellite into orbit two years later, carried by a Scout rocket from Wallops Island on the east coast of the United States. The project placed Italy as the third country in the world to have launched a satellite that reached space, after those made by Moscow or Washington. Today, the relationship between Italy and the United States is particularly robust, supported by ASI, which has ensured since the Agency foundation international diplomatic representation and contributions to scientific and exploratory missions. Italian astronauts were the first Europeans to travel to the International Space Station (ISS), with Umberto Guidoni being the first, followed by Luca Parmitano, who also became the first European astronaut to command ISS operations, followed by Samantha Cristoforetti. These results have been achieved also thanks to the national industrial on the ISS, half of whose pressurised volumes were built in Italy.⁵¹

These achievements were made possible by Italy's collaboration with NASA's STS-46 and STS-52 Space Shuttle missions in 1992, which allowed for the first Italian spaceflight by Franco Malerba and the joint ASI-NASA LAGEOS II mission. The satellite for the same mission was launched into orbit using the Italian Research Interim Stage propulsion system, developed by the predecessors of Thales Alenia Space and Avio, key players in the Italian and European space industry.

This special partnership in space has been enriched since 2012 by the presence of a dedicated space attaché at the Italian Embassy in Washington and by agreements with the US Space Command in the field of defence. Recently, the General Space Office under the responsibility of the Chief of Defence signed another collaboration agreement for the assignment of an Italian liaison officer at the US Space Command. The officer's task in the framework of the cooperation with the US Command is to share knowledge and experiences with the US command, facilitate communications between space units, represent Italy in matters related to military space and support partnerships between the two countries in space and defence.⁵²

⁵¹ Shelli Brunswick, "From Galileo to the Lunar Gateway: Mapping Italy's Growing Space Industry", in *SpaceNews*, 19 April 2023, <https://wp.me/p5sx4f-CAk>.

⁵² US Space Command, *USSPACECOM, Italian Defence General Staff Sign Liaison Officer Agreement*, 19 April 2023, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/3368562>.

In general, the relationship between the two countries represents a strategic bilateral cooperation on multiple fronts, enabling Italy's presence in human space exploration, including at an industrial level. Such cooperation should be carefully balanced to avoid discrepancies with Rome's positioning in Europe, especially as Italy aims to return to the Moon in this decade.⁵³

3.1 Artemis and the Moon

The government's strategic priorities in space and aerospace presented in 2019 included human and robotic space exploration as national strategic sectors.⁵⁴ In this regard, the document emphasises the preeminent role of the Italian scientific and industrial community in the space sector, which should be maintained by ensuring Italy's presence in new exploration programmes, both through ESA and bilaterally, "primarily with NASA".⁵⁵ The strategic priorities mentioned possible cooperation in space exploration with Russia and China, considering China's significant growth in lunar missions with the Chang'e programme and its plans for a low Earth orbit space station. However, it is clear that these references were contingent on the historical and political moment in which the strategic document was created and are now set aside, both for Italy in its bilateral relations and for Europe in scientific relations with Moscow and Beijing, redirecting efforts toward traditional partners. Specific areas where Italy must ensure its role in space exploration include remote and in-situ investigation capabilities, lunar orbit presence and future human presence in space.

The government's strategic priorities, the first of their kind and particularly important for bringing space into the specific focus of the Prime Minister's office, have followed a positive implementation process. Already in the fall of 2019, during the International Astronautical Congress (IAC) in Washington, ASI signed a statement of intent with NASA for lunar return missions, making Italy the first European country to join the initiative. A year later, Italy announced the signing of the Artemis Accords adhering to a set of guiding principles for the new era of celestial body exploration. With the Accords, along with other European countries, parties committed to define the specifics of cooperation in subsequent implementation agreements entrusted to their respective space agencies. In June 2022, ASI signed a bilateral agreement during the 17th meeting of the Inter-ministerial Committee for Space and Aerospace Policies (COMINT), attended by NASA Administrator Bill Nelson. This marked a significant step forward in deepening cooperation in the Artemis programme and working on Lunar Surface Multi-Purpose Habitation (MPH) modules to enable more in-depth and long-term lunar exploration. As part of other ad hoc agreements, Italy was assigned to the manufacturing of certain

⁵³ Shelli Brunswick, "From Galileo to the Lunar Gateway", cit.

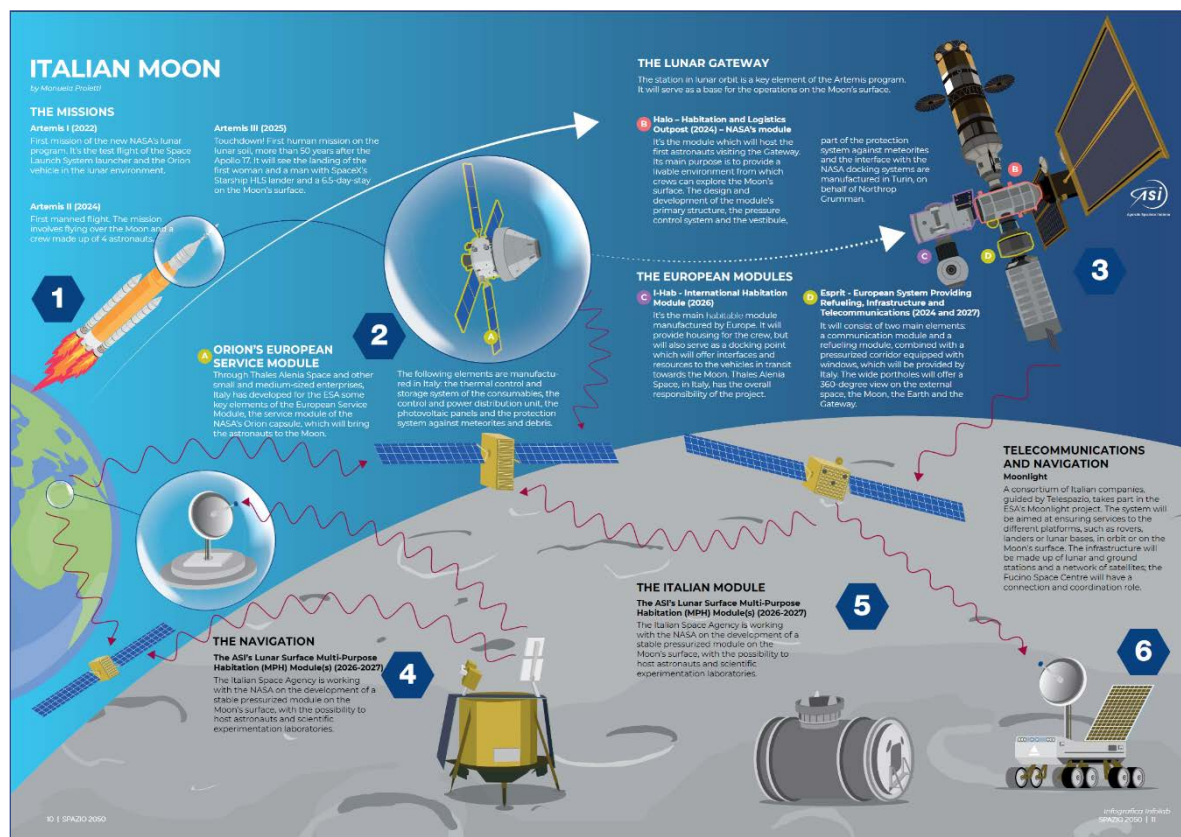
⁵⁴ Italian Government, *Government Guidelines on Space and Aerospace*, 25 March 2019, p. 5, https://presidenza.governo.it/AmministrazioneTrasparente/Organizzazione/ArticolazioneUffici/UfficiDirettaPresidente/UfficiDiretta_CONTE/COMINT/DEL_20190325_aerospazio-EN.pdf.

⁵⁵ Ibid.

