Space Security

The learning unit offers a comprehensive exploration of space security, covering risks such as space weather and intentional threats, emphasising the importance of Space Situational Awareness, governance frameworks and the EU's role in promoting responsible behaviour. It also examines emerging space partnerships amidst geopolitical tensions, highlighting the need for collaboration in ensuring peaceful space exploration.

Dr Jana Robinson
Kristína Sikoraiová
František Avrat
Kelig Chappuis
Dr Jakub Pražák
Patrik Martínek
Nico Mastrangelo
Prague Security Studies Institute

Cite as: Dr Jana Robinson, Kristína Sikoraiová, František Avrat, Kelig Chappuis, Dr Jakub Pražák, Patrik Martínek and Nico Mastrangelo, "Space Security" in EUNPDC eLearning, ed. Niklas Schoernig, Peace Research Institute Frankfurt. Available at https://eunpdc-elearning.netlify.app/lu-08/, last modified 4 December 2025

The EU Non-Proliferation and Disarmament eLearning Course aims to cover all aspects of the EU non-proliferation and disarmament agenda. It's produced by PRIF with financial assistance of the European Union. The contents of individual learning units are the sole responsibility of the respective authors and don't necessariy reflect the position of the European Union.

Funded by the European Union

1. Introduction

Greetings from the authors

- **Jana Robinson**
  Jana Robinson: Managing director of the Prague Security Studies Institute
- **Kristína Sikoraiová**
  Kristína Sikoraiová: International Relations and Diplomacy
- **František Avrat**
  František Avrat Project Coordinator
- **Kelig Chappuis**
  Kelig Chappuis: Project Coordinator for PSSI's Space Security Program
- **Dr Jakub Pražák**
  Dr Jakub Pražák: Research Fellow in the PSSI's Space Security Program
- **Patrik Martínek**
  Patrik Martínek: Project Coordinator at PSSI
- **Nico Mastrangelo**
  Nico Mastrangelo: Student of PPE

Hello, my name is Jana Robinson and I am managing director of the Prague Security Studies Institute.

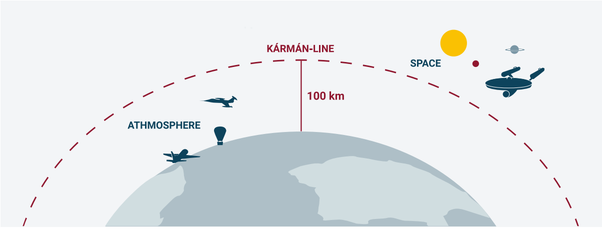
I'm delighted to provide you with a brief introduction concerning the space Security Learning Unit prepared in collaboration with the EU, non proliferation and Disarmament Consortium.

The learning unit was recently updated to reflect the latest developments in this crucial security field by our capable PSSI space security team, specifically **Kristína Sikoraiová**, **František Avrat**, **Dr Jakub Pražák**, and **Patrik Martínek**.

There is no question that space is now indispensable to every facet of national power. While more vulnerable, there's a large likelihood that a conflict is likely to be. Triggered in the space domain and trickled down to the terrestrial realm. After completing this unit, you will become familiar with.

Key issues concerning the Nexus of commercial and military activities and multilateral cooperation risks to safety of space operations, counter space capabilities, including those below the spectrum of traditional political or military responses. Space Situational awareness and Space domain awareness. Space governance. The European Union and space and the new space race and competition for international. Space partnerships. I hope that you enjoy it.

Outer space extends beyond the realms of celestial bodies and their atmospheres. For those observing from Earth, space is commonly considered to commence approximately 100 kilometres above sea level, known as the Kármán line. This conceptual boundary marks an altitude where the presence of air becomes negligible, devoid of enough density for breathing or scattering light.[1]

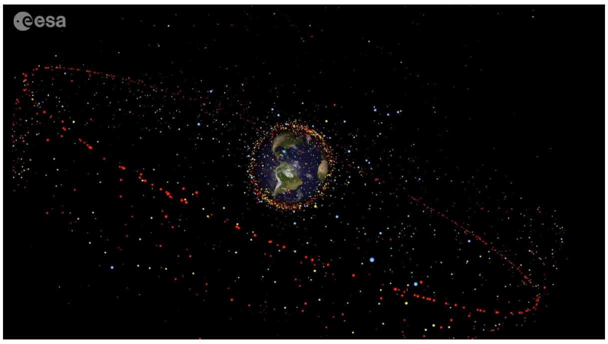


Grübelfabrik (CC BY NC)

Security concerns have accompanied space activities since their inception in the 1950s, with the successful launch of Sputnik 1 by the Soviet Union being widely seen as the start of the space age. The effective functioning of space assets for observation, early warning, navigation/timing, communications and an array of other security-related capabilities has proven essential to the preservation of international stability. Today, space is a global enabler with applications that have a profound impact on the daily lives of people and the prosperity of nations. Space has evolved from being an exclusively governmental domain to one that has embraced the private sector, including commercial satellite and launch owners/operators.

Space capabilities are indispensable for most aspects of modern life, providing services such as synchronisation of financial transactions, enabling transportation, providing weather forecasting, supporting smartphones and offering entertainment services. In short, satellite-based applications are fundamental to the day-to-day lives of an increasing number of people and are becoming an integral part of the global data infrastructure.

According to ESA there are currently around 9,000 operational satellites in orbit[2], owned by more than 80 countries[3], and the number is constantly growing.



Distribution of space debris in orbit around Earth
© ESA - European Space Agency

In fact, thousands of satellites are currently in the planning and development phase to provide new services such as space internet and 5G connectivity. The ability to access and use space is critical to the well-being of all nations and people.

Space junk, conceptual artwork
ROGER HARRIS/SCIENCE PHOTO LIBRARY

Space security involves a wide spectrum of topics, including safeguarding space assets and ground segments against a threat or disruption that could have significant implications for national security, defence and civilian applications, as well as normative aspects of responsible behaviour and international treaties governing space operations.

Space security encompasses:

- secure access to and use of space;
- security on Earth from threats originating in space.

Space threats emanate from:

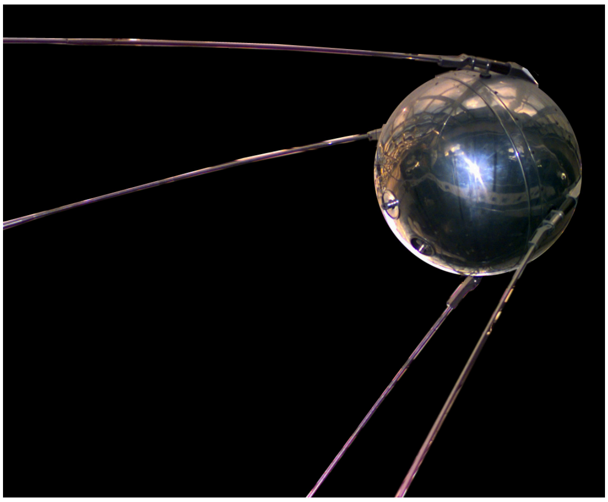
- natural hazards (e.g. space weather); technical mishaps (e.g. unintentional interference); and intentional actions;
- counterspace activities involving the development of multifaceted capabilities that could be used to disrupt, deny, degrade or destroy space systems.

Although the unit primarily focuses on space security, it is essential to underscore the nuanced but critical distinction between this and the concept of space safety. While space security predominantly addresses the safeguarding of space assets against deliberate threats and ensuring the resilience of space operations, space safety pertains more specifically to the establishment and maintenance of protocols and agreements governing safe interaction between human actors operating in the space domain.

To understand the intricate realm of space and its attendant security concerns, a comprehensive analysis of divergent viewpoints is indispensable. This necessitates a deep dive into the multifaceted dimensions of these different positions, encompassing commercial, military and multilateral outlooks.

Space commercialisation

The first use of space goes back to the early Cold War. This was an era dominated by the rivalry between the United States and the Soviet Union, placing national security space at the forefront of space activities.



Replica of Sputnik 1, USSR, the first artificial satellite to reach outer space
NASA/public domain https://commons.wikimedia.org/wiki/File:Sputnik_asm.jpg

The progressive development throughout the Cold War era showed that space technologies are inherently dual use. Moreover, space development has become a strategic and prestigious endeavour for powerful countries.[4]

As the Cold War ended, new opportunities arose for both military and civil collaboration, also demonstrating the benefits of public–private partnerships (PPPs). This has gradually led to the emergence of new space actors, both government and private.[5]

Historically, space activities were focused on big, time-consuming and very expensive projects, such as the James Webb telescope.

Photo of galaxies IC 2163 and NGC 2207 by the James Webb Space Telescope. Distance approx. 81 +/- 39 million lightyears
NASA/public domain

In recent years, with the entrance of the private sector and smaller countries that cannot afford such huge undertakings or investment risks, projects are less time-consuming and R&D-intensive, with a shorter duration of missions and fixed prices. This shift was enabled by the miniaturisation of satellites – CubeSats, which offer a cheap way of trying out a new technology, as well as cheaper access to space due to reusable launchers. These factors allow for more rapid technological demonstration in orbit rather than in the lab.[6]

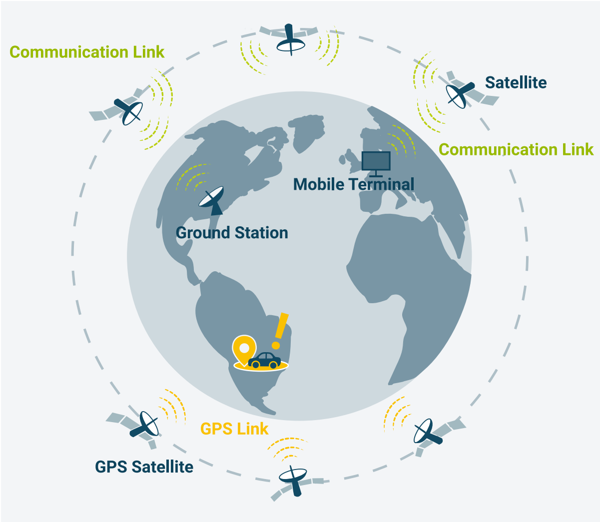
In the US, private investors, such as Elon Musk, Jeff Bezos and Richard Branson, have boosted interest in commercial space opportunities on the part of venture capital and private equity investors, now seemingly more willing to absorb the sizable risks related to space activities. Europe has adopted a number of measures to support new investment in start-ups, as well as early and mature space companies (e.g. via the European Investment Fund, the European Space Fund, etc.).

The military perspective on space security

The space domain holds significant importance for military operations due to various critical functions, offering an array of indispensable functionalities that underpin modern warfare. This strategic evolution, formally acknowledged by NATO in December 2019 through its recognition of space as an operational domain, underscores the integral role of space in joint military activities among allies and beyond.[7]

> …NATO and Allies, within their respective authority, are committed to ensuring the security of our communications, including 5G, recognising the need to rely on secure and resilient systems. We have declared space an operational domain for NATO, recognising its importance in keeping us safe and tackling security challenges, while upholding international law…
>
> London Declaration, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in London 3-4 December 2019

Satellites orbiting the Earth serve as the linchpin for global communication and navigation systems, forming the backbone of secure and reliable military communications. These satellites enable precision navigation during operations, providing essential support for troop movements, logistical coordination and strategic deployment.



Schematic drawing of how satellites enable communication and positioning via GPS above the earth
Grübelfabrik, CC BY-NC-ND 4.0

The advanced sensing technologies that space-based assets are equipped with play a pivotal role in surveillance and intelligence gathering. These capabilities provide real-time, high-resolution imagery, facilitating military situational awareness. Information derived from space-based sensors aids in threat detection, intelligence gathering and strategic decision-making, offering a substantial advantage in planning and executing military operations. The significance of space in missile warning systems cannot be overstated.[8] Infrared sensors positioned in space can detect and track missile launches across the globe. Early warning systems, predominantly based in space, enable swift responses and effective counter-measures against missile threats, ensuring rapid reaction in critical moments.[9]

Global Navigation Satellite Systems (GNSS), primarily composed of satellites in space, are indispensable for precise positioning, navigation and timing. Military operations, including the functioning of precision-guided weapons and logistical coordination, rely heavily on the accurate data provided by these satellites. The synchronisation and coordination enabled by GNSS serve as a force multiplier, significantly enhancing the effectiveness of military forces on the ground and in the air. Moreover, technologies such as reconnaissance satellites, weather monitoring systems and communication satellites contribute significantly to better-informed decision-making and the coordination of military operations in various terrains and scenarios.