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modules – International-Habitat (I-Hab), Habitation and Logistics Outpost (HALO) and European System Providing Refueling, Infrastructure and Telecommunications (ESPRIT) – for the Lunar Gateway, the lunar orbit station essential for facilitating surface operations and crucial for future missions to Mars.⁵⁶

Figure 5 | The Italian Moon technologies



Source: Manuela Proietti, "Italian Moon", cit.

Cooperation within the Artemis programme has initiated a series of positive developments in Italy's research and development sector. A notable example is ArgoMoon, an ASI CubeSat developed by Argotec. It is the only European CubeSat aboard the Artemis 1 mission launched successfully in November 2022, designed to provide images of launch operations.⁵⁷ Another innovation is the Lunar GNSS Receiver Experiment (LuGRE) project, developed in collaboration with NASA, aimed at enabling navigation and positioning systems on the Moon. This is particularly important for surface operations and landings.⁵⁸ Italy has also supported lunar

⁵⁶ Manuela Proietti, "Italian Moon", in *Spazio 2050*, No. 4 (June 2022), p. 10-11, https://issuu.com/globalscience.it/docs/ing_spazio.2050_june_2022.

⁵⁷ ASI, *Missione Artemis: Argomoon il fotoreporter lunare made in Italy scalda i motori sulla rampa di lancio per i test finali*, 18 March 2022, <https://www.asi.it/?p=29780>.

⁵⁸ ASI, *L'Italia muove un altro passo verso la navigazione lunare*, 2 March 2023, <https://www.asi>.

exploration components within ESA, starting with the ministerial councils in 2019 and 2022.⁵⁹ On these occasions, Italy stood out by signing an unprecedented number of contributions to programmes related to the Moon. One of these is the Moonlight project for the development of a lunar telecommunications and navigation system, a new European contribution to NASA's satellite communication programme between Earth and the Moon.

3.2 Space exploration and scientific missions

Bilateral cooperation with the United States has also resulted in the project on Light Italian CubeSat for Imaging of Asteroids (LICIACube), a satellite part of the Double Asteroid Redirection Test (DART) planetary defence mission. The success of this mission was recounted and documented by the Italian space sector.⁶⁰ The agreement between space agencies regarding deep space exploration also involves another strategic space infrastructure within Italy, the Sardinia Deep Space Antenna (SDSA), located in San Basilio (Cagliari). It has recently become part of NASA's Deep Space Network for interplanetary missions.⁶¹ Collaboration between ASI, the national research community and NASA is particularly active in scientific missions. Examples include the Imaging X-ray Polarimetry Explorer (IXPE) for studying the universe, launched in 2021, and the recent Multi-Angle Imager for Aerosols (MAIA) currently under development to study the impact of atmospheric pollution on public health.⁶²

3.3 Commercial agreements and New Space

The strong transatlantic institutional cooperation in the space sector has created numerous commercial and industrial spillovers. The National Research Council (Consiglio Nazionale delle Ricerche – CNR) and the Italian Air Force have partnered with Virgin Galactic for suborbital flights, a collaboration intended to create opportunities for the Grottaglie spaceport in Taranto. Furthermore, the private company Axiom has selected Italian Air Force Colonel Walter Villadei as an astronaut for upcoming human missions in orbit. A memorandum of understanding with Axiom signed in 2022 could identify new opportunities for cooperation, considering that the Texan company aims to launch a private station into orbit in the next three years, with modules developed by Thales Alenia Space

it/?p=39378.

⁵⁹ ASI, *CM22, sullo spazio l'Italia si conferma protagonista in Europa*, 23 November 2022, <https://www.asi.it/?p=36865>.

⁶⁰ ASI, *LICIACube: Here Come the First Images Captured by an Italian Satellite in the Deep Space*, 23 September 2022, <https://www.asi.it/en/?p=35249>.

⁶¹ ASI website: *Sardinia Deep Space Antenna-SDSA*, <https://www.asi.it/en/?p=17697>; ASI, *Annual Report 2022*, April 2023, p. 31, https://www.asi.it/wp-content/uploads/2023/07/Asi-Annual-Report_22_ENG_WEB.pdf.

⁶² ASI, *IXPE Mission: NASA and Italian Space Agency Still Together in Space, with INFN and INAF's Made in Italy Technology*, 9 December 2021, <https://www.asi.it/en/?p=27533>; NASA, *NASA and Italian Space Agency Join Forces on Air Pollution Mission*, 8 March 2023, <https://www.jpl.nasa.gov/news/nasa-and-italian-space-agency-join-forces-on-air-pollution-mission>.

Italia, confirming Italian expertise in the field and the success of cooperation initiated more than twenty years ago.⁶³ The aerospace industry is among the main areas of interest for the Italian Trade Agency office purposely established in Houston as the ultimate space centre.

This robust cooperation, which has seen consistent and progressive developments over time, transcends political fluctuations, thus providing stability. This is due to the efforts of respective space agencies and to space diplomacy, which are key to building a lasting relationship based on the recognition of each other's strengths. Looking ahead, despite the already highly positive and growing track record in cooperation activities, the Italy-United States relationship could benefit from further enhancement through ad hoc political agreements aimed at institutionalising a diverse space dialogue, addressing both ongoing areas of cooperation and new flagship projects. This would expand the prospects for collaboration, both bilaterally and within significant forums like NATO or the Combined Space Operations Initiative, offering substantial political support in a period marked by the increasing involvement of more and more states in space activities.

⁶³ Axiom Space website: <https://www.axiomspace.com>; Thales Group, *Thales Alenia Space to Provide the First Two Pressurized Modules for Axiom Space Station*, 15 July 2021, <https://www.thalesgroup.com/en/node/2739234>.

4. Europe and space

by Karolina Muti and Giancarlo La Rocca

4.1 European space governance: The ESA-EU duo

The institutional architecture that will shape European space governance in the coming decades is currently undergoing a redefinition. This governance revolves around finding a *modus operandi* among various stakeholders, particularly ESA, the EU and the member states of both organisations. This raises several strategic, political, industrial and technological questions.

In June 2021, the two organisations signed a Financial Framework Partnership Agreement (FFPA) aimed at defining the roles and responsibilities of key actors: the Commission, EUSPA, officially established in the same year, and ESA, which was to retain a certain level of autonomy.⁶⁴ However, the agreement may become outdated, given EUSPA expanding responsibilities and the potential reorganisation of ESA.

Key issues in terms of governance include:

- *Space as a component of greater European strategic autonomy:*⁶⁵ Space is seen as a critical component for achieving greater European strategic autonomy and technological sovereignty.
- *Transatlantic relations:* Many EU countries engaged in the space sector maintain strong transatlantic ties, as evidenced by collaborations such as the Artemis programme and the MoU between the United States and France.
- *Space and defence integration:*⁶⁶ The increasing integration of space and defence activities requires involvement from defence and interior ministries, national space agencies and the entire industrial sector, from large system integrators to SMEs and startups.

The EU is currently at a crucial stage in developing its space dimension, with an increasing role for the Commission in decision-making. In recent years, this process has accelerated through various initiatives, including the establishment of EUSPA, the Commission's Action Plan on synergies between civil, defence and space industries, and the presentation of a "space package" by the Commission in February 2022.

⁶⁴ ESA, *ESA and EU Celebrate a Fresh Start for Space in Europe*, 22 June 2021, https://www.esa.int/Newsroom/Press_Releases/Esa_and_Eu_celebrate_a_fresh_start_for_space_in_Europe.

⁶⁵ Daniel Fiott, "The European Space Sector as an Enabler of Eu Strategic Autonomy", in *In-Depth Analysis*, December 2020, [https://www.europarl.europa.eu/thinktank/en/document/EXPO_IDA\(2020\)653620](https://www.europarl.europa.eu/thinktank/en/document/EXPO_IDA(2020)653620).