The dual-use nature of space technology, originally developed for civilian purposes but adopted and adapted for military use, reflects the evolution of space as a vital theatre for both civilian and military endeavours. This duality fuels the interest in countering potential threats in space and emphasises the establishment of dedicated space forces and robust counter-measures to safeguard national security interests in this increasingly contested and vital domain.

1957–1980: The space race and the birth of space security concerns

1957 · Launch of Sputnik 1
The Soviet Union launches Sputnik 1, marking the beginning of the space age and initiating the space race.

1958 · Establishment of NASA
NASA is established in the United States, accelerating space exploration efforts.

1961 · Yuri Gagarin's Historic Orbit
Yuri Gagarin becomes the first human to orbit Earth aboard Vostok 1, a monumental achievement in space history.

1967 · Signing of the Outer Space Treaty
The Outer Space Treaty is signed, laying the foundation for international space law, emphasising peaceful uses of outer space, banning weapons of mass destruction in space, and promoting cooperation.

1969 · Apollo 11 Moon Landing
The Apollo 11 mission lands astronauts Neil Armstrong and Buzz Aldrin on the Moon, a historic moment for humanity.

1975 · Apollo-Soyuz Test Project
The Apollo-Soyuz Test Project fosters US-Soviet cooperation in space, showcasing potential for collaborative efforts in space exploration and setting precedents for cooperation.

1983 · Strategic Defense Initiative (SDI)
President Reagan's Strategic Defense Initiative (SDI) heightens discussions about space-based missile defence systems.

1990 · End of the Cold War
The end of the Cold War prompts a shift in space policies, encouraging cooperation and collaboration among former adversaries.

1991 · START I Treaty Signed
The START I treaty is signed, limiting strategic nuclear arms between the US and USSR and indirectly impacting space security discussions.

Multilateral cooperation in the space realm

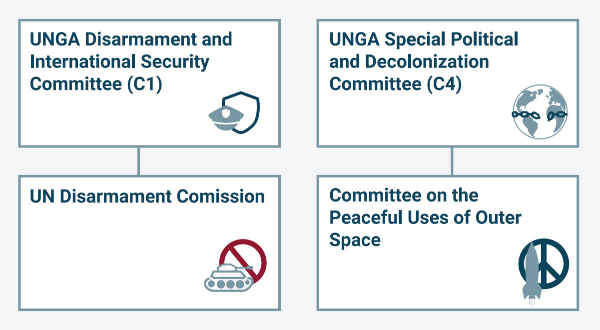
The multilateral dimension of space activities underscores the collaborative and cooperative efforts between nations in the exploration and utilisation of outer space. In an era marked by increasing international participation in space missions and growing reliance on space-based technologies, the importance of multilateral cooperation cannot be emphasised enough. This dimension encompasses a wide range of activities, from jointly planned and executed space missions to the sharing of scientific data, technology transfer and the establishment of international agreements to ensure the responsible and peaceful use of space

Secretary-General Boutros Boutros-Ghali celebrates 50th anniversary of the UN with Shuttle-Mir docking mission, 17 November 1995.
UN Photo/Milton Grant #966/CC BY-NC-ND 2.0

Some countries seek to capitalise on the benefits of space by operating their own satellites (e.g. Bangladesh, Indonesia, Malaysia, Pakistan, Singapore, Australia, Taiwan, South Africa, Mexico, Vietnam, Egypt, etc.), and some – not having indigenous space capabilities – are seeking to derive space-based benefits (e.g. many African countries). Countries with limited or no capabilities have often sought partnerships with China and/or Russia in the development of their space sectors, even if they are Western allies.[10]

To achieve their strategic goals, however, China and Russia repeatedly circumvent or even violate internationally negotiated norms. China has frequently been accused of industrial espionage[11], intellectual property theft[12] and heavily subsidised pricing, which are often a function of Chinese non-transparent ownership structures and unfair business practices.[13] As mentioned above, the construction of space infrastructure and proliferation of related technologies, equipment and services to other countries is a substantive part of both China's and Russia's strategic initiatives in space.

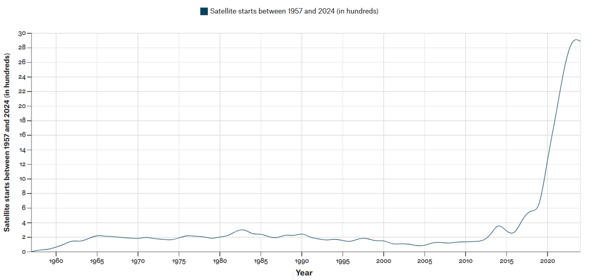
Further, questions regarding space security are discussed in the UN General Assembly's Disarmament and International Security Committee (First Committee)[14] and the Special Political and Decolonization Committee (Fourth Committee).[15] The First Committee works closely with the UN Disarmament Commission, while the Fourth oversees the Committee on the Peaceful Uses of Outer Space.[16]



The UN Disarmament Commission is a multilateral forum mainly focused on the proliferation of weapons of mass destruction (WMDs). Even though it is not a formal body of the UN, it is financed from the UN budget and is accountable to the UN General Assembly[17].

Conclusion

The space sector has witnessed a surge of activities, ranging from satellite launches and telecommunications to space tourism and resource exploitation a list of all satellite launches worldwide since 1957 can be found here [`https://planet4589.org/space/gcat/data/derived/launchlog.html`].



Overview of the number of satellite launches between 1957 and 2024
https://planet4589.org/space/gcat/data/derived/launchlog.html, own consolidation and graphic

Moreover, there is a growing number of nations actively participating in space activities. Space has become a realm of strategic interest for many countries, with an emphasis on national security, intelligence gathering and communication networks. The dual-use nature of space technologies further emphasises the necessity of safeguarding these assets, highlighting the emergence of dedicated space forces and the need for protective measures to secure national interests in this critical domain. The expansion of space capabilities and the increasing number of actors involved create both opportunities and challenges in terms of international cooperation, governance and potential conflicts.

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this Chapter

Erwin, Sandra. “DOD Satcom: Big Money for Military Satellites, Slow Shift to Commercial Services”. spacenews.com, 22 June 2022, available at: [`https://spacenews.com/dod-satcom-big-money-for-military-satellites-slow-shift-to-commercial-services/`].

European Space Agency. “Space Debris by the Numbers”. ESA, 12 September 2023, available at: [`https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers`].

FBI. Federal Bureau of Investigation. [`https://www.fbi.gov/news/speeches/responding-effectively-to-the-chinese-economic-espionage-threat`].

GPS.gov. “The Global Positioning System”. GPS.gov: GPS Overview, February 2021, available at: [`https://www.gps.gov/systems/gps/`].

Howell, Elizabeth. “What Is Space?”. Space.com, 17 February 2022, available at: [`https://www.space.com/24870-what-is-space.html`].

Lockheed Martin. 2023. “Early Missile Warning - Space Based-Infrared System (SBIRS)”. Lockheed Martin, available at: [`https://www.lockheedmartin.com/en-us/products/sbirs.html`].

Quintana, E. 2017. “The new space age: Questions for defence and security”. The RUSI Journal 162 (3): pp. 88–109.

Radu, Sintia. 2020. “China Is Hurting Innovation, Report Shows”. U.S. News, available at: [`https://www.usnews.com/news/best-countries`].

Spatial Post. “17+ Revolutionary Application of Remote Sensing in Defence Technology”.

spatialpost.com, 30 May 2023, available at: [`https://www.spatialpost.com/application-of-remote-sensing-in-defence/`].

The Nuclear Threat Initiative. 2021. “Conference On Disarmament (CD)”. Nti.org, available at: [`https://www.nti.org/education-center/treaties-and-regimes/conference-on-disarmament/`].

United Nations. 2021. “Disarmament And International Security (First Committee)”. Un.org, available at: [`https://www.un.org/en/ga/first/`].

United Nations. 2021. “Special Political and Decolonization (Fourth Committee)”. Un.org, available at: [`https://www.un.org/en/ga/fourth/index.shtml`].

United Nations Office for Outer Space Affairs. 2021. “Committee On The Peaceful Uses Of Outer Space”. UNOOSA, available at: [`https://www.unoosa.org/oosa/en/ourwork/copuos/index.html`].

Wray, Christopher. 2020. "Responding Effectively to the Chinese Economic Espionage Threat".

Wu, Chu. 2020. "Tensions Mount over China's Industrial Espionage in US". VOA. Voice of America (VOA News), available at: [https://www.voanews.com/a/east-asia-pacific_voa-news-china_tensions-mount-over-chinas-industrial-espionage-us/6194032.html].

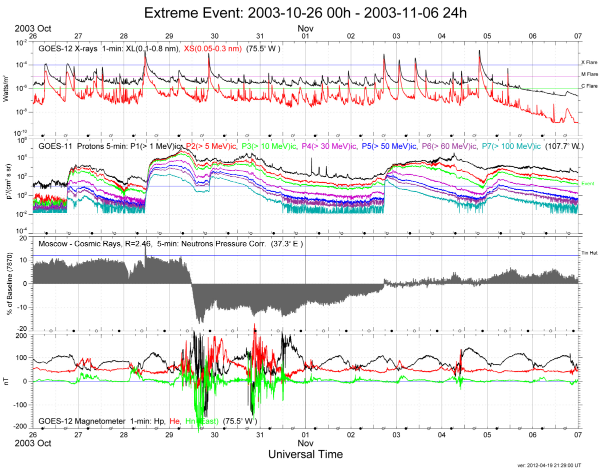
1. Howell, Elizabeth. "What Is Space?". Space.com, 17 February 2022, available at: [https://www.space.com/24870-what-is-space.html].
2. As of 6 December 2023.
3. European Space Agency. "Space Debris by the Numbers". ESA, 20 February 2024, available at: [https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers]
4. Ibid.
5. Ibid.
6. Quintana, E. 2017. "The new space age: Questions for defence and security", The RUSI Journal 162 (3): pp.88–109.
7. Erwin, Sandra. "DOD Satcom: Big Money for Military Satellites, Slow Shift to Commercial Services". spacenews.com, 22 June 2022, available at: [https://spacenews.com/dod-satcom-big-money-for-military-satellites-slow-shift-to-commercial-services/].
8. Spatial Post. "17+ Revolutionary Application of Remote Sensing in Defence Technology". spatialpost.com, 30 May 2023, available at: [https://www.spatialpost.com/application-of-remote-sensing-in-defence/].
9. Lockheed Martin. 2023. "Early Missile Warning - Space Based-Infrared System (SBIRS)". Lockheed Martin, available at: [https://www.lockheedmartin.com/en-us/products/sbirs.html].
10. According to PSSI's internal research.
11. Wu, Chu. 2020. "Tensions Mount over China's Industrial Espionage in US". VOA. Voice of America (VOA News), available at: [https://www.voanews.com/a/east-asia-pacific_voa-news-china_tensions-mount-over-chinas-industrial-espionage-us/6194032.html].
12. Wray, Christopher. 2020. "Responding Effectively to the Chinese Economic Espionage Threat". FBI. Federal Bureau of Investigation, available at: [https://www.fbi.gov/news/speeches/responding-effectively-to-the-chinese-economic-espionage-threat].
13. Radu, Sintia. 2020. "China Is Hurting Innovation, Report Shows". U.S. News, available at: [https://www.usnews.com/news/best-countries].
14. United Nations. 2021. "Disarmament And International Security (First Committee)". Un.org, available at: [https://www.un.org/en/ga/first/].
15. United Nations. 2021. "Special Political and Decolonization (Fourth Committee)". Un.org, available at: [https://www.un.org/en/ga/fourth/index.shtml].
16. United Nations Office for Outer Space Affairs. 2021. "Committee On The Peaceful Uses Of Outer Space". UNOOSA, available at: [https://www.unoosa.org/oosa/en/ourwork/copuos/index.html]
17. The Nuclear Threat Initiative. 2021 "Conference On Disarmament (CD)". Nti.org, available at: [https://www.nti.org/education-center/treaties-and-regimes/conference-on-disarmament/].