⁶⁶ Alessandro Marrone and Michele Nones (eds), "The Expanding Nexus between Space and Defence", in *Documenti IAI*, No. 22|01 (February 2022), <https://www.iai.it/en/node/14669>.

In May 2021, EUSPA, an agency dedicated to implementing the EU space programme, was established in Prague. A few months earlier, the Commission published an 11-point Action Plan on synergies between civil, defence and space industries.⁶⁷ In February 2022, the Commission unveiled a so-called “space package”, including a joint communication on the EU approach to Space Traffic Management (STM)⁶⁸ and a secure communication system called Infrastructure for Resilience, Interconnectivity and Security by Satellite² (IRIS²) to be developed between 2023 and 2027.

In March 2022, the Strategic Compass endorsed by EU heads of state and government also marked a new level of ambition and awareness for Space Europe and its resilience, announcing a series of initiatives.⁶⁹ These include an EU Space Strategy for Security and Defence (EUSSD), unveiled in March 2023, new investments in protecting the Union’s space assets from intentional and unintentional threats, and the development of secure government satellite communications. The document also calls for a strengthening of the EU Satellite Centre (EU SatCen) by 2025 to enhance geospatial intelligence.

Looking at ESA, the last Ministerial Conference was held in Paris in November 2022, just a month after the Giorgia Meloni-led government took office, with the appointment of Minister of Enterprise and Made in Italy Adolfo Urso as the government’s representative for space activities. During the Ministerial Conference, Italy increased its contribution by 20 per cent over 2019, making up 18.2 per cent of the agency’s total budget.⁷⁰ Rome will lead the ExoMars Mars exploration mission and signed a joint statement with Paris and Berlin on the future framework for using European launchers. At the Ministerial conference emerged Synergies with the United Kingdom on the new Moonlight programme, part of the European contribution to Artemis. ESA is also involved in the management of Italian NRRP programmes, such as for the Iride constellation.

4.2 EU programmes, capabilities and initiatives

IRIS²: IRIS² aims to provide secure, autonomous and reliable government satellite communications. It envisages collaboration between the Commission and ESA. Indeed, the latter will be able to oversee the development and validation of IRIS² implementation activities and contribute through its optional programmes.⁷¹

⁶⁷ European Commission, *Action Plan on Synergies between Civil, Defence and Space Industries* (COM/2021/70), 22 February 2021, <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52021DC0070>.

⁶⁸ See Giancarlo La Rocca, Karolina Muti and Alessandro Marrone, “The EU Approach to Space Traffic Management”, in *Spaceways STM Briefs*, No. 3 (June 2022), <https://www.iai.it/en/node/15639>.

⁶⁹ European Council, *A Strategic Compass for Security and Defence*, 21 March 2022, <https://data.consilium.europa.eu/doc/document/ST-7371-2022-INIT/en/pdf>.

⁷⁰ ASI, *Annual Report 2022*, cit., p. 36.

⁷¹ European Commission, *IRIS² Industry Information Day - Presentation*, 31 March 2023, <https://>

EUSPA, on the other hand, is in the process of procuring the infrastructure of the GovSatCom Hub, which will be responsible for implementing the operational interface between the services arising from the hub and the users. The IRIS² programme also encourages SMEs and start-ups participation through the Small and Medium Enterprise Integration Plan. With the participation of Telespazio and through a higher contribution to optional ESA programmes, the broad involvement of Italian SMEs is possible, provided that the national space complex moves promptly and effectively within the cooperative and competitive European context.⁷²

The nature of IRIS² as an EU flagship programme and of its prospects remain however an open question. IRIS² should be seen as an EU strategic autonomy instrument, based on a robust institutional demand, rather than a chase after United States or European private constellations, also due to sustainability and safety of congested orbits. IRIS² The strong institutional demand in the intentions of the European Commissioner for Internal Market Thierry Breton, (under whose supervision the Directorate-General for Defence Industry and Space [DG DEFIS] operates), should be extended also to Africa. However, the positioning of IRIDE2 in the European and international markets remains unclear, also considering the timeframe envisaged for the programme's development and in particular its time-to-market.

Horizon Europe: The EU Horizon Europe programme for 2023–2024 includes funding for projects related to "Open Strategic Autonomy in Developing, Deploying and Using Global Space-Based Infrastructures, Services, Applications and Data", with a focus on quantum technologies in communications and gravimetry, as well as strengthening European space access capabilities and space surveillance and tracking (SST).

European Defence Fund (EDF): The Responsive European Architecture for Space (REACTS) project under EDF seeks to launch small satellites (between 20 and 200 kg) in various orbits, at least up to the distance of 400 kilometres, with short notice (up to 72 hours), to respond to operational and tactical needs of European armed forces and institutions. This capacity has important implications for intelligence, surveillance and reconnaissance (ISR) and for satellite communications (SatCom), where it is crucial to ensure the continuity of operational capability, including that of monitoring and responding to various threats, risks and events.⁷³ During the project, a concept of operations (ConOps) of the system will be defined. Twelve EU member states and Norway take part in the project, for a budget of 19 million euro. The initiative is coordinated by the German company OHB. The Italian partners

defence-industry-space.ec.europa.eu/node/446_en.

⁷² Interview, 16 May 2023.

⁷³ EU Funding & Tenders Opportunities Portal: *Responsive Space System* (EDF-2022-RA-SPACE-RSS), <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/edf-2022-ra-space-rss>.

involved in the consortium are Telespazio, D-Orbit, MBDA Italy and T41.⁷⁴

The ODINS'EYE II project, also under EDF, focuses on the development of a "space-based missile early warning" system. It can count on a budget of 96 million euro in funding and is coordinated by OHB as well.⁷⁵ The project should address tactical intelligence and missile defence needs, particularly toward ballistic missiles, hypersonic missiles and anti-satellite systems (ASAT). The programme is synergic with the Timely Warning and Interception with Space-based TheatER Surveillance (TWISTER) project under the Permanent Structured Cooperation (PESCO) framework.⁷⁶

4.3 Earth Observation and Africa

Italy has a significant interest in the relationship between ESA and the African continent, given its national interests in the broader Mediterranean region. ESA, indeed, collaborates with all the African countries' space agencies. The agency is part of the African Union's Advisory Council dedicated to space and it owns infrastructures in the continent. ESA is starting to involve Africa in its own meteorological activities,⁷⁷ for instance, using geostationary satellites to provide data related to the African continent. ESA investment in EO in Africa has increased in recent years, aligning with a significant growth of African countries' budgets dedicated to space activities. The later augmented by 80 per cent in the last six years.⁷⁸ Due to the climate change impact, the expertise, knowledge and lessons learned from space projects in Africa are beneficial in Southern Europe.

Initiatives like the Lisbon Manifesto on EO for Africa and Europe,⁷⁹ the EO Africa R&D Facility and the GMES and Africa programme demonstrate growing cooperation between the two continents in the field of EO. ESA hosts African researchers and organises dedicated training and participates in the EO Africa Network for international scientific collaboration.

⁷⁴ European Commission, *European Defence Fund: REACTS* (Factsheet), 26 June 2023, https://defence-industry-space.ec.europa.eu/system/files/2023-06/REACTS-Factsheet_EDF22.pdf. IAI is a subcontractor of the consortium.

⁷⁵ European Commission, *European Defence Fund: ODIN's Eye* (Factsheet), 26 June 2023, https://defence-industry-space.ec.europa.eu/system/files/2023-06/ODINS%27EYE%20II-Factsheet_EDF22.pdf.

⁷⁶ Italian stakeholders involved in the project include Leonardo, Thales Alenia Space Italy, MBDA Italy and the IAI, among others. Leonardo and IAI are in the consortium as full partners, with the remainder as subcontractors.

⁷⁷ Speech by Frederic Nordlund, Head of ESA's External Relations Department, during the conference: "Making Space Matter Summit", Brussels, 6 June 2023, <https://www.youtube.com/watch?v=bDYQpjgYS0E>.

⁷⁸ Ibid.

⁷⁹ Portuguese Presidency of the European Council, *The Lisbon Manifesto on Earth Observation for Africa and Europe*, Lisbon, 11 June 2021, <https://www.ptspace.pt/wp-content/uploads/2022/01/Manifesto-Europe-Africa-Space-Earth-Observation-High-Level-Forum-1.pdf>.

The Lisbon Manifesto on Earth Observation for Africa and Europe has been organised by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the Commission, ESA, EUSPA and the African Union Commission. The initiative resulted in an interesting example of institutional cooperation between the two continents.

The EO Africa R&D Facility has been launched jointly by ESA and the African Union Commission. It aims to support European-African collaboration in research related to EO applications and in the 17 one-year projects funded in 2022–2023.⁸⁰ Italy has only one collaborative project with Ethiopia, as do Poland and Germany, while the Netherlands is involved in four projects, France in three, and Spain and the UK in two.

The Global Monitoring for Environment and Security and Africa (GMES and Africa) is a joint programme of the Commission and the African Union Commission. It aims to strengthen and develop infrastructure for more coherent exploitation of EO data, technologies and services to support environmental and sustainable development policy in Africa and the Caribbean, with a focus on water and natural resources and marine and coastal areas.⁸¹

Italy's excellence in EO and the space sector in general makes Rome well-positioned to engage in such initiatives and strengthen diplomatic ties with African nations. These initiatives not only enhance Italy's diplomatic and scientific engagement but also help integrate the space sector more effectively into Italy's foreign and security policy.⁸²

⁸⁰ EO4Society, *EO AFRICA R&D Research Projects – Awarded Proposals (Second Call)*, 9 March 2023, <https://eo4society.esa.int/?p=21983>.

⁸¹ EU4OceanObs website: *GMES and Africa Programme*, <https://www.eu4oceanobs.eu/?p=2374>.

⁸² Karolina Muti, "Reach for the Stars: Bridging Italy's Potential in Space with Its Foreign and Security Policy", in *IAI Commentaries*, No. 23|01 (January 2023), <https://www.iai.it/en/node/16432>.

5. EU's space strategy for security and defence: An in-depth analysis

by *Karolina Muti and Giancarlo La Rocca*

5.1 Overview of contents

The European Union Space Strategy for Security and Defence (EUSSD)⁸³ aims to outline the actions needed to increase the resilience and security of space systems, and identify measures to deter and respond to threats, including cyber threats. The negotiation and definition of the EUSSD was entrusted to the European External Action Service (EEAS), which drafted the document and organised workshops with member states with the full involvement of the Commission. The document was published during the Swedish presidency of the Council of the EU on 10 March 2023. The EUSSD represents a unicum in the European space framework, considering that the previous 2016 Space Strategy for Europe⁸⁴ did not specifically address security and defence issues. Indeed, this kind of development was particularly awaited because of its relevance to the future of the EU space programme, considering the protection of Galileo, which is ready for an evolution to the second generation, and in view of the new IRIS² component.

The strategy gives a definition of the space domain, referring to the cyber component and radiofrequency links, as well as the ground and launch segments and user terminals. The document provides a space threat landscape that includes kinetic and non-kinetic threats, with a focus on cyber, which is considered a specific vulnerability of space systems. The High Representative and the Single Intelligence Analysis Capability (SIAC) are expected to prepare an annual classified report to track the evolution of counterspace capabilities. For what concerns the latter, the document clarifies the Italian commitment to avoid destructive tests of direct-ascent anti-satellite missiles, announced in April 2023.⁸⁵ The strategy approaches the issue of dual-use⁸⁶ from the perspective of on-orbit behaviours, which is not connected to the payload or owner's nature, but to how the object behaves in orbit.

The Commission envisions the development of an EU Space Law, which should build on the existing regulatory framework. The Commission aims to work with

⁸³ European Commission, *European Union Space Strategy for Security and Defence* (JOIN/2023/9), 10 March 2023, <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52023JC0009>.

⁸⁴ European Commission, *Space Strategy for Europe* (COM/2016/705), 26 October 2016, <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52016DC0705>.

⁸⁵ Italian Ministry of Foreign Affairs and International Cooperation, *Statement by Deputy Prime Minister Tajani on Italy's Commitment not to Conduct Destructive Direct-Ascent Anti-Satellite Missile Tests*, 6 April 2023, <https://www.esteri.it/en/?p=99261>.

⁸⁶ Dual use refers to those technologies, assets, services, systems or approaches that have both civilian and military applications.

member states to identify space services and systems deemed essential to the economic functioning of society and the security of national operations. The goal is to define and implement a common minimum level of resilience for critical space services and to develop coordinated national preparedness, resilience plans and contingency protocols. In this regard, the relevance of the inclusion of cybersecurity requirements “by design” in essential space systems is enhanced, as well as the application of non-specific space legislation (such as the NIS2 Directive on network and information security) and the so-called “Cyber Resilience Act”.⁸⁷

The strategy also envisages the creation of a US-modeled EU Space Information Sharing and Analysis Centre (ISAC),⁸⁸ supported by EUSPA, to share best practices and support measures with direct involvement of industry as well as public entities. The strategy dwells on the importance of systematically embedding space within the Union’s other key dossiers, such as the critical raw materials dossier and the European semiconductor regulation and addresses the security risks of the space sector and its supply chain, including from the perspective of foreign direct investment from non-EU countries.

The document includes a paragraph on the capabilities needed to ensure space access and resilience of on-orbit and ground systems. It specifically refers to “versatile and responsive launchers, space situational awareness services, in-orbit servicing and secured sovereign cloud dedicated to space services”.⁸⁹ A central chapter of the document concerns the pivot from SSA to Space Domain Awareness (SDA), which is a concept closer to the operational approach of the US military and NATO allies, that serves to detect, identify, characterise and attribute objects and threats in orbit. The paper also provides an interpretation of the mutual assistance clause (Art. 42.7 TEU) with respect to space that sets a high level of ambition: “Any Member State can invoke the mutual assistance clause enshrined in the EU treaties [...] should a space threat or incident amount to an armed attack on its territory”.⁹⁰

The strategy also aims to enhance the use of space systems and services for security and defence applications, including specific measures for military users, in the traditional areas of Earth observation, Positioning, Navigation and Timing (PNT), SatCom and SDA/SSA/SST. Additionally, the new EU government service for Earth observation acquires particular relevance, as it boasts improved security and defence requirements, where EUSPA covers a key role. The programmes also include the expansion of Copernicus, the Public Regulated Service (PRS) of Galileo, the EU Radio Navigation Solution (EURAS),⁹¹ in which Italy is involved, IRIS², and

⁸⁷ European Commission, *Proposal for a Regulation on Horizontal Cybersecurity Requirements for Products with Digital Elements* (COM/2022/454), 15 September 2022, <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52022PC0454>.

⁸⁸ See US Space Policy Directive-5.

⁸⁹ European Commission, *European Union Space Strategy for Security and Defence*, cit., point 2.4.

⁹⁰ *Ibid.*, point 3.2.

⁹¹ The goal of EURAS is to promote the development of the EU’s military positioning, navigation and synchronisation capabilities and cooperation by exploiting Galileo and the public regulated service.

SST assets, where Italy has a strong position. The development of human capital will be necessary for performing specific activities. Therefore, there is a need to leverage the large-scale partnership in the aerospace and defence sector of the Pact for Skills, as well as a new EU space academy, developed with the support of EUSPA.

The final section of the strategy concerns partnerships: with the United Nations on responsible behaviour, with the United States, with third countries (Canada, Norway, Japan), with NATO, based on the latest joint statement on EU-NATO cooperation in January 2023, where space is identified as an area for enhanced cooperation.