2. Risks to the safety of space operations

In the realm of space security, a critical aspect revolves around understanding the risks that impede the safety of space operations. These risks encompass various factors, each posing unique challenges to the functionality and security of assets operating within the vast expanse of space. Exploring these risks, ranging from space weather and near-Earth objects to space debris, radio frequency interference and spectrum issues, provides a comprehensive view of the potential threats that could compromise the safety and reliability of space missions and infrastructure.

Space weather

According to the National Aeronautics and Space Administration (NASA), space weather refers to the fluctuations that occur in the space environment between the sun and Earth. Specifically, it encompasses various phenomena that influence both orbital systems and technologies on the Earth's surface[1]. The main types of space weather and their effects on human space operations include solar flares, coronal mass ejections (CMEs) and solar energetic particles (SEPs).



GOES-11 and GOES-12 monitored space weather conditions during the October 2003 solar activity
Daniel Wilkinson/Wikipedia, CC BY-SA 3.0

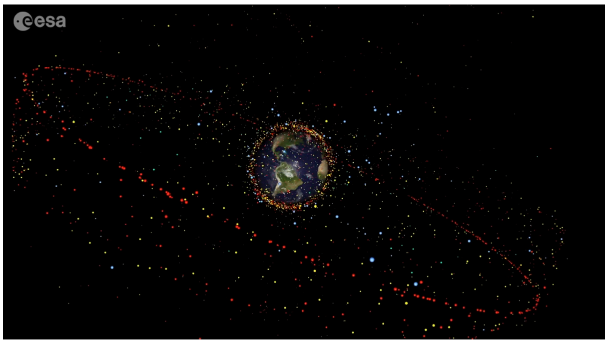
Near-Earth objects (NEOs)

Near-Earth objects are asteroids and comets that have been pushed into orbits allowing them to enter the Earth's proximity[2]. Each year, the Earth is hit by around 6,100 meteorites large enough to reach the ground. The majority of them land unnoticed in uninhabited areas. If the meteors are large enough and land in inhabited areas, they can cause property damage and possibly even deaths[3].

Asteroid Ida with its small moon Dactyl as seen from NASA's Galileo spacecraft
NASA, public domain

Space debris

Space debris, also known as space junk, is defunct human-made objects in space that can no longer be maneuvered or controlled and are thus orbiting Earth uncontrollably. As of 12 September 2023, there were some 2,000 defunct satellites still in orbit. Moreover, there are about 35,060 debris objects regularly tracked by ESA's space surveillance networks and maintained in their catalogue. Due to the capacity and capability limitations of tracking infrastructure, objects smaller than 10 cm cannot be tracked. According to the ESA's statistical model, there are 1,000,000 space debris objects between 1 and 10 cm in size and some 130 million between 1 mm and 1 cm.[4]



Distribution of space debris in orbit around Earth
© ESA - European Space Agency

Radio frequency interference (RFI)

Radio frequency interference (RFI) refers to unwanted energy that negatively affects radio communication systems, leading to performance degradation or information loss. The effects can range from mild disruptions to complete loss of service. Various devices that use radio frequency, including radio, cellular, radar, satellite, Wi-Fi, GPS and unmanned aircraft systems, are potentially vulnerable to RFI.[5]

Spectrum issues

The electromagnetic spectrum is the name given to a range of frequencies used for transmitting and receiving signals. It includes radio waves, microwaves, infrared, visible light, ultraviolet, X-rays and gamma rays.[6] The demand for spectrum resources in space has been growing rapidly with the proliferation of satellites, space-based applications and the increasing reliance on space-based technologies. However, the spectrum is a finite and valuable resource that must be allocated and managed effectively to avoid interference and ensure the reliable operation of space-based systems.[7] The limited spectrum increases the chance of interference between satellites.[8] Greater competition for the available spectrum bands leads to diplomatic conflicts and increases the demand for constructive international collaboration to manage the electromagnetic spectrum effectively[9].[10]

The International Telecommunication Union (ITU) oversees the regulation and allocation of frequencies across the electromagnetic spectrum, ensuring efficient and equitable use of this vital resource for global communication and technology development.[11]

Conclusion

The exploration of space brings immense benefits, but it is not without risks. Space weather, near-Earth objects, space debris, radio frequency interference and spectrum issues all pose significant threats. Space weather, comprising solar flares and energetic particles, can disrupt technologies in space and on Earth. Near-Earth objects, like asteroids, can cause damage upon impact. Space debris, from defunct satellites to smaller fragments, orbits Earth uncontrollably, posing risks to operational spacecraft and satellites. Radio frequency interference disrupts communication systems, affecting various devices relying on radio frequencies. The growing demand for the electromagnetic spectrum, due to satellites and space-based tech, raises concerns about interference and requires international collaboration for effective management. Addressing these risks necessitates collaborative efforts, technological advancements and global cooperation to ensure safe and sustainable space exploration and utilisation.

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

Cave, Martin/Doyle, Christopher/Webb, William. 2007. Essentials of Modern Spectrum Management. Cambridge: Cambridge University Press.

Cybersecurity and Infrastructure Security Agency. "Radio Frequency Interference Best Practices Guidebook, February 2020 - CISA". cisa.gov, February 2020, available at: [https://www.cisa.gov/sites/default/files/publications/safecom-ncswic_rf_interference_best_practices_guidebook_2.7.20_-_final_508c.pdf].

Chapman, Clark R. 2004. "The hazard of near-Earth asteroid impacts on earth". Earth and Planetary Science Letters 222 (1): 1–15.

ESA. Space debris by the numbers, available at: [https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers] (last accessed: 31 October 2023).

ITU. "About International Telecommunication Union (ITU)". ITU, January 2024, available at: [https://www.itu.int/en/about/Pages/default.aspx].

ITU. "How 5G Networks, Satellites and Spectrum Enable Access to Information". ITU News, 15 December 2021, available at: [https://www.itu.int/hub/2021/09/how-5g-networks-satellites-and-spectrum-enable-access-to-information/].

Lewis, James Andrew. "Spectrum Allocation for a Contest with China". csis.org, 7 June 2023, available at: [https://www.csis.org/analysis/spectrum-allocation-contest-china].

Lovett, Richard A. "Earth Hit by 17 Meteors a Day". Cosmos, 30 April 2020, available at: [https://cosmosmagazine.com/space/earth-hit-by-17-meteors-a-day/].

NASA. "Electromagnetic Spectrum - Introduction". Astronomer's Toolbox, March 2013, available at: [https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html].

NASA. "Space Weather Phenomena." Space Weather Phenomena | NOAA / NWS Space Weather Prediction Center, available at: [https://www.swpc.noaa.gov/phenomena#:~:text=Space%20Weather%20describes%20the%20variations,in%20orbit%20and%20on%20Earth] (last accessed: 31 October 2023).

1. NASA. "Space Weather Phenomena". Space Weather Phenomena | NOAA / NWS Space Weather Prediction Center, available at:. [https://www.swpc.noaa.gov/phenomena#:~:text=Space%20Weather%20describes%20the%20variations,in%20orbit%20and%20on%20Earth] (last accessed: 31 October 2023).
2. Chapman, Clark R. 2004. "The hazard of near-Earth asteroid impacts on earth." Earth and Planetary Science Letters 222 (1): 1–15.
3. Lovett, Richard A. "Earth Hit by 17 Meteors a Day". Cosmos, 30 April 2020, available at: [https://cosmosmagazine.com/space/earth-hit-by-17-meteors-a-day/].
4. ESA. Space debris by the numbers, available at: [https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers] (last accessed: 31 October 2023).
5. Cybersecurity and Infrastructure Security Agency. "Radio Frequency Interference Best Practices Guidebook, February 2020 - CISA". cisa.gov, February 2020, available at: [https://www.cisa.gov/sites/default/files/publications/safecom-ncswic_rf_interference_best_practices_guidebook_2.7.20_-_final_508c.pdf].
6. NASA. "Electromagnetic Spectrum - Introduction". Astronomer's Toolbox, March 2013, available at: [https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html].

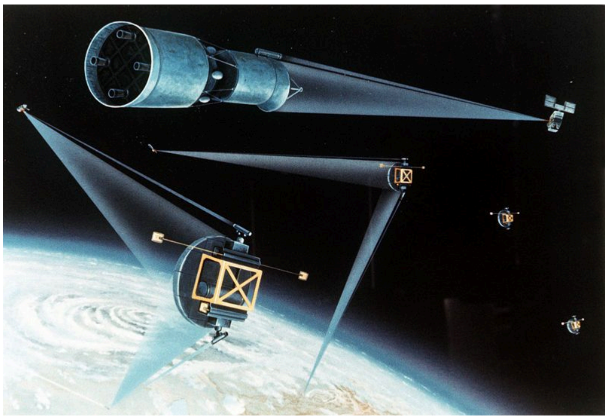
7. ITU. "How 5G Networks, Satellites and Spectrum Enable Access to Information". ITU News, 15 December 2021, available at: [https://www.itu.int/hub/2021/09/how-5g-networks-satellites-and-spectrum-enable-access-to-information/].
8. Ibid.
9. Lewis, James Andrew. "Spectrum Allocation for a Contest with China". csis.org, 7 June 2023, available at: [https://www.csis.org/analysis/spectrum-allocation-contest-china].
10. Cave, Martin/Doyle, Christopher/Webb, William. 2007. Essentials of modern spectrum management. Cambridge: Cambridge University Press.
11. ITU. "About International Telecommunication Union (ITU)". ITU, January 2024, available at: [https://www.itu.int/en/about/Pages/default.aspx].

3. Intentional threats to space operations

Counterspace capabilities

With the military relevance of space rising for all kinds of operations on Earth, more and more players are investing in weapon systems to threaten and attack the space assets of a potential military adversary. Many experts believe that a future war between spacefaring nations will begin with a targeted strike with space weapons against reconnaissance, communications and navigation satellites.

It is essential to emphasise at the outset that given the dual-use nature of space systems, defining what exactly constitutes a space weapon is challenging.



An artist's concept of Soviet land, air and space-based lasers (1987)
US Department of Defense, via Wikimedia Commons/public domain

Consequently, there is no internationally recognised definition of a space weapon. Terms such as 'counterspace weapon' or 'counterspace capability' are sometimes used interchangeably to describe systems enabling attacks on any segment of the space system. Hence, the definition encompasses attacks that aim to 'deceive, disrupt, deny, degrade, or destroy space systems or services' (for more information, see the *U.S. Joint Publication 3–14, Space Operations*). In addition to this, in theory, space-to-Earth attacks on terrestrial targets are also possible (see, e.g. Project *Thor*).

Generally speaking, space weapons can be either space-based or ground-based and can be divided into kinetic, directed energy, electronic and cyberweapons. However, there are currently no weapons officially stationed in outer space, and only non-destructive attacks are being actively conducted.[1] The use of destructive (especially kinetic) weapons is primarily confined by the proliferation of space debris that would endanger other (including allied) space systems. Nevertheless, there are no adequate assurances that space will not be weaponised in the future and that a destructive attack will not occur.

Kinetic space weapons

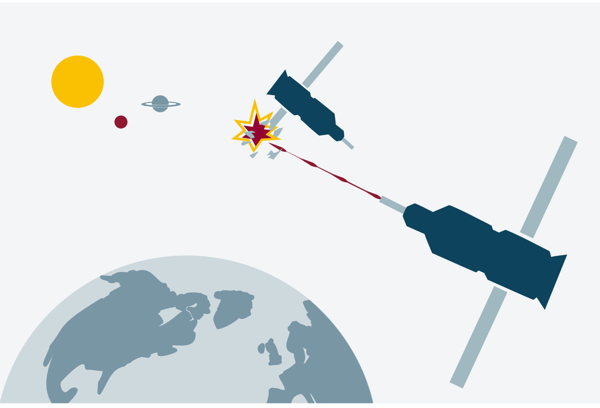
Kinetic space weapons destroy satellites by a kinetic impact (or eventually by nearby detonation). They comprise direct ascent kinetic anti-satellite (ASAT) weapons, co-orbital anti-satellite weapons or traditional terrestrial attacks on space ground segments. Kinetic attacks result in the irreversible destruction of space systems and, in space, create hazardous space debris that endangers other systems and thus limits their practical utility despite their effective destructive potential. As of August 2023, direct ascent kinetic anti-satellite weapons had been successfully tested by four nations – the United States, China, India and Russia.

The United States first successfully tested a direct ascent kinetic anti-satellite weapon in 1985 by using ASM-135 ASAT launched from an F-15 fighter to destroy the obsolete Solwind P78-1 satellite. It then reconfirmed its anti-satellite capability in 2008 by using an SM-3 missile from the Aegis ballistic missile defence system to destroy the USA-193 satellite. In 2007, China tested a modified DF-21 ballistic missile (dubbed SC-19) to destroy the Fengyun-1C satellite. Targeting Microsat-R, India tested the modified ballistic missile interceptor Prithvi Defence Vehicle Mark-II in 2019. Lastly, in 2021, Russia conducted a direct ascent kinetic anti-satellite test with the anti-ballistic missile Nudol PL-19 by intercepting the Cosmos 1408 satellite. The tests conducted, especially by China and Russia, are deemed highly irresponsible due to the large amount of debris created. High-altitude debris clouds can orbit for decades, and Chinese and Russian anti-satellite tests even endangered the inhabitants of the International Space Station.

Beyond this, the United States is also capable of advanced orbital rendezvous and proximity operations in both low Earth orbit and geostationary orbit that could lead to the development of co-orbital anti-satellite weapons within a short period of time. China has proven similar capabilities, and Russia already tested co-orbital satellite weapons during the Cold War and, since 2010, has renewed those capabilities.

Satellite launching projectiles against an intercontinental missile
Source: Grübelfabrik, CC BY-NC-ND 4.0

Directed energy space weapons
Directed energy (or non-kinetic physical) space weapons include low and high-power lasers, high-powered microwaves (HPM) and electromagnetic pulse (EMP).

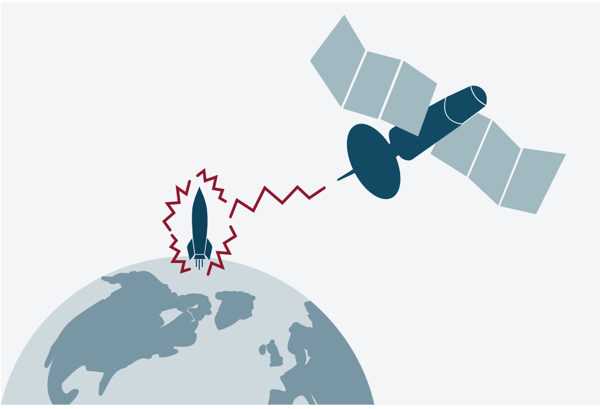


Satellite firing a laser against another satellite
Source: Grübelfabrik, CC BY-NC-ND 4.0

Low-power lasers can 'blind' or 'dazzle' enemy satellites. Dazzling refers to temporary loss of sight of the satellite, and blinding causes permanent damage to satellite optics. High-power lasers thus permanently damage other satellite electronics. High-powered microwaves disrupt satellite electronics, corrupt data stored in memory, cause processors to restart, and, at higher power levels, cause permanent damage to electrical circuits and processors. Electromagnetic pulse is created by nuclear explosions and can damage satellite electronics in a large radius. Directed energy attacks operate at the speed of light and, in some cases, are difficult to attribute.

The major space powers – the United States, Russia and China – are engaged in developing directed energy space weapons and can probably dazzle or blind low Earth orbit satellites. Moreover, France is developing ground-based and space-based lasers with offensive capabilities with the aim of them being operational by 2030.

Electronic space weapons
Electronic space weapons interfere with the electromagnetic spectrum through which space systems transmit and receive data. Electronic attacks include satellite jamming, spoofing and meaconing. Jamming attacks emit noise in the same radio frequency (RF) as the satellite and within the field of view of its antennas. Uplink jamming interferes with the signal from Earth to space, while downlink jamming targets the signal coming from space to Earth. Spoofing is a method of sending fake signals or commands to the receiver. Meaconing refers to a particular type of spoofing that only re-transmits the original signal copy and thus does not require breaking the encryption. Electronic attack, for instance, interferes with GPS signals and communications satellites or sends false locations to the receiver.



Satellite „zapping"" a missile with some electronic ray
Source: Grübelfabrik, CC BY-NC-ND 4.0

Electronic warfare capabilities are relatively cheap and sometimes commercially available. Therefore, all major space powers have advanced electronic warfare capabilities that can be utilised as space weapons.

Cyberspace weapons
Compared to other space weapons, cyberattacks are inexpensive, flexible and generally reversible methods of disruption which are difficult to attribute. The impact of cyberattacks ranges from data loss to widespread disruptions or permanent loss of a satellite. Despite sometimes requiring advanced technical knowledge, due to their cost-effectiveness and availability, cyberattacks are employed by states, but also private groups or individuals. For instance, in 2007 and 2008, China allegedly interfered with two US government satellites. In 2009, Iraqi insurgents used cheap SkyGrabber software to hack US military Predator drones. Between 2008 and 2016, the Russian-led Turla group accessed sensitive data from Western embassies, governments and military institutions.

There are plenty of more recent examples as well. Following the invasion of Ukraine in 2022, Russia launched cyberattacks on Viasat and SpaceX space companies, which also revealed further gaps in cyber protection. While SpaceX's Starlink proved to be resistant to the Russian cyberattacks, Viasat allegedly downplayed the cyber threat that led to disruptions in Ukraine and throughout Europe.

Space hybrid operations

Space hybrid operations are defined as 'intentional, temporary, mostly reversible, and often harmful space actions/activities specifically designed to exploit the links to other domains and conducted just below the threshold of requiring meaningful military or political retaliatory responses'[2]. They comprise (1) directed energy operations; (2) orbital operations; (3) electronic operations; (4) cyber operations; and (5) economic and financial (E&F) operations.[3] Space hybrid operations are characterised by ambiguous attribution, and temporary and reversible effects, and are generally not publicly visible.[4] Accordingly, space hybrid operations are a convenient method of undermining an adversary's capabilities while limiting space debris proliferation and, in comparison to kinetic and other destructive methods, are relatively considerate to the space environment.[5]

Illustrations of deployable space hybrid operations (Robinson et al., 2018, p. 3)

SPACE HYBRID OPERATION[6]	EXAMPLES	ATTRIBUTION	REVERSIBILITY
Directed energy operations that may result in space debris[7]	Low-power laser dazzling or blinding; [8] high-power microwave (HPM) or ultra-wideband (UWB) emitters	Varies	Generally reversible
Orbital operations that generally do not result in space debris	Space object tracking and identification; rendezvous and proximity operations (RPO)	Varies	Fully reversible
Electronic operations[9]	Jamming[10] (orbital/uplink, terrestrial/downlink); spoofing[11]	Moderate	Fully reversible
Cyber operations[12]	Attack on satellite or ground station antennas; attack on ground stations connected to terrestrial networks; attack on user terminals that connect to satellites	Difficult	Generally reversible
Economic and financial (E&F) operations[13]	Investments in target country's space infrastructure for purpose of influence/control; provision of loans and construction/launch of target country's space system(s)	Varies	Generally reversible

Nevertheless, space hybrid interference can be measured, similarly to cyberattacks, via the 'effects-based doctrine'. This means that the qualification of the attack is assessed in light of the consequences and damage caused. If a particular space hybrid disruption causes substantial harm and damage, the quantity and quality of which is equivalent to the destruction produced by a conventional armed attack (e.g. deactivation of data/signals paralysing the functioning of the critical infrastructure of the state, causing significant damage or even fatalities), the qualification of 'armed attack' might apply.[14]

Space hybrid operations are conducted in the 'grey zone' below the threshold of conflict. That said, space hybrid operations reside in harmful/offensive capabilities that can be employed during space warfare, potentially accompanied by, for instance, kinetic anti-satellite weapons.

Dual-use nature of space technology

Most space technology is inherently dual use, meaning it can be used for military and civilian purposes, e.g. position, navigation, and timing (PNT) services are used for civilian traffic management as well as precision missile guidance. Dual-use technology can therefore be defined as 'a technology that has both military utility and sufficient commercial potential to support a viable industrial base'.[15] Furthermore, even seemingly benign space technology can be abused for malicious and potentially offensive purposes. For instance, the increasing number of space debris calls for the deployment of active debris removal systems to displace obsolete systems and other debris. However, a system capable of removing dysfunctional satellites could also be used against an operational one.[16]

2001 · Dennis Tito becomes the first space tourist

Dennis Tito visits the International Space Station (ISS) aboard a Russian Soyuz spacecraft, marking the beginning of commercial space tourism.

2004 · Mars Exploration Rovers land on Mars

Spirit and Opportunity, NASA's Mars Exploration Rovers, land on Mars and begin exploring the Martian surface, greatly enhancing our understanding of the planet.

2007 · China tests an anti-satellite missile

China downs its weather satellite Fengyun-1C with a ground-launched missile, raising global concerns about the militarisation of space.

2010 · U.S. National Space Policy addresses space security

The U.S. National Space Policy highlights growing space security challenges and emphasizes cooperation while preserving space as a peaceful domain.

Satellites wield the paradoxical potential to not only harmonise in orbit but also, ominously, to orchestrate their own demise and rend asunder their celestial peers. In 2020, the United States Space Command raised concerns about a Russian satellite, Cosmos 2543, exhibiting unusual behaviour by closely manoeuvring near a US government satellite, the KH-11, which is part of America's reconnaissance satellite constellation. This manoeuvre was seen as potentially threatening and raised the alarm within the US space community.[17]

There have been reports of Chinese satellites exhibiting similar behaviour. In 2018, the Chinese satellite SJ-17 was observed within close proximity to other Chinese satellites. While these incidents did not directly involve Western satellites, they underscored concerns about the potential capabilities and intentions of these satellites.[18]

In the context of dual-use technologies, on-orbit servicing (OOS) refers to the capability to repair, maintain, upgrade or refuel satellites, spacecraft or other assets while they are in space and it can have both civilian and military applications.[19]

Civilian applications of OOS include extending the operational life of satellites by refuelling them or replacing faulty components, thus reducing the need for costly replacements and contributing to sustainability in space. It can also enable the deployment of larger and more complex space structures by assembling them in orbit from smaller components that have been launched separately.

On the military side, OOS can support national security objectives by allowing for the maintenance and upgrade of military satellites, enhancing their resilience and responsiveness. It can also facilitate the deployment of reconnaissance, surveillance and communication capabilities in space, supporting military operations and strategic goals.

Active debris removal (ADR) refers to the process of actively retrieving defunct or non-functioning satellites, rocket stages and other space debris from the Earth's orbit. In the context of dual-use technologies, ADR involves the utilising technologies that have both civilian and military applications.[20]

On the civilian side, ADR is primarily aimed at mitigating the growing problem of space debris, which poses a significant risk to operational satellites and spacecraft. As more objects are launched into space, the amount of debris increases, raising concerns about collisions and the generation of even more debris in a cascading effect known as the Kessler syndrome.[21] Active debris removal technologies are crucial for maintaining the long-term sustainability of space activities by reducing the risk of collisions and ensuring the safety of critical space assets.

From a military perspective, ADR technologies can also be viewed as dual use because they have potential applications for enhancing national security. Military satellites and spacecraft are equally vulnerable to collisions with space debris, which could disrupt communications, surveillance and navigation systems. By developing and deploying ADR capabilities, military forces can protect their space assets and maintain their strategic advantage in space operations.[22]

Conclusion

Space hybrid operations, defined as deliberate, mostly reversible activities in space, conducted strategically below the threshold that would necessitate significant military or political retaliation, and space weapons, categorised into kinetic, directed energy, electronic and cyber types, pose complex challenges due to their dual-use nature. While kinetic weapons cause irreversible satellite damage and create hazardous space debris, directed energy technologies disrupt or damage satellites through lasers and microwaves. Electronic warfare, involving jamming and spoofing, interferes with space signals, and cost-effective and flexible cyberattacks pose significant threats to space assets. The dual-use nature of space tech demands stringent governance and international cooperation to ensure responsible and sustainable space utilisation

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

Alver, James, Andrew Garza, and Christopher May. "An Analysis of the Potential Misuse of Active Debris Removal, On-Orbit Servicing, and Rendezvous & Proximity Operations Technologies". The George Washington University, Washington, D.C., 2019.