5.2 Observations

The EU Space Strategy represents a significant initial step towards a European-level reflection on space-related security and defence issues, both at the community and intergovernmental levels. A desirable paradigm shift within European institutions, that is gradually taking place, should take into account the perspective of security and defence, with the direct involvement of EUSPA, the Directorate-General for Defence Industry and Space (DG DEFIS) and the EEAS. Indeed, the resilience of EU space systems is essential for the related economic and commercial benefits for the Old Continent.

Although national agencies are not directly mentioned, the role of the Member States is evident. The midterm review of the Multiannual Financial Framework 2021–2027 of the Union, which could identify sectors for enhanced investments in the next 3–4 years, needs to be evaluated in terms of financing and economic planning.

Looking at implications for Italy, the in-orbit servicing sector mentioned in the strategy is among the main national objectives in space matters. Moreover, the emphasis on Earth observation capabilities positively highlights national activities, linked to the National Recovery and Resilience Plan (NRRP) and to the Italian industrial presence for the expansion of Copernicus. Italy is also actively involved in the development of the second generation of Galileo satellites and has a role, although minor, in the IRIS² consortium. In the cyber sector, the Italian industrial sector has a solid capability, with companies like Elettronica and Leonardo, being the prime contractor for the European Space Agency's Cyber-Security Operations Centre (C-SOC). In the SST sector, it is important to note the strong national component within the European consortium (EU Space Surveillance and Tracking – EUSST), as well as investments in the Flyeye telescope. Italy is at the forefront in both hard (sensors) and soft (data storage and analysis) capabilities in the field of SSA.

In addition to Italy, Belgium, Germany, and Poland are also involved in the French-led project.

Right before the publication of the strategy, the EU conducted the Stra 2023 exercise to test the European response mechanism in the event of a cyber anomaly in a Galileo satellite, involving all relevant institutional actors, and particular attention was dedicated to Italy, which hosts the Galileo Control Centre at Fucino. Other scenarios were also tested during France's AsterX 2023 exercise, which developed specific responses to cyber threats against space systems. The Italian Ministry of Defence's Space Operations Command (Comando delle Operazioni Spaziali – COS) participated along with counterparts from Belgium, Germany and the United States.

5.3 Space access: Launchers

In the strategy, the theme of launchers reflects the tensions among member states. Thus, it is treated with a contingent approach, with an emphasis on micro and mini launchers and only a reference to the Kourou launch site, overlooking the possibility of having European continental launch sites that could significantly enhance responsive launch capabilities. The latest launch of Ariane 5 on 5 July 2023, and some delays in Ariane 6 and Vega C, showed the existence of a capacity gap in Europe's space access, questioning the entire launcher policy adopted so far.

Indeed, the effects of the pandemic crisis and the Russia-Ukraine conflict contributed a shift from possible "European preference" for launchers, to being forced to turn to the US market to launch assets into orbit. The decision made in previous years to rely on Russian launchers for launching strategic capabilities such as Galileo now appears short-sighted. External shocks are accompanied by internal factors that complicate the security framework for space access in Europe, such as the long and cumbersome processes related to the development of Ariane 6 and Vega C. The capabilities of Ariane 6 and Vega C to respond to national and European institutional demand cannot be replaced by micro and mini launchers developed outside of ESA Ministerial Council Meetings, which are technically incapable of launching strategically valuable satellites like Sentinel and Galileo. The solution will have to envisage multiple interventions, addressing internal and external risk factors. At the same time, it should not blindly follow models like SpaceX, which are probably irreplicable in this century, because of the peculiar characteristics that led to their birth and success. Simplicity and clarity of objectives remain significant growth tools for space in Europe. However, it is also necessary to think outside the box when dealing with European programme development mechanisms and processes.

In this context, innovations could arise from the perspective of widespread and timely space access. The strategy indeed mentions "responsive launch systems". Drawing on a concept developed in the United States, the strategy aims to increase space deterrence through immediate response capabilities to address potential gaps in orbit capacity. In this regard, it will be important to support Italy's willingness to develop responsive launch capabilities, also utilising the Grottaglie site. Italy is involved in a broad consortium for the development of a Responsive Space System

funded by the European Defence Fund in this line of activity.⁹²

5.4 SSA and SDA

The strategy mentions the concepts of SSA (Space Situational Awareness) and SDA (Space Domain Awareness), which, however, need more precise definitions to ensure consistency. This implies an initial discussion among member states to establish shared definitions of key terms in the space sector, including SSA, SDA, SST and STM. Despite the publication of documents like the joint communication from the Commission on the EU's approach to STM in February 2022, differences persist among member states, within the European space community and EU institutions on how these terms are interpreted. For example, there is currently no shared European definition of STM.⁹³ Regarding EU space law, Italy lacks comprehensive space legislation, and it would be important to clarify the government's efforts in this regard, as it could lead to a parallel national and European regulatory framework for space.

5.5 Response to space threats and incidents: Article 42.7

EUSPA is identified as the key technical and operational actor in the European space security context plays a central role in responding to threats from and in space, with a concentration of competencies and a strengthening of its security component. This is evident in Decision 698 of 2021, which the strategy proposes to amend in favour of a direct reference to EUSPA's role in protecting the entire European space programme. This is also reflected in the expansion of EUSPA's Security Monitoring Centres beyond the scope of Galileo alone. ESA is mentioned sparingly and sometimes indirectly, with a reference to the EDA-ESA-Commission task force created in 2008, which is expected to be reactivated with new initiatives. However, this task force has had limited effects despite the need for better coordination among these actors.

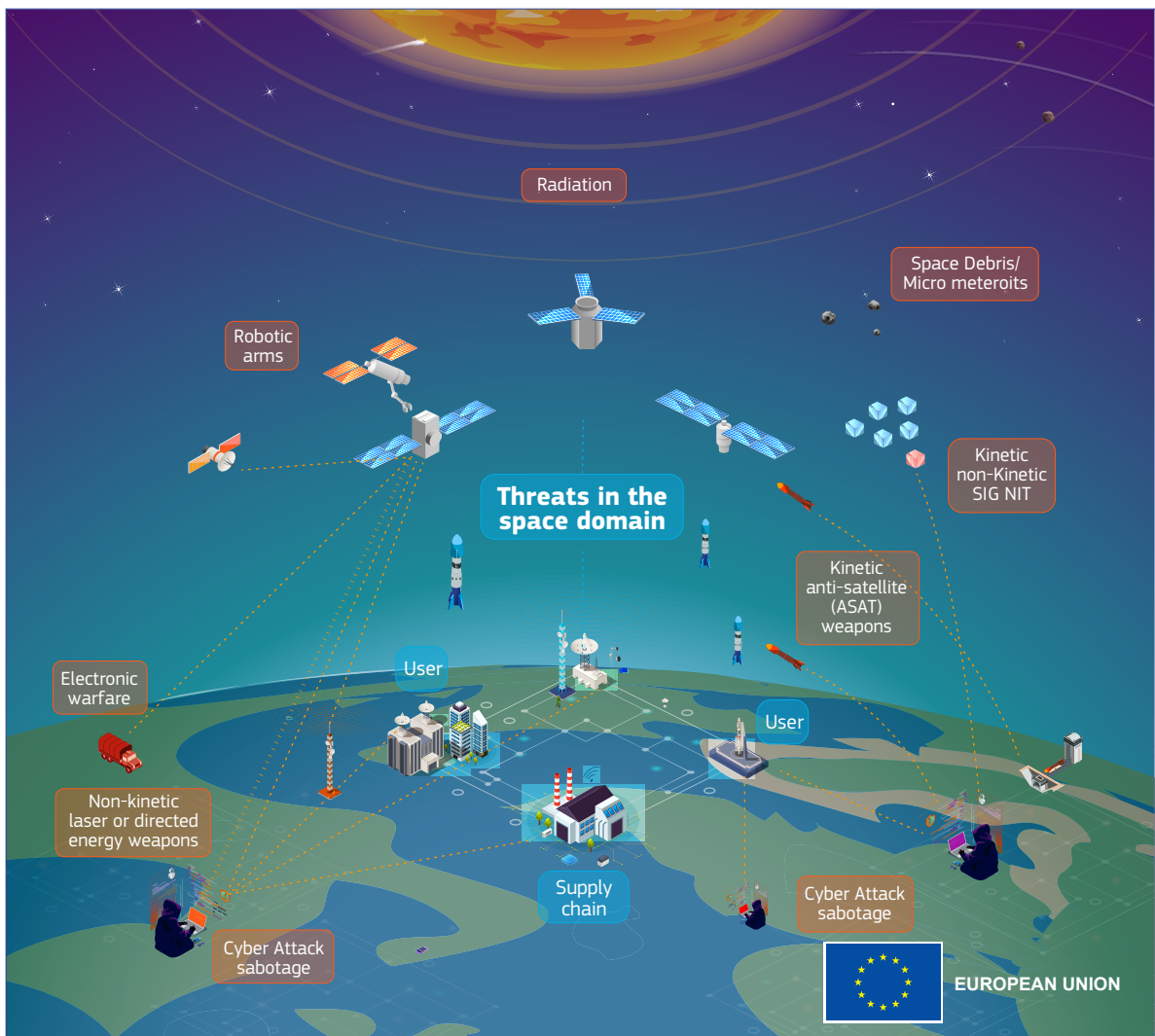
The strategy indicates that in the event of a threat from space or an incident equivalent to an armed attack on the territory of a member state, Article 42.7 of the Treaty on European Union (TEU) can be invoked for mutual defence within the EU. This implies at least two considerations. Firstly, Article 42.7 has only been invoked once since its entry into force, in 2015 following the terrorist attacks in Paris, and it is considered of dubious practical utility in the event of an armed attack by a significant portion of the security expert community. In such cases, EU member states, the vast majority of which are also NATO members, would rely on Article 5 of the Washington Treaty, which establishes collective defence for allied territory and is considered a more credible guarantee by allies. The NATO's interpretation of Article 5 explicitly includes cyber and space attacks, whereas the EU strategy remains more ambiguous regarding the activation of Article 42.7, which has so far