Bingen, Kari A./Johnson, Kaitlyn/Young, Makena/Raymond, John. 2023. "Space Threat Assessment 2023". CSIS, available at: [`https://www.csis.org/analysis/space-threat-assessment-2023`].

Cohen, Rachel S. "Spacecom Calls out Apparent Russian Space Weapon Test". Air & Space Forces Magazine, 24 July 2020, available at: [`https://www.airandspaceforces.com/spacecom-calls-out-apparent-russian-space-weapon-test/`].

DLR. On-orbit servicing technologies, 1 February 2022, available at: [`https://www.dlr.de/rb/PortalData/38/Resources/dokumente/leistungen/DLR_RB_Portfolio_OOS.pdf`].

Doboš, Bohumil/Pražák, Jakub. 2019. "To Clear or to Eliminate? Active Debris Removal Systems as Antisatellite Weapons". Space Policy 47: 217–23, available at: [`https://doi.org/10.1016/j.spacepol.2019.01.007`].

ESA. Active debris removal, 1 January 2024, available at: [`https://www.esa.int/Space_Safety/Space_Debris/Active_debris_removal`].

Johnson-Freese, Joan. 2007. Space as a strategic asset. New York: Columbia University Press.

Manson, Katrina. 2023. "The Satellite Hack Everyone Is Finally Talking About". Bloomberg, available at: [`https://www.bloomberg.com/features/2023-russia-viasat-hack-ukraine/`].

McConnaughey, Paul K./Femmininneo, Mark G./Koelfgen, Syri J./Lepsch, Roger A./Ryan, Richard M./Taylor, Steven A. 2012. "NASA's Launch Propulsion Systems Technology Roadmap". NASA, Office of the

Chief Technologist, available at: [https://ntrs.nasa.gov/api/citations/20120014957/downloads/20120014957.pdf].

Ministère des Armées. 2023. "LPM 2024-2030: Les Grandes Orientations". [https://satelliteobservation.net/], available at: [https://satelliteobservation.files.wordpress.com/2023/04/livret-de-presentation-de-la-loi-de-programmation-militaire-2024-2030-6-avril-2023.pdf].

Mistry, Dinshaw/Gopalaswamy, Bharath. 2012. "Ballistic Missiles and Space Launch Vehicles in Regional Powers". Astropolitics 10 (2): 126–51, available at: [https://doi.org/10.1080/14777622.2012.696014].

Mowthorpe, Matthew/Trichas, Markos. "A Review of Chinese Counterspace Activities". The Space Review: A review of Chinese counterspace activities, 1 August 2022, available at: [https://www.thespacereview.com/article/4431/1].

Peck, Michael. 2023. "Russia's Electronic Warriors Are Intercepting Ukrainian Troops' Communications and Jamming Their GPS-Guided Bombs, Experts Say". Business Insider, available at: [https://www.businessinsider.com/russian-electronic-warfare-interfering-with-ukrainian-radios-bombs-2023-7].

Pražák, Jakub. 2021. "Dual-Use Conundrum: Towards the Weaponization of Outer Space?" Acta Astronautica 187: 397–405, available at: [https://doi.org/10.1016/j.actaastro.2020.12.051].

Pražák, Jakub. 2022. "On the Threshold of Space Warfare". Astropolitics 20 (2–3): 175–91, available at: [https://doi.org/10.1080/14777622.2022.2142351].

Pražák, Jakub. 2021. "Space Cyber Threats and Need for Enhanced Resilience of Space Assets". Proceedings of the European Conference on Information Warfare and Security, available at: [https://doi.org/10.34190/ews.21.006].

Rashid, Fahmida Y. 2011. "Chinese Military Hackers Blamed for Attacking Two U.S. Satellites". eWEEK, available at: [https://www.eweek.com/security/chinese-military-hackers-blamed-for-attacking-two-u.s.-satellites/].

Robinson, Jana/Šmuclerová, Martina/Degl'Innocenti, Lapo/Perrichon, Lisa/ Pražák, Jakub. 2018. Europe's Preparedness to Respond to Space Hybrid Operations. Prague Security Studies Institute Report, available at: [https://www.pssi.cz/download//docs/8252_597-europe-s-preparedness-to-respond-to-space-hybrid-operations.pdf].

Smeltzer, Stanley/Wagner, Nathan. 2022. "De-Orbit Analysis using Active Debris Removal for High Priority Objects". In: ASCEND 2022, p. 4,275.

United States Department of Defense. "Joint Publication 3-14: Space Operations". www.jcs.mil [http://www.jcs.mil], 2020, available at: [https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_14Ch1.pdf].

Velkovsky, Pavel/Mohan, Janani/Simon, Maxwell. "Satellite Jamming". On the Radar, 3 April 2019, available at: [https://ontheradar.csis.org/issue-briefs/satellite-jamming/#fn:1].

Weeden, Brian/Samson, Victoria. 2023. Global Counterspace Capabilities Report, available at: [https://swfound.org/counterspace/]

1. Weeden, Brian/Samson, Victoria. 2023. Global Counterspace Capabilities Report, p. xvi, available at: [https://swfound.org/counterspace/].
2. Robinson, Jana/Šmuclerová, Martina/Degl'Innocenti, Lapo/Perrichon, Lisa/Pražák, Jakub. 2018. Report. Europe's Preparedness to Respond to Space Hybrid Operations. Prague Security Studies Institute, p. 3, available at: [https://www.pssi.cz/download//docs/8252_597-europe-s-preparedness-to-respond-to-space-hybrid-operations.pdf].
3. Ibid.
4. Robinson, Jana/Šmuclerová, Martina/Degl'Innocenti, Lapo/Perrichon, Lisa/Pražák, Jakub. 2018. Report. Europe's Preparedness to Respond to Space Hybrid Operations. Prague Security Studies Institute, p. 4, available at: [https://www.pssi.cz/download//docs/8252_597-europe-s-preparedness-to-respond-to-space-hybrid-operations.pdf].
5. Pražák, Jakub. 2022. "On the Threshold of Space Warfare". Astropolitics 20 (2–3): 175–91, available at: [https://doi.org/10.1080/14777622.2022.2142351].
6. This list purposely does not include ground-based kinetic ASAT weapons, co-orbital kinetic weapons, electromagnetic pulse (EMP) weapons, high-power lasers etc. as their effects are easier to attribute and are not reversible.
7. The attack is swift and degradation of the target spacecraft may not be immediately apparent.
8. Spoofs or jams of satellite electro-optical sensors using laser radiation that is in the sensor pass band (in-band), temporarily blinding the satellite.
9. The use of electromagnetic or directed energy to control the electromagnetic spectrum or to attack an adversary's space system. Communications/navigation satellites and other satellite's communications, data and command links are likely targets.
10. Emitting noise or some other signal for the purpose of preventing the sensor from being able to collect the real signals.
11. Emitting false signals that mimic real signals to cover the real signals (a type of electronic decoy).
12. Targets data and the systems that use that data (i.e. information services and operator's control over the asset).
13. Use of economic and financial transactions to advance 'space sector capture' (PSSI defines space sector capture as 'a state actor's provision of space-related equipment, technology, services and financing ultimately designed to limit the freedom of action and independence of the recipient state's space sector, generally implemented on an incremental basis').
14. Robinson, Jana/Šmuclerová, Martina/Degl'Innocenti, Lapo/Perrichon, Lisa/Pražák, Jakub. 2018. Report. Europe's Preparedness to Respond to Space Hybrid Operations. Prague Security Studies Institute, p. 18, available at: [https://www.pssi.cz/download//docs/8252_597-europe-s-preparedness-to-respond-to-space-hybrid-operations.pdf].
15. Johnson-Freese, Joan. 2007. Space as a Strategic Asset. New York: Columbia University Press. p. 28.
16. Doboš, Bohumil/ Pražák, Jakub. 2019. "To Clear or to Eliminate? Active Debris Removal Systems as Antisatellite Weapons". Space Policy 47: 217–23, available at: [https://doi.org/10.1016/j.spacepol.2019.01.007].
17. Cohen, Rachel S. "Spacecom Calls out Apparent Russian Space Weapon Test". Air & Space Forces Magazine, 24 July 2020, available at: [https://www.airandspaceforces.com/spacecom-calls-out-apparent-russian-space-weapon-test/].
18. Mowthorpe, Matthew/Trichas, Markos. "A Review of Chinese Counterspace Activities". The Space Review: A review of Chinese counterspace activities, 1 August 2022, available at: [https://www.thespacereview.com/article/4431/1].
19. DLR. On-orbit servicing technologies, 1 February 2022, available at: [https://www.dlr.de/rb/PortalData/38/Resources/dokumente/leistungen/DLR_RB_Portfolio_OOS.pdf].
20. ESA. Active debris removal, 1 January 2024, available at: [https://www.esa.int/Space_Safety/Space_Debris/Active_debris_removal].
21. Smeltzer, Stanley/Wagner, Nathan. 2022. "De-Orbit Analysis using Active Debris Removal for High Priority Objects". In: ASCEND 2022, p. 4,275.
22. Alver, James/Garza, Andrew/May, Christopher. 2019. "An Analysis of the Potential Misuse of Active Debris Removal, On-Orbit Servicing, and Rendezvous & Proximity Operations Technologies". The George Washington University, Washington, D.C.

4. Space Situational Awareness (SSA) and Space Domain Awareness (SDA)

Space Situational Awareness (SSA) encompasses an understanding of a wide variety of risks to space operations and assets through the ability to detect, track, identify and catalogue objects in space (this ability is referred to as Space Surveillance and Tracking or SST); observe space weather events (SWE) and near-Earth objects (NEOs); and monitor manoeuvres and other events in space.

In 2019, the US officially introduced the term Space Domain Awareness (SDA), which expands on the classical SSA/SST data by adding relevant space intelligence (i.e. contextual knowledge such as whether a satellite is operational, its capabilities, purpose, etc.). The U.S. Space Force defines SDA as the 'identification, characterization, and understanding of any factor associated with the space domain that could affect space operations and thereby affect the security, safety, economy, or environment…'.[1]

Besides their role in mission assurance and the understanding of space debris, SSA and SDA are the fundamental capabilities underpinning the governance of the space domain, including through international collaborative agreements and interactions.

The US has the most comprehensive SSA capability and, as of March 2023, shares SSA data with 33 countries and 129 commercial operators.[2] [3] Russia and China collect their own SSA data. Other countries and regions are also developing SSA capabilities (e.g. Europe, Japan, etc.).

In 2021, the EU (through Regulation (EU) 2021/696) instituted SSA as one of the five main components of the EU Space Programme (alongside Galileo, EGNOS, Copernicus and GOVSATCOM).[4]

Building on existing structures created by the 2014 EU Decision (Decision 541/2014/EU) establishing a Framework for Space Surveillance and Tracking Support, it currently has an SST Partnership, which includes 15 member states contributing their national assets. Those states are Austria (FFG), Czech Republic (MDCR), Denmark (RDAF), Finland (FMI), France (CNES), Germany (German Space Agency at DLR), Greece (NOA), Italy (ASI), Latvia (IZM), the Netherlands (EZK), Poland (POLSA), Portugal (PT MoD), Romania (ROSA), Spain (AEE) and Sweden (SNSA).

The oversight of space operations relies on Space Situational Awareness (SSA) and the newer concept of Space Domain Awareness (SDA). The former involves tracking space objects, observing space weather and monitoring near-Earth objects and space events. The latter, introduced in 2019 by the US, expands on SSA by incorporating contextual intelligence, such as understanding satellite functionalities. While the US leads in SSA, other countries, including Russia, China and Europe, are developing their capabilities

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

EU. 2021. Regulation (EU) 2021/696. Official Journal of the European Union [online], available at: [https://eur-lex.europa.eu/eli/reg/2021/696/oj].

Theresa Hitchens. 2023. SPACECOM expands allied, industry cooperation: Gen. Dickinson. Breaking Defense [online], available at: [https://breakingdefense.com/2023/02/spacecom-expands-allied-industy-cooperation-gen-dickinson/].

U.S. Space Command, 2021. USSPACECOM signs 100th commercial agreement to share space data, service. U.S. Space Command [online], available at: [https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2680576/usspacecom-signs-100th-commercial-agreement-to-share-space-data-service/].

USSF. 2022. Space Doctrine Note (SDN) Operations. U.S. Space Force [online], available at: [https://media.defense.gov/2022/Feb/02/2002931717/-1/-1/0/SDN%20OPERATIONS%2025%20JANUARY%202022.PDF].

1. USSF. 2022. Space Doctrine Note (SDN) Operations. U.S. Space Force [online], available at: [https://media.defense.gov/2022/Feb/02/2002931717/-1/-1/0/SDN%20OPERATIONS%2025%20JANUARY%202022.PDF].
2. U.S. Space Command, 2021. USSPACECOM signs 100th commercial agreement to share space data, service. U.S. Space Command [online], available at: [https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2680576/usspacecom-signs-100th-commercial-agreement-to-share-space-data-service/].
3. Theresa Hitchens. 2023. SPACECOM expands allied, industy cooperation: Gen. Dickinson. Breaking Defense [online], available at: [https://breakingdefense.com/2023/02/spacecom-expands-allied-industy-cooperation-gen-dickinson/]
4. EU. 2021. Regulation (EU) 2021/696. Official Journal of the European Union [online], available at: [https://eur-lex.europa.eu/eli/reg/2021/696/oj]

5. Space governance

The history of space law goes back to the beginning of the space age in the 1950s, when the United Nations, after the launch of Sputnik in 1957, decided, in 1959, to establish the UN Committee on the Peaceful Uses of Outer Space, also referred to as UN COPUOS. Another essential international body related to space governance and arms control is the Conference of Disarmament (CD), formed in 1979. The CD is a multilateral disarmament negotiation forum, financed from the UN budget, which reports to the UN General Assembly and considers its proposals and recommendations.[1]

The Fifty-Sixth Session of the UN Committee on the Peaceful Uses of Outer Space
U.S. Mission to International Organizations in Vienna UNVIE/CC BY ND 2.0

The UN laid the groundwork for the main principles governing outer space activities in the form of five space treaties, five sets of principles on space-related activities[2] and various UN resolutions.

The five space treaties are:

- The Outer Space Treaty (1967)
- The Rescue Agreement (1968)
- The Liability Convention (1972)
- The Registration Convention (1975)
- The Moon Agreement (1979)

The five sets of principles on space-related activities are:

- The 'Declaration of Legal Principles' (1963)
- The 'Broadcasting Principles' (1982)
- The 'Remote Sensing Principles' (1986)
- The 'Nuclear Power Sources Principles' (1992)
- The 'Benefits Declaration' (1996)

The Outer Space Treaty

The 'Magna Carta' of space law is the **UN Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies** (the so-called Outer Space Treaty or OST). The Outer Space Treaty institutionalised the framework for outer space activities.

January 27, 1967: Signing of the Outer Space Treaty
UN Photo/UN7420754

The Treaty entered into force in 1967 during the space race between the United States and the Soviet Union and security was a key element. Its purpose was to prevent space from becoming another area of conflict. This is why, for example, the Treaty established the concepts of non-appropriation of outer space, the freedom of exploration, the prevention of harmful interference with space activities and the environment, as well as principles of peaceful cooperation and scientific exploration.

The Outer Space Treaty banned the 'placement of nuclear weapons or other weapons of mass destruction' in space and emphasised that space is only to be used for 'peaceful purposes'.

How ChatGPT envisions the Outer Space Treaty
ChatGPT

However, the Treaty only bans the placement of nuclear weapons in space, not their development and testing (though testing was banned by the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water). Nor does the Outer Space Treaty specifically prohibit the use of nuclear ballistic missiles travelling through space due to its focus on preventing the placement of nuclear weapons in orbit or on celestial bodies. Since the Treaty was negotiated during the Cold War era when nuclear deterrence strategies were prevalent, achieving consensus on a complete ban on nuclear weapons in space proved challenging. Moreover, the Treaty does not ban the placement of conventional weapons, such as co-orbital mines, in space, nor does it address ballistic missiles – nuclear equipped or not – that ascent to and move through space. As the last space treaty – the Moon Treaty – was signed as long ago as 1979, there are concerns about whether this body of law, developed during the Cold War, is sufficient to address the much more complex situations in space today

As negotiating amendments to the Outer Space Treaty or signing a new Treaty would possibly be a decades-long process, countries have engaged in various other initiatives to strengthen space governance. Some countries, such as Russia and China, promote the concept of 'arms control for space' whereas others, such as European countries and the United States, lean towards responsible norms of behaviour in outer space-related initiatives. Due to the inherent dual-use nature of space technologies, arms control proposals for space are problematic, mainly because of the issue of verification.

TREATY

Outer Space Treaty

Effective 10 October 1967   Legally binding   115 Member States

The Outer Space Treaty (1967) establishes that outer space, including the Moon and celestial bodies, is free for exploration and use by all nations. It prohibits the placement of nuclear weapons in space, claims of sovereignty, and military activities. The treaty emphasizes peaceful purposes and international cooperation.

Current Adoption

AFG	DZA	ATG	ARG	ARM	AUS	AUT	AZE	BHS	BHR	BGD	BRB
BLR	BEL	BEN	BIH	BRA	BGR	BFA	CAN	CHL	CHN	COL	HRV
CUB	CYP	CZE	DNK	DOM	ECU	EGY	SLV	GNQ	EST	FJI	FIN
FRA	DEU	GRC	GNB	HUN	ISL	IND	IDN	IRQ	IRL	ISR	ITA
JAM	JPN	KAZ	KEN	PRK	KOR	KWT	LAO	LBN	LBY	LTU	LUX
MDG	MLI	MLT	MUS	MEX	MNG	MAR	MMR	NPL	NLD	NZL	NIC
NER	NGA	NOR	OMN	PAK	PAN	PNG	PRY	PER	POL	PRT	QAT
ROU	RUS	VCT	SMR	SAU	SYC	SLE	SGP	SVK	SVN	ZAF	ESP
LKA	SWE	CHE	SYR	THA	TGO	TON	TUN	TUR	UGA	UKR	ARE
GBR	USA	URY	VEN	VNM	YEM	ZMB	AGO	ALB	AND	BDI	BLZ
BOL	BRN	BTN	BWA	CAF	CIV	CMR	COD	COG	COK	COM	CPV
CRI	DJI	DMA	ERI	ETH	FSM	GAB	GEO	GHA	GIN	GMB	GRD
GTM	GUY	HND	HTI	IRN	JOR	KGZ	KHM	KIR	KNA	LBR	LCA
LIE	LSO	LVA	MCO	MDA	MDV	MHL	MKD	MNE	MOZ	MRT	MWI
MYS	NAM	NIU	NRU	PHL	PLW	PSE	RWA	SDN	SEN	SLB	SOM
SRB	SSD	STP	SUR	SWZ	TCD	TJK	TKM	TLS	TTO	TUV	TZA
UZB	VAT	VUT	WSM	ZWE							

☐ Adopted by ratification
■ Not adopted

Data: United Nations Treaty Collection

The Hague Code of Conduct

The Hague Code of Conduct against Ballistic Missile Proliferation (HCoC) is a set of voluntary norms seeking to address missile proliferation. Given the similarities between the technologies used in ballistic missiles and civilian rockets, the Hague Code also introduces transparency measures such as annual declarations and pre-launch notifications regarding ballistic missile and space launch programs. The HCoC also states that *'Space Launch Vehicle programs should not be used to conceal Ballistic Missile programs'.*[3] The HCoC was signed and entered into force in 2002 in the Hague (Netherlands). As of June 2023, a total of 143 nations had joined the HCoC (141 United Nations members, the Cook Islands and the Holy See).[4] However, the Hague Code of Conduct does not contain an effective verification and compliance mechanism. It also faces issues related to non-compliance.

INSTITUTION

The Hague Code of Conduct against Ballistic Missile Proliferation

Established 26 November 2002 143 Members

The Hague Code of Conduct against Ballistic Missile Proliferation (HCoC) is a multilateral, voluntary initiative aimed at preventing the spread of ballistic missiles capable of delivering weapons of mass destruction (WMD). Established in 2002, it complements existing non-proliferation measures like the Missile Technology Control Regime (MTCR). The HCoC promotes transparency and confidence-building through annual declarations on ballistic missile and space-launch programs, as well as pre-launch notifications. While not legally binding, it encourages responsible behavior among its 145 subscribing states, serving as a critical tool for global security by fostering dialogue and cooperation to limit the proliferation of missile technologies.

Guidelines for the Long-term Sustainability of Outer Space Activities

etween 2010 and 2018, the UN COPUOS working group negotiated what are known as Guidelines for the Long-term Sustainability of Outer Space Activities (LTS Guidelines). In June 2018, a total of 21 guidelines were adopted. The UN COPUOS guidelines are not legally binding. However, the states who have adopted the guidelines are responsible for the security and safety of space activities and may implement these rules into national legislation. Such steps are crucial, not only for states themselves but also for commercial and other non-state actors. Although the adoption of 21 guidelines was considered a substantive success, space activities are rapidly evolving, and the rules that were negotiated arguably do not sufficiently reflect the dynamic development of the space sector. Instead, they should be seen as the groundwork for developing a new set of guidelines, the LTS 2.0, in the near future.

Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects

Prevention of an arms race in space (PAROS) has been on the agenda since 1985. A draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT) was first proposed by China and Russia in 2008, and a revised version in 2014. In 2004, Russia pledged at the UN General Assembly First Committee 'not to be the first to place weapons of any kind in outer space'. However, the draft treaty was opposed by the United States due to its significant flaws. The PPWT, for instance, does not address direct ascent kinetic anti-satellite weapons, nor does it propose efficient verification mechanisms or exact definitions. Moreover, Russia irresponsibly tested a direct ascent kinetic anti-satellite weapon in 2021 and recently demonstrated advanced orbital operations that could relate to the testing of co-orbital anti-satellite weapons.

Reducing space threats through norms, rules, and principles of responsible behaviors

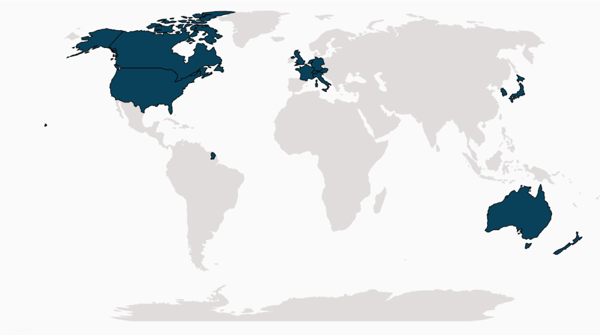
Due to the verification issues created by the dual-use nature of space technology and weapons, the alternative approach to the arms control of outer space is a gradual implementation of new norms, rules and principles of responsible behaviour that can create the foundation for viable legally binding arms control treaties in the future. The most notable initiative in this regard, building on the European Code of Conduct from 2012, is the 'Reducing space threats through norms, rules, and principles of responsible behaviors' resolution that was first adopted by the UN General Assembly in 2020. As part of this resolution, an open-ended working group (OEWG) has been established with the goal of making recommendations to the General Assembly. This norm-oriented resolution endorses a 'bottom-up' approach to space arms control and is widely supported by democratic states. However, countries like Russia and China are opposed to such initiatives and are stalling the process.