⁹² EU Funding & Tenders Opportunities Portal: *Responsive Space System*, cit.

⁹³ See in this regard rationale and results of the Spaceways project: <https://spaceways-h2020.eu>.

only referred to cases of armed attack on the territory of a member state.⁹⁴ Regarding the activation of Article 42.7 in the event of a space threat or incident, the strategy states that: “Any Member State can invoke the mutual assistance clause enshrined in the EU treaties (Article 42.7 of the Treaty of the European Union), should a space threat or incident amount to an armed attack on its territory”.⁹⁵

Figure 6 | Threats in the space domain



Source: UE, *Infographics - Threats in the Space Domain*, 9 March 2023, https://defence-industry-space.ec.europa.eu/node/437_en.

⁹⁴ Speech by Daniel Fiott at the seminar on “EU-NATO Cooperation: Competition or Complementarity?”, 15 February 2023, <https://www.nupi.no/en/events/2023/eu-nato-cooperation-competition-or-complementarity>.

⁹⁵ European Commission, *European Union Space Strategy for Security and Defence*, cit., point 3.2.

Therefore, while the strategy appears to clearly extend Article 42.7 to space, the chosen terminology and formulation allow for various interpretations regarding which space threats or incidents may “equivalate” to a conventional attack. It is necessary to identify which of the most likely space threat scenarios are equivalent to an armed attack, considering that this type of threat includes both attacks on in-orbit space systems and ground infrastructure, and may involve both kinetic and non-kinetic attacks.⁹⁶ Concerning counter-space operations in orbit, it is likely that non-kinetic attacks, especially cyber and electromagnetic attacks, will prevail in the future.⁹⁷

5.6 Response to space threats and incidents: Relationship with NATO

The extension of Article 42.7 to space threats and incidents represents an ambitious foreign, security and defence policy choice. It assumes a complex chain of command and multi-level decision-making, involving a wide range of private and public actors, both military and non-military. It is a complex process closely tied to the governance of the European space, which, in turn, involves the division of tasks and competencies. Nevertheless, three fundamental considerations can be made.

First, the traditional low credibility of the mutual defence clause will likely persist in this “space” context.

Second, many current hybrid threats operate below the threshold of armed attack, including in the space domain. Hence, many attacks may maintain a profile that does not make them directly comparable or “equivalent” to an armed attack.

Third, cyber and electromagnetic attacks are challenging to attribute. Some degree of ambiguity in the chosen wording may be deliberate to leave potential adversaries in doubt and discourage hostile actions, following the logic of deterrence. This is similar to the language, clear but rather generic, used in the interpretation of Article 5 of the Washington Treaty in its extension to the cyber and space domains – as endorsed by the Alliance’s Strategic Concept adopted by the allies in 2022, which fully integrated space into NATO’s deterrence and defence posture.⁹⁸ While Article 42.7 currently appears as a secondary and not entirely suitable instrument for addressing space threats, it raises the question of cooperation with NATO, as mentioned in the clause itself: “Commitments and cooperation in this area shall be consistent with commitments under the North Atlantic Treaty Organisation, which, for those States which are members of it, remains the foundation of their collective defence and the forum for its implementation.”⁹⁹

⁹⁶ Non-kinetic attacks include, for example, acts of electronic warfare and cyberattacks.

⁹⁷ Ottavia Credi, Giancarlo La Rocca and Alessandro Marrone, “Il dominio spaziale e la minaccia cyber”, in *Documenti IAI*, No. 23|06 (March 2023), <https://www.iai.it/en/node/16806>.

⁹⁸ Alessandro Marrone, “NATO’s New Strategic Concept: Novelties and Priorities”, in *IAI Commentaries*, No. 22|30 (July 2022), <https://www.iai.it/en/node/15667>.

⁹⁹ See Article 42: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:12008M042>.

With EUSPA's increased responsibilities for protecting EU space systems and responding to attacks, it will be essential to define and clarify the decision-making and command chain for scenarios involving a counterspace attack, particularly in relation to NATO, due to the ambiguities of the mutual defence clause and the extension of Article 5 to assets in orbit. Coordination with the Alliance is encouraged by the growing number of states that are members of both organisations, particularly after Finland's accession and the prospective membership of Sweden. Furthermore, as previously mentioned, the joint NATO-EU declaration in 2023 identifies space as one of the areas where cooperation between the two organisations should be strengthened and announces the creation of a joint task force for the protection of critical infrastructure (of which space systems are undoubtedly a part).

In light of these considerations, the references to cooperation with NATO in the strategy appear somewhat subdued. For unresolved operational issues on how to respond to a space threat, it would be particularly important to ensure that the "parallel and coordinated" exercises organised by the two institutions "include" a component related to the space domain and not merely "could include",¹⁰⁰ as demonstrated by the role of space in the conflict in Ukraine.¹⁰¹ A dialogue on these aspects between EU-appointed institutions (EEAS, EUSPA, DG DEFIS) and NATO would be necessary, especially considering that the NATO Space Centre of Excellence in Toulouse is now operational. Member states of both organisations, particularly through their respective Ministries of Defence, should facilitate this kind of coordination, considering their frontline role in crisis scenarios.

5.7 Partnership with the United Kingdom

Regarding partnerships with non-EU countries, alongside Norway and Canada, the absence of an important NATO member located in Europe, such as the United Kingdom, is notable. This poses challenges both from a European and Italian perspective. From a European standpoint, the United Kingdom is a crucial actor in the fields of security, defence and aerospace. Seven years after the Brexit referendum, the difficulty in finding a new *modus operandi* in the relations between the EU and London negatively impacts the EU-ESA relationship, in particular. For Italy, the partnership with the United Kingdom is particularly important because the two countries have a long-standing cooperation in the aerospace sector. In addition to this, both Italy and the United Kingdom participate in NASA's Artemis programme, and synergies have been observed with London, especially regarding the Moonlight programme.