Destructive direct ascent anti-satellite missile testing

In 2022, the United States declared a self-imposed ban on direct ascent destructive anti-satellite weapons tests, further promoting new norms for responsible behaviour in outer space. While visiting Vandenberg Space Force Base in California on April 18, 2022, US Vice President Kamala Harris declared in regard to destructive anti-satellite tests:

> "I am pleased to announce that as of today, the United States commits not to conduct destructive direct-ascent anti-satellite missile testing. Simply put: These tests are dangerous, and we will not conduct them. We are the first nation to make such a commitment. And today, on behalf of the United States of America, I call on all nations to join us. Whether a nation is spacefaring or not, we believe this will benefit everyone, just as space benefits everyone. In the days and months ahead, we will work with other nations to establish this as a new international norm for responsible behavior in space. And there is a direct connection between such a norm and the daily life of the American people."
>
> Remarks by Vice President Kamala Harris on the Ongoing Work to Establish Norms in Space.

As of July 2023, a total of 14 nations had joined this commitment, including, alongside the United States, Australia, Austria, Canada, France, Germany, Italy, Japan, the Netherlands, New Zealand, South Korea, Switzerland, Lithuania and the United Kingdom



Member countries who joint the US in declaring a moratorium on destructive anti-satellite tests
PRIF/Grübelfabrik (CC BY NC)

In December 2022, the UN General Assembly approved a 'Destructive direct-ascent anti-satellite missile testing' resolution that '*calls upon all States to commit not to conduct destructive direct-ascent anti-satellite missile tests*[5]'. A total of 155 nations voted in favour of the resolution. However, nine countries, including Russia and China, opposed it. Moreover, UN resolutions are not legally binding. It would therefore be welcomed if more nations were to make official commitments to this international norm, which would reinforce space arms control and peaceful uses of outer space.

Conclusion

The governance of outer space, established through UN bodies and treaties such as the Outer Space Treaty, aimed to prevent space from becoming a battleground. However, challenges persist due to evolving technologies as well as disagreements among nations. Efforts to address the situation include arms control proposals and promoting responsible behaviour in space activities. Despite initiatives such as self-imposed bans on certain types of testing, global alignment on these commitments remains a challenge. Strengthening space governance requires updated frameworks that take technological advancements into account while fostering international cooperation for peaceful space exploration.

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

"Conference on Disarmament (CD)". The Nuclear Threat Initiative, 2023, available at: `[https://www.nti.org/education-center/treaties-and-regimes/conference-on-disarmament/]`.

"Destructive direct-ascent anti-satellite missile testing". 2022, available at: `[https://documents-dds-ny.un.org/doc/UNDOC/GEN/N22/738/92/PDF/N2273892.pdf?OpenElement]`.

"List of HCoC Subscribing States". The Hague Code of Conduct, 2020, available at: `[https://www.hcoc.at/subscribing-states/list-of-hcoc-subscribing-states.html]`.

"Text of the HCoC". The Hague Code of Conduct, 2012, available at: `[https://www.hcoc.at/what-is-hcoc/text-of-the-hcoc.html]`.

United Nations. 2023. "Space Law Treaties and Principles". United Nations Office for Outer Space Affairs, available at: `[https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html]`.

1. "Conference on Disarmament (CD)". The Nuclear Threat Initiative, 2023, available at: `[https://www.nti.org/education-center/treaties-and-regimes/conference-on-disarmament/]`.
2. United Nations. 2023. "Space Law Treaties and Principles." United Nations Office for Outer Space Affairs, available at: `[https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html]`.
3. "Text of the HCoC". The Hague Code of Conduct, 2012, available at: `[https://www.hcoc.at/what-is-hcoc/text-of-the-hcoc.html]` .
4. "List of HCoC Subscribing States". The Hague Code of Conduct, 2020, available at: `[https://www.hcoc.at/subscribing-states/list-of-hcoc-subscribing-states.html]`.
5. "Destructive direct-ascent anti-satellite missile testing". 2022, available at: `[https://documents-dds-ny.un.org/doc/UNDOC/GEN/N22/738/92/PDF/N2273892.pdf?OpenElement]`

6. The EU and space

The EU believes that without active diplomacy, incidents and even conflicts involving the space domain are inevitable. In 2008, the EU proposed an International Code of Conduct for Outer Space Activities and, between 2012 and 2015, held extensive consultations with many UN nations. However, apart from European countries and other 'like-minded' partners, it did not gather sufficient support and therefore had no concrete outcome.

In 2019, the EU launched the 'Safety, Security and Sustainability of Outer Space' (3SOS) public diplomacy initiative promoted by the European External Action Service (EEAS). This non-treaty-based effort to advance space security sidesteps the daunting task of defining space weapons or advocating a certain brand of arms control.

The 2016 EU Global Strategy confirmed that it plans to promote the security of its space-based services and work on principles for responsible space behaviour. The 2022 EU Strategic Compass identified space as a strategic domain and called for developing an EU Space Strategy for Security and Defence (EU SSSD), which was then adopted in 2023.

EUROPEAN UNION

EUROPEAN UNION SPACE STRATEGY FOR SECURITY AND DEFENCE

MARCH 2024

#EUDefence
#EUSpace
#StrategicCompass
#EUDefenceIndustry

Space is critical for our societies and economy and is a key enabler for security and defence.

In a geopolitical context of increasing power competition and intensification of threats to the EU and its Member States, EU leaders have identified in the Strategic Compass space as a strategic domain. As a result, the first **EU Space Strategy for Security and Defence** was released in 2023. While implementing this new strategy, **the EU is taking action to defend its interests, deter hostile activities in space and strengthen its strategic posture and autonomy.**

SPACE DOMAIN AND SPACE THREATS

The space domain includes all elements relevant for the functioning of space systems and the delivery of space-based services, including the physical space environment, different orbits and spacecraft, their ground and launch infrastructure, radio frequency links, user terminals, information related to and delivered from these space assets, the relating cyber environment and the underlying industrial space sector.

Threats generated by **counterspace capabilities** are directed against **space systems**, their supporting **ground infrastructure**, and the **data-links** between space systems and the ground infrastructure. **Counterspace capabilities** include direct-ascent and co-orbital anti-satellite systems, cyber attacks, electronic warfare and directed energy.

They can **disrupt, damage or destroy**, with **reversible or irreversible** effect.

The space sector and its **supply-chains** are also vulnerable to interferences by competitors.

UNDERSTANDING SPACE THREATS

The High Representative, with the support of Single Intelligence Analysis Capability, issues a classified **annual space threat landscape analysis** that includes the evolution of counterspace capabilities.

The EU Space Strategy for Security and Defence
https://defence-industry-space.ec.europa.eu/document/download/5e3dfcd1-2ff2-4fd1-85f7-74d0d9b62b3a_en

The EU Space Strategy endorses engagement in multilateral fora and the promotion of norms, rules and principles of responsible behaviours in outer space.

The five main pillars of the strategy are:[1]

- ensuring a shared understanding of space threats;
- enhancing the resilience and protection of space systems and services in the EU;
- strengthening the collective ability of the EU to respond to any attacks and threats putting at risk the EU's security interests;
- developing dual-use space capabilities, including for security and defence purposes; and
- fostering global partnerships.

The EU SSSD also encourages dialogue with third countries, in particular with the United States and other like-minded nations, including strengthening the EU's cooperation with NATO.[2] The latter recognised space as a new operational domain in 2019 and, in 2022, admitted that attacks to, from or within space present a clear challenge to the security of the Alliance and could lead to the invocation of Article 5 of the North Atlantic Treaty.[3]

EU Space Programme

In 2021, the EU Space Programme was implemented, establishing the European Union Agency for the Space Programme (EUSPA) in Prague, replacing and expanding the former European Agency for Global Navigation Satellite Systems (GSA). The new programme expands the role of EUSPA, adding two new components – management of the exploitation of Galileo and EGNOS. Most importantly, EUSPA became responsible for the security accreditation of all the components of the EU Space Programme.[4]

The five main components of the EU Space Programme[5] are:

- Galileo: Navigation (GNSS)
- EGNOS: Navigation (GNSS)
- Copernicus: Remote sensing (Earth observation)
- GOVSATCOM: Secure communication
- SSA: Space Situational Awareness

Conclusion

The European Union (EU) has actively pursued initiatives to address space security challenges and governance. Despite some setbacks in gaining broad support for specific proposals such as the International Code of Conduct for Outer Space Activities, the EU remains committed to ensuring the safety, security and sustainability of space activities. Through efforts such as the 'Safety, Security and Sustainability of Outer Space' (3SOS) initiative and the EU Space Strategy for Security and Defence (EU SSSD), the EU aims to enhance shared understanding of space threats, fortify the resilience of space systems, develop collective response capabilities and foster global partnerships. Engaging in dialogue with entities such as the United States and NATO, the EU emphasises collaborative efforts to address space security. The establishment of the European Union Agency for the Space Programme (EUSPA) under the EU Space Programme points to an expansion of the EU's role in navigation, remote sensing, secure communication and Space Situational Awareness.

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

EU. 2021. Regulation (EU) 2021/696. Official Journal of the European Union [online], available at: [https://eur-lex.europa.eu/eli/reg/2021/696/oj].

European Commission. 2023. "EU Space Strategy for Security and Defence". European Union, available at: [https://defence-industry-space.ec.europa.eu/eu-space-policy/eu-space-strategy-security-and-defence_en].

European Council. 2023. "EU cooperation on security and defence". European Union, available at: [https://www.consilium.europa.eu/en/policies/defence-security/#space].

Kaatz-Drzeżdżon, Ewelina. 2021. "New EU Space Regulation comes into force". Entrusted [online], available at: [https://entrusted.eu/news-events/news/space-programme-2021-2027-gives-new-prospects-2]

"NATO's Approach to Space". NATO, 2023, available at: [https://www.nato.int/cps/en/natohq/topics_175419.htm].

1. European Council. 2023. "EU cooperation on security and defence". European Union, available at: [https://www.consilium.europa.eu/en/policies/defence-security/#space].
2. European Commission. 2023. "EU Space Strategy for Security and Defence". European Union, available at: [https://defence-industry-space.ec.europa.eu/eu-space-policy/eu-space-strategy-security-and-defence_en].
3. "NATO's Approach to Space". NATO, 2023, available at: [https://www.nato.int/cps/en/natohq/topics_175419.htm].
4. Kaatz-Drzeżdżon, Ewelina. 2021. "New EU Space Regulation comes into force". Entrusted [online], available at: [https://entrusted.eu/news-events/news/space-programme-2021-2027-gives-new-prospects-2].
5. EU. 2021. Regulation (EU) 2021/696. Official Journal of the European Union [online], available at: [https://eur-lex.europa.eu/eli/reg/2021/696/oj]

7. New space race and competition for space partnerships

Space partnerships have become an operational, political and strategic centrepiece among major global powers. At the same time, the geopolitical environment has deteriorated significantly over the past decade, reflecting the ambition of powers such as China and Russia to assume greater leadership roles regionally and globally. In recent years, this has led to an escalation of conflicting interests and international competition between spacefaring powers, particularly the US and China.

2019 · Chandrayaan-2 Mission by India
India's Chandrayaan-2 mission aims to explore the Moon's south pole and investigate lunar water ice, marking a significant step in lunar exploration.

2019 · Chang'e-4 Lands on the Far Side of the Moon
China's Chang'e-4 spacecraft successfully lands on the far side of the Moon, becoming the first mission to achieve this feat.

2019 · US Establishes Space Force
The United States establishes the Space Force, emphasizing the growing importance of space as a military domain.

2020 · SpaceX's Crewed Test Flight to ISS
SpaceX conducts the first crewed test private sector flight to the ISS, carrying astronauts aboard the Dragon spacecraft, a historic milestone for commercial space travel.

2021 · Discussions on Space Regulation
Growing commercial space endeavors intensify discussions about regulating private sector activities in space, highlighting the need for governance frameworks.

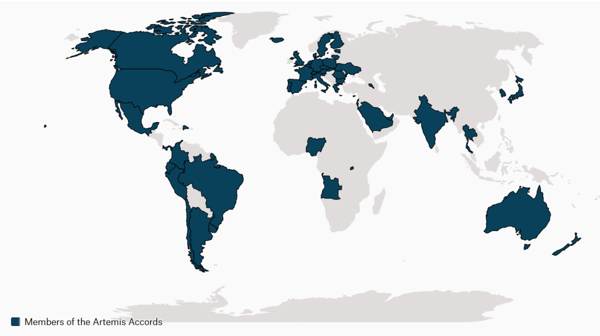
Present · Future Governance of Space Activities
Ongoing debates and initiatives focus on balancing innovation and security, shaping the future governance of space activities.