¹⁰⁰ European Commission, *European Union Space Strategy for Security and Defence*, cit., point 5.5.

¹⁰¹ Giancarlo La Rocca, "Il fronte spaziale della guerra in Ucraina", in *AffarInternazionali*, 27 May 2022, <https://www.affarinternazionali.it/?p=98311>. In the case of an entry of Ukraine into the EU, the invasion of the Russian Federation would be one of the cases where Art. 42.7 TEU could apply and where EUSPA would have to intervene to protect space assets.

6. Cybersecurity of space systems: National governance and considerations on risks and vulnerabilities

by Ottavia Credi

6.1 Regulatory and institutional framework

Cybersecurity for space systems encompasses two distinct yet deeply interconnected dimensions: the space domain and the cyber domain. This connection is evident from the evolving regulatory framework governing activities in both areas, which are of fundamental importance for a country's growth.

The legislative decree No. 105 of 21 September 2019 (later converted into Law No. 133 of the same year), introduced measures concerning the National Cybersecurity Perimeter.¹⁰² The objective of the Perimeter is to protect national computer networks, systems and services from the risk of aggressive actions conducted in cyberspace. Subsequently, with the Prime Minister's decree No. 131 of 30 July 2020, space was included among the sectors falling within the National Cybersecurity Perimeter. Consequently, public and private entities operating in the space sector are required to provide an annual list of assets considered strategic for their sector and subject to adequate cybersecurity standards.¹⁰³

In parallel, the National Security Strategy for Space, issued in 2019 by the Presidency of the Council of Ministers, established guidelines for the security of space systems.¹⁰⁴ The strategy also addresses cyber threats, notably computer and electromagnetic attacks.

The National Agency for Cybersecurity (Agenzia nazionale per la cybersecurity – ACN) was officially established by the legislative decree No. 82 of 14 June 2021 (later converted into Law No. 109), responsible for governing the management of the country's activities in cybersecurity.¹⁰⁵ In May 2022, the agency published the

¹⁰² Italian Chamber of Deputies-Research Department, *D.L. 105/2019: Perimetro di sicurezza cibernetica*, 11 November 2019, <https://temi.camera.it/leg18/temi/d-l-105-2019-perimetro-di-sicurezza-nazionale-cibernetica.html>.

¹⁰³ Decree of the President of the Council of Ministers No. 131 of 30 July 2020: *Regolamento in materia di perimetro di sicurezza nazionale cibernetica*, Art. 3, <https://www.normattiva.it/uri-res/N2Ls?urn:nir:presidente.consiglio:decreto:2020;131>; website of the Italian Ministry of Enterprises and Made in Italy: *Perimetro Sicurezza Cibernetica*, <https://atc.mise.gov.it/index.php/sicurezza/perimetro-sicurezza>.

¹⁰⁴ Italian Government, *National Security Strategy for Space*, 18 July 2019, https://presidenza.governo.it/AmministrazioneTrasparente/Organizzazione/ArticolazioneUffici/UfficiDirettaPresidente/UfficiDiretta_CONTE/COMINT/NationalSecurityStrategySpace.pdf.

¹⁰⁵ Decree of the President of the Council of Ministers of 14 June 2021: *Disposizioni urgenti in materia di cybersicurezza, definizione dell'architettura nazionale di cybersicurezza e istituzione dell'Agenzia per la cybersicurezza nazionale*, <https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legge:2021;82>. See also the speech of Gianluca Galasso, Italian National Cybersecurity Agency Head

National Cybersecurity Strategy 2022-2026, which identifies various types of risks and actions to enhance the country's cybersecurity.¹⁰⁶ The strategy aims to achieve 82 measures over four years through a dedicated implementation plan.¹⁰⁷ Among these measures is the goal of developing national and European technology for innovative and sensitive sectors, including the space domain. In June 2023, the ACN published its Annual Report to Parliament for the year 2022.¹⁰⁸ While it does not specifically reference space systems, it emphasises the need to ensure high levels of cybersecurity and cyber resilience for critical national infrastructures that enable essential services for the state and its citizens. This is particularly important due to the observed increase in malicious activities targeting these infrastructures. One recent development in the regulatory framework relevant to both the space and cyber domains is an agreement signed by ASI and the State Police in April 2023 for the prevention and counteraction of cybercrimes.¹⁰⁹ The agreement aims to enhance the security of networks and information systems supporting ASI's institutional functions through the sharing of information for a timely response to potential cyber threats and the strengthening of risk prevention and analysis activities in cyberspace.

6.2 Risks and vulnerabilities

A space system consists of several segments, including the ground segment (infrastructure supporting devices in orbit) and the space segment (satellites in orbit). When assessing the different vulnerability levels of these segments to cyber threats, a cost-effectiveness logic can be applied. In other words, an adversary conducting an attack is likely to target the segment that would suffer the most damage relative to the adversary's available resources.

Ground infrastructures are considered the computing centres of space systems. The design of control centres is meticulous, especially for military components, and includes rigorous security studies, including cybersecurity.¹¹⁰ However, the risk of aggression is not negligible. Ground segments connected to the public network, such as those of some major space industries, are considered more vulnerable to cyberattacks.¹¹¹ Among the various elements that make up the ground segment,

of Operations, at the IAI conference on "La minaccia cyber allo spazio", 14 March 2023, <https://www.iai.it/it/node/16684>; For more information on ACN, see the official website: <https://www.acn.gov.it>.

¹⁰⁶ ACN, *National Cybersecurity Strategy 2022-2026*, April 2022, https://www.acn.gov.it/ACN_EN_Strategia.pdf.

¹⁰⁷ ACN, *Implementation Plan: National Cybersecurity Strategy 2022-2026*, April 2022, https://www.acn.gov.it/ACN_EN_Implementazione.pdf.

¹⁰⁸ ACN, *Annual Report 2022*, 19 June 2023, <https://www.acn.gov.it/en/agenzia/relazione-annuale>.

¹⁰⁹ ASI, *Polizia di Stato e Agenzia Spaziale Italiano siglano l'accordo sulla prevenzione e il contrasto dei crimini informatici*, 4 April 2023, <https://www.asi.it/?p=40337>.

¹¹⁰ Interview, 16 May 2023.

¹¹¹ Ibid. This is somewhat different for military control centres, such as the Italian System for Confidential Communications and Alerts (SICRAL). See the website of the Italian Ministry of Defence: *Il sistema SICRAL*, <http://web.archive.org/web/20211208064007/http://www.difesa.it/Content/Manifestazioni/FORUMPA/2004/SistemaSICRAL/Pagine/default.aspx>.

ground antennas used for controlling assets in orbit are particularly exposed to this type of threat.¹¹²

The space segment, generally disconnected from networks, is considered to be less vulnerable to cyberattacks. It has fewer points of connection and a relatively limited bandwidth compared to terrestrial networks.¹¹³ To launch a hypothetical cyberattack on a satellite in geostationary orbit (about 30,000 kilometres from Earth), significant resources would be required, including a high-power ground antenna.¹¹⁴

Compared to other computer systems, those in orbit are therefore considered less sophisticated but more robust, with fewer entry points, making satellites safer and less vulnerable to cyberattacks. Even in satellite constellations, the lack of communication between different assets helps limit the consequences of a cyberattack to widespread malfunctions, resulting in a reduction in service performance.¹¹⁵

According to these considerations, it is possible to consider satellites in orbit relatively cyber-secure, when compared with the ground infrastructure. However, while a cyberattack on a space system is considered unlikely, it is highly risky.¹¹⁶ In other words, there is a low frequency of attacks but a high probability of success, with potentially disruptive consequences. If an adversary were to gain control of a satellite, they could, for example, modify its configuration parameters, including payload settings.