US-led international partnership: The Artemis Accords

Since the signing of a new Space Policy Directive in December 2017, the Artemis Program has been the flagship project of the United States Space Program. [1] It consists of an ambitious series of missions aimed at achieving the goal of returning men and women to the Moon and preparing for the next stage of Mars exploration. Core objectives include crewed lunar landings (Artemis I-III), putting the first extraterrestrial space station into orbit (Lunar Gateway, Artemis IV and beyond) and, in the longer term, establishing a permanent base on the Moon.

Although NASA has taken a leading role in the project, the Artemis Program is, by design, a multinational effort in which NASA works hand in hand with the agencies of Europe (ESA), Canada (CSA) and Japan (JAXA) as historical partners, particularly when it comes to the Gateway, and has announced cooperation with Israel (ISA), Australia (ASA) and India (ISRO). It also relies on close collaboration with private companies, such as SpaceX (Dragon, Falcon, Starship), Lockheed Martin (Orion), Boeing, Northrop Grumman (SLS) and Blue Origin (HLS).[2] The programme's core identity is rooted in fostering space exploration as a shared and common endeavour for humankind, as it brings together the expertise and capabilities of various nations and entities.

Conjointly with the programme, the US has advanced a body of non-binding arrangements, serving as a prerequisite for participation, called the Artemis Accords.[3] They are intended to serve as a comprehensive framework that outlines the principles and procedures for international cooperation in the exploration and exploitation of the Moon and other celestial bodies. The Accords consist of ten core principles derived from the foundational framework established by the 1967 Outer Space Treaty. These are principally designed to guide international partners towards sustainable practices and ensure the responsible and transparent use of outer space for peaceful purposes. The Artemis Accords are a significant multilateral attempt at reinforcing the aging body of space law that has been in existence since the Cold War. By signing the Accords, countries demonstrate their commitment to a democratic, fair and multilateral approach to space exploration. At the time of writing (December 2023), 33 nations are currently party to the Accords[4]



Member countries of the Artemis Accords

The Accords have also attracted some criticism. In particular, the clauses regarding the extraction of space resources are based on a limited interpretation of space being 'not subject to national appropriation' as outlined by the 1966 Outer Space Treaty.[5] The view taken by the Accords is that this only applies to national claims of sovereignty but not to private interests, and would thus allow some forms of space mining for commercial exploitation. This view is debated by legal scholars, although the only openly contradictory interpretation in international law exists in the 1979 Moon Treaty, which has been ratified by only three of the Accords' current signatories – Australia, the Netherlands and Saudi Arabia.[6]

Russia and China

Two major spacefaring nations have refused to participate in the collaborative effort spearheaded by the Artemis projects: China and Russia. Both the Chinese (CNSA) and Russian agencies (Roscosmos) have instead announced their own joint international programme, which aims to establish a permanent lunar base by the 2030s, the International Lunar Research Station (ILRS).[7]

China has become a particularly fast-rising player, seeking to establish a dominant position in space exploration and resource exploitation with an ambitious space programme. It aims to become a leading space power by 2045 and has promoted its space interests and partnerships via its Space Information Corridor and industrial strategies such as 'Made in China 2025' and 'China Standards 2035'.[8] China also pursues civil-military fusion, which is an aggressive national strategy to develop a 'world-class military' by 2049.[9] However, the authoritarian regime and lack of transparency of the Chinese Communist Party (CCP) raise concerns about the intentions behind and potential consequences of these activities. China does not have a history of being very inclusive with its partners when it comes to its programme and has been repeatedly accused of industrial espionage and intellectual property theft.[10] In light of this, in 2011, the U.S. Congress banned NASA from cooperating with CNSA, notably preventing China from contributing to the ISS.[11] As a result, China launched its own space station (Tiangong), which became fully operational in 2021.

In contrast to China, Russia's role in space is gradually declining and benefits mostly from the legacy of the Soviet Union. While it still collaborates with Western partners on the ISS, Russia has increasingly emphasised unilateral geostrategic and economic interests in the space domain and beyond, as seen in its 2021 National Security Strategy.[12] Although it still possesses significant launch and satellite-building capabilities, Russia's space programme, in particular after the 2014 and 2022 aggression against Ukraine, has suffered from losing access to Western technologies and is becoming increasingly dependent on players such as China as suppliers of materials and innovation.[13]

One substantial part of China's and Russia's strategic initiatives in space is the building of space infrastructure and the proliferation of related technologies, equipment and services to other countries. This is often done against internationally negotiated norms and by means of heavily subsidised pricing, which creates unfair competition for the rest of the world. Their partnerships also create problematic economic and political dependencies, and fail to foster the sustainable development of the space sector in the recipient countries by obviating the need for indigenous capabilities and expertise.[14]

Conclusion

In the modern space race, global powers such as the US, China and Russia compete fiercely for space dominance. The US leads with the Artemis Program, involving multiple nations and private companies, while China is rapidly advancing its space programme, with its eye on global leadership. Russia's space influence is waning, as it faces challenges due to geopolitical tensions and reliance on China. Amidst this competition, concerns arise about fairness and transparency in global space partnerships. As nations vie for supremacy, the race for space not only drives technological advancements but also shapes global power dynamics and ethical considerations

Quiz

View quiz at `https://eunpdc-elearning.netlify.app/lu-08/`

Sources for this chapter

China National Space Administration. "JOINT STATEMENT Between CNSA And ROSCOSMOS Regarding Cooperation for the Construction of the International Lunar Research Station". 29 April 2021, available at: [`https://www.cnsa.gov.cn/english/n6465668/n6465670/c6811967/content.html`].

Cooper, Julian. 2021. “Russia’s updated National Security Strategy”. Russian Studies Series 2/21, available at: [https://www.ndc.nato.int/research/research.php?icode=704#_edn1].

NASA. “Artemis Accords”, available at: [https://www.nasa.gov/artemis-accords/].

NASA. “Artemis Partners”, available at: [https://www.nasa.gov/artemis-partners/].

Pekkanen, Saadia M. 2019. “Governing the New Space Race”. AJIL Unbound 113: 92–97, available at: [https://doi.org/10.1017/aju.2019.16].

Robinson, Jana/Kukpová, Tereza B./Martínek, Patrik. 2020. “Strategic Competition for Space Partnerships and Markets”. In: Shrogl, K. (eds) Handbook of Space Security. Cham: Springer, available at: [https://doi.org/10.1007/978-3-030-23210-8_141].

Sheehan, Matt/Blumenthal, Marjory/Nelson, Michael R. “Three Takeaways From China’s New Standards Strategy”. Carnegie Endowment for International Peace, 28 October 2021, available at: [https://carnegieendowment.org/2021/10/28/three-takeaways-from-china-s-new-standards-strategy-pub-85678].

United Nations. “Agreement governing the Activities of States on the Moon and Other Celestial Bodies”. Treaty Collection, New York, 5 December 1979, available at: [https://www.state.gov/united-states-welcomes-the-republic-of-angolas-signature-of-the-artemis-accords/].

United Nations. “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies”. RES 2222 (XXI), 19 December 1966, available at: [https://www.unoosa.org/oosa/oosadoc/data/resolutions/1966/general_assembly_21st_session/res_2222_xxi.html].

U.S. Congress. “Department of Defense and Full-year Continuing Appropriations Act, 2011”. Public Law 112-10, 15 April 2011, available at: [https://www.congress.gov/112/plaws/publ10/PLAW-112publ10.pdf].

U.S. Department of Defense. 2023. “Military and Security Developments involving the People’s Republic of China”. Annual Report to Congress, available at: [https://media.defense.gov/2023/Oct/19/2003323409/-1/-1/1/2023-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA.PDF].

U.S. Department of State. “United States Welcomes the Republic of Angola’s Signature of the Artemis Accords”. Media Note, Office of the Spokesperson, 4 December 2023, available at: [https://www.state.gov/united-states-welcomes-the-republic-of-angolas-signature-of-the-artemis-accords/].

Vidal, Florian/Privalov, Roman. 2023. “Russia in Outer Space: A Shrinking Space Power in the Era of Global Change”. Space Policy, available at: [https://doi.org/10.1016/j.spacepol.2023.101579].

White House. “Space Policy Directive-1, Reinvigorating America’s Human Space Exploration Program”. Presidential Memoranda, Washington, D.C., 11 December 2017, available at: [https://2017-2021.state.gov/space-policy-directive-1-reinvigorating-americas-human-space-exploration-program/].

1. White House. “Space Policy Directive-1, Reinvigorating America’s Human Space Exploration Program”. Presidential Memoranda, Washington, D.C., 11 December 2017, available at: [https://2017-2021.state.gov/space-policy-directive-1-reinvigorating-americas-human-space-exploration-program/].
2. NASA. “Artemis Partners”, available at: [https://www.nasa.gov/artemis-partners/].
3. NASA. “Artemis Accords”, available at: [https://www.nasa.gov/artemis-accords/].
4. U.S. Department of State. “United States Welcomes the Republic of Angola’s Signature of the Artemis Accords”. Media Note, Office of the Spokesperson, 4 December 2023, available at: [https://www.state.gov/united-states-welcomes-the-republic-of-angolas-signature-of-the-artemis-accords/].
5. United Nations. “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies”. RES 2222 (XXI), 19 December 1966, available at: [https://www.unoosa.org/oosa/oosadoc/data/resolutions/1966/general_assembly_21st_session/res_2222_xxi.html].
6. United Nations. “Agreement governing the Activities of States on the Moon and Other Celestial Bodies”. Treaty Collection, New York, 5 December 1979, available at: [https://www.state.gov/united-states-welcomes-the-republic-of-angolas-signature-of-the-artemis-accords/]
7. China National Space Administration. “JOINT STATEMENT Between CNSA And ROSCOSMOS Regarding Cooperation for the Construction of the International Lunar Research Station”. 29 April 2021, available at: [https://www.cnsa.gov.cn/english/n6465668/n6465670/c6811967/content.html].
8. Sheehan, Matt/Blumenthal, Marjory/Nelson, Michael R. “Three Takeaways From China’s New Standards Strategy”. Carnegie Endowment for International Peace, 28 October2021, available at: [https://carnegieendowment.org/2021/10/28/three-takeaways-from-china-s-new-standards-strategy-pub-85678].
9. U.S. Department of Defense. 2023. “Military and Security Developments involving the People’s Republic of China”. Annual Report to Congress, available at: [https://media.defense.gov/2023/Oct/19/2003323409/-1/-1/1/2023-MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA.PDF]
10. Robinson, Jana/Kukpová, Tereza B./Martínek, Patrik. 2020. “Strategic Competition for Space Partnerships and Markets”. In: Shrogl, K. (eds) Handbook of Space Security. Cham: Springer, available at: [https://doi.org/10.1007/978-3-030-23210-8_141].
11. U.S. Congress. “Department of Defense and Full-year Continuing Appropriations Act, 2011”. Public Law 112-10, 15 April 2011, available at: [https://www.congress.gov/112/plaws/publ10/PLAW-112publ10.pdf].
12. Cooper, Julian. 2021. “Russia’s updated National Security Strategy”. Russian Studies Series 2/21, available at: [https://www.ndc.nato.int/research/research.php?icode=704#_edn1].
13. Vidal, Florian/Privalov, Roman. 2023. “Russia in Outer Space: A Shrinking Space Power in the Era of Global Change”. Space Policy, available at: [https://doi.org/10.1016/j.spacepol.2023.101579]
14. Robinson, Jana/Kukpová, Tereza B./Martínek, Patrik. 2020. “Strategic Competition for Space Partnerships and Markets”. In: Shrogl, K. (eds.) Handbook of Space Security. Cham: Springer, available at: [https://doi.org/10.1007/978-3-030-23210-8_141].

Terms

Space Security
This refers to the safeguarding of space assets and ground segments from threats or disruptions that could impact national security, defence and civilian applications.