6.3 Recent developments

The cyber threat to space is a global issue, made particularly serious by the gradual and constant technological progress in the space domain.¹¹⁷ Recent developments suggest a future where fiber-optic communications will be integrated with satellite communications.¹¹⁸ However, there is a tendency among actors in the space sector to protect information about their cyber vulnerabilities, coupled with insufficient data sharing by national government entities, as well as at the EU and ESA levels. This often results in an incomplete understanding of the cybersecurity risks affecting space systems and, consequently, a general underestimation of the threat.¹¹⁹

¹¹² Interviews, 16 May 2023 and 19 May 2023.

¹¹³ Interview, 16 May 2023.

¹¹⁴ Ibid.

¹¹⁵ Ibid.

¹¹⁶ Ibid.

¹¹⁷ Interview, 29 May 2023.

¹¹⁸ Ibid.

¹¹⁹ Interview, 19 May 2023; Ottavia Credi, Giancarlo La Rocca and Alessandro Marrone, "Il dominio spaziale e la minaccia cyber", cit.

Nonetheless, some positive developments are worth noting. A constructive example at the European level is the third edition of the CySat exercise organised by ESA.¹²⁰ This event, entirely dedicated to cybersecurity for the European space industry, included the simulation of a cyberattack against Ops-Sat, an ESA nanosatellite. Through this exercise in “ethical hacking”, ESA aims to strengthen the cybersecurity of its assets in orbit, protect hosted data, and make onboard applications more resilient to potential cyberattacks.

There is also increasing attention to the cyber threat to space in the United States, with the US Senate reintroducing legislation in May 2023 that requires the Department of State to work to prevent cyberattacks on commercial satellites.¹²¹ The same year, the National Institute of Standards and Technology (NIST) published the document “Introduction to Cybersecurity for Commercial Satellite Operations”, detailing some cybersecurity measures applied to commercial satellites.¹²²

6.4 Next steps

Considering the evolution of the cyber threat and risks in space, it would be advisable for governments to invest efforts and resources in protecting space assets and infrastructure, with a view to gradually harmonising various national measures at the supranational level. This aligns with the strategic intervention lines listed in the National Security Strategy for Space, which includes “adequate and sustainable investments” to protect the development of industrial and scientific activities in space.¹²³

When evaluating possible actions to enhance the protection and resilience of space systems against cyber threats, it is important to remember that there are no one-size-fits-all solutions. Countermeasures need to be adapted to the adversary conducting the attack.¹²⁴

Two areas where Italy could invest are highlighted. The first involves the need for space systems to incorporate cybersecurity requirements from the design phase, adopting a security-by-design approach, all the way to the end of the production chain.¹²⁵ From a European perspective, the European Quantum Communication

¹²⁰ “Thales prende il controllo del satellite dimostrativo dell’Esa nel primo esercizio di cybersecurity di questo tipo”, in *Ansa*, 26 April 2023, https://www.ansa.it/sito/notizie/economia/business_wire/news/2023-04-26_126509698.html.

¹²¹ Marcia Smith, “Senators Reintroduce Satellite Cybersecurity Legislation”, in *SpacePolicyOnline*, 4 May 2023, <https://spacepolicyonline.com/?p=61918>.

¹²² Matthew Scholl and Theresa Suloway, *Introduction to Cybersecurity for Commercial Satellite Operations*, National Institute of Standards and Technology, July 2023, <https://csrc.nist.gov/pubs/ir/8270/final>.

¹²³ Italian Government, *National Security Strategy for Space*, cit., p. 5.

¹²⁴ Interviews, 19 May 2023 and 16 May 2023.

¹²⁵ Interview, 29 May 2023.

Infrastructure, known as EuroQCI, represents an ambitious initiative aiming to build an innovative communication system by integrating quantum technologies into conventional communication structures, both at the terrestrial network and space levels, ensuring complete coverage for the entire European system.¹²⁶ It is anticipated that the secure connectivity system IRIS² will benefit from this quantum infrastructure.

The second area of activity pertains to the integration of cybersecurity into governance processes, both at the corporate and institutional levels. The European Directive NIS2 (Network and Information Security), issued in December 2022, is a significant step towards institutional involvement in cybersecurity matters. It stipulates that all EU member states must respond to common threats uniformly.¹²⁷ At the national level, it would be desirable for the NIS2 to be implemented rapidly, with space included in the management of information technology and communication services. This would ensure that the entire industrial sector is bound to provide adequate methods of response to potential cyber threats.¹²⁸

updated 8 July 2023

¹²⁶ For more information see: ESA, "EuroQCI (European Quantum Communication Infrastructure)", in *eoPortal*, 27 January 2022, <https://www.eoportal.org/other-space-activities/euroqci>.

¹²⁷ See European Parliament and Council of the European Union, *Directive (EU) 2022/2555 of 14 December 2022 on Measures for a High Common Level of Cybersecurity across the Union*, <http://data.europa.eu/eli/dir/2022/2555/oj>.

¹²⁸ Interview, 29 May 2023.

Abbreviations

ACN	Agenzia per la cybersicurezza nazionale
AIAD	Federazione aziende italiane per l'aerospazio, difesa e sicurezza
AIPAS	Associazione delle imprese per le attività spaziali
ASAS	Association for Space-based Applications and Services
ASAT	Anti-satellite
ASI	Italian Space Agency
BIC	Business Incubator Centre
CDP	Cassa Depositi e Prestiti
CNR	Consiglio Nazionale delle Ricerche
COMINT	Inter-ministerial Committee for Space and Aerospace Policies
ConOps	Concept of operations
COS	Comando delle Operazioni Spaziali
COTS	Commercial-off-the-shelf
C-SOC	Cyber-Security Operations Centre
DART	Double Asteroid Redirection Test
DG DEFIS	Directorate-General for Defence Industry and Space
EDA	European Defence Agency
EDF	European Defence Fund
EEAS	European External Action Service
EO	Earth Observation
ESA	European Space Agency
ESPRIT	European System Providing Refueling, Infrastructure and Telecommunications
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EURAS	EU Radio Navigation Solution
EuroQCI	European Quantum Communication Infrastructure
EUSPA	European Union Agency for the Space Programme
EUSST	EU Space Surveillance and Tracking
ExoMars	Mars exploration mission
FFPA	Financial Framework Partnership Agreement
GNSS	Global Navigation Satellite System
GMES	Global Monitoring for Environment and Security
HALO	Habitation and Logistics Outpost
IAC	International Astronautical Congress
ICT	Information and communication technologies

I-Hab	International-Habitat
IOS	In-orbit services
IoT	Internet of Things
IRIS	Infrastructure for Resilience, Interconnectivity and Security by Satellite
ISAC	Information Sharing and Analysis Centre
ISR	Intelligence, Surveillance and Reconnaissance
ISS	International Space Station
ITA	Italian Trade Agency
IXPE	Imaging X-ray Polarimetry Explorer
LICIACube	Light Italian Cubesat for Imaging of Asteroids
LuGRE	Lunar GNSS Receiver Experiment
MAIA	Multi-Angle Imager for Aerosols
MPH	Multi-Purpose Habitation
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NIS	Network and Information Security
NIST	National Institute of Standards and Technology
NRRP	National Recovery and Resilience Plan
PESCO	Permanent Structured Cooperation
PNT	Positioning, Navigation and Timing
R&D	Research and Development
REACTS	Responsive European Architecture for Space
SatCom	Satellite Communications
SDA	Space Domain Awareness
SDSA	Sardinia Deep Space Antenna
SIAC	Single Intelligence Analysis Capability
SME	Small and medium-sized enterprise
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
STM	Space Traffic Management
TEU	Treaty on European Union
TWISTER	Timely Warning and Interception with Space-based Theater Surveillance
UK	United Kingdom
US	United States

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