

The Cologne Manual on Space Traffic Management

(CM-STM)

Co-operation project between the Institute of Air Law, Space Law and Cyber Law at
the University of Cologne and the German Aerospace Center (DLR)

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Abbreviations

AI	Artificial Intelligence
AIS	Aeronautical Information Services
ANSPs	Air Navigation Service Providers
ARRA	The Rescue and Return Agreement (1968)
ASA(s)	Air Services Agreement(s)
ASM	Airspace Management
ATC	Air Traffic Control
ATS	Air Traffic Services
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
CDMs	Conjunction Data Messages
CM-STM	Cologne Manual on Space Traffic Management
CONOPS	concept of operations
DLR	German Aerospace Center
EASA	European Union Aviation Safety Agency
ESA	European Space Agency
EU	European Union
EU ETS	European Union Emissions Trading System
EUSPA	European Union Agency for the Space Programme
EU SST	European Union Space Surveillance and Tracking
FAA	Federal Aviation Administration (USA)
GEO	Geostationary Orbit
IADC	Inter-Agency Space Debris Coordination Committee
ICAN	International Commission for Air Navigation
ICAO	International Civil Aviation Organisation
IHL	International Humanitarian Law
ILA	International Law Association
ILO	International Labour Organisation
IMO	International Maritime Organisation
ISO	International Organization for Standardization
ISS	International Space Station
IT	Information Technology



ITU	International Telecommunications Union
JAXA	Japanese Aerospace Exploration Agency
LEO	Low Earth Orbit
LIAB	The Liability Convention (1972)
LOAs	Letters of Agreement
LTS Guidelines	Long-term Sustainability Guidelines
MEO	Medium Earth Orbit
MOON	The Moon Agreement (1979)
NASA	National Aeronautics and Space Administration
NEOs	Near-Earth Objects
NOTAM	Notice to Air Missions (Notice to Airmen)
OST	The Outer Space Treaty (1967)
REG	The Registration Convention (1975)
RegPractRes	Registration Practices Resolution
SDMG	Space Debris Mitigation Guidelines
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
STC	Space Traffic Coordination
STM	Space Traffic Management
SWIM	System Wide Information Management
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea (1994)
UNCOPUOS	United Nations Committee for the Peaceful Uses of Outer Space
UNGA	United Nations General Assembly
UNOOSA	United Nations Office for Outer Space Affairs
UNSG	Secretary General of the United Nations
US SSN	United States Space Surveillance Network
VFR	Visual Flight Conditions



General introduction to the Cologne Manual on Space Traffic Management

The rapid evolution of technology is enabling more actors and more activities in outer space than at any point in human history and is projected to continue to steadily grow in future. Consequently, space traffic has reached unprecedented numbers of active space objects as well as of the accumulation of space debris, which endangers active space objects. Meanwhile, Earth's orbits are a finite resource, and the risk of collision has become a near daily reality of space object operators. The burgeoning activities in outer space – encompassing launches, space exploration and use, and scientific research – therefore necessitate a robust system to manage these endeavours responsibly.

In the ever-evolving landscape of outer space, a significant collaboration has emerged between the Institute of Air Law, Space Law, and Cyber Law at the University of Cologne and the German Aerospace Center (DLR). This partnership has been dedicated to a three-year project which developed a comprehensive study on Space Traffic Management (STM). At the heart of this initiative has been the creation of the "Cologne Manual on Space Traffic Management," which aspires to formulate scientifically grounded yet practical guidelines akin to a "traffic code" for outer space. This endeavour not only builds upon the historical collaborations between the Institute and the DLR but also responds to the growing complexities of space activities, particularly as private entities increasingly participate in space exploration and utilisation.

I. Project Overview and Objectives

The primary objective of this project has been to produce the Cologne Manual as a scientifically and legally sound and practically applicable framework for Space Traffic Management. The urgency of this task is underscored by the mentioned exponential rise in space activities, which necessitates a robust regulatory framework to minimise collision risk and formation of space debris. Presently ad hoc measures are being exercised in practice to coordinate and manage space traffic, however, the success of these is credited to still manageable numbers. The space sector is swiftly entering an era of a boom similar to the one experienced in post second world war aviation. This promises to strain present technological tracking and monitoring capabilities and make numbers of space traffic unmanageable. The existing large constellations such as Starlink are already testing the present ad hoc coordination measures, and their continued effectiveness is relying on Starlink self-manoeuving initiative and low risk thresholds triggering a manoeuvre. With space activity projected to steadily rise and as further large constellations are in the planning by the USA, UK, China and others, such measures and space traffic will in a very short time become untenable. A systematic, scientifically



and legally sound and practically applicable framework for Space Traffic Management is urgently required.

The Institute of Air Law, Space Law and Cyber Law at the University of Cologne has leveraged its considerable legal expertise in aviation, space and cyber domains to produce the Cologne Manual on Space Traffic Management. The DLR, with a wealth of practical experience in both aerospace and aviation sectors, significantly contributed to the project, making this collaboration particularly well-suited to address the intricate dimensions of STM.

Over the course of three years, the project unfolded in several stages, culminating in the formulation of a concrete Manual for regulation of space traffic. To facilitate this, over 40 international experts have been working together, spanning five continents and various professions in the legal as well as technical fields, including experts from space agencies such as the European Space Agency (ESA), the Japanese Aerospace Exploration Agency (JAXA), the Brazilian Space Agency and the Kenya Space Agency (KSA). During the work of the project, four working groups have been established, each focusing on key legal and technical areas essential to the development of a comprehensive STM framework. The first group concentrated on existing space law and its current regulatory landscape, assessing the potential for necessary improvements. The second group explored the intersection of air traffic management and space traffic, investigating whether established concepts from aviation can be adapted for use in outer space and how rising air and space traffic can be safely synchronised. The third group addressed the necessity of facilitating a sustainable space traffic, and, finally, the fourth group focused on cyber security issues in the context of STM.

The collaborative nature of the project was designed to foster continuous dialogue among the working groups, with several interim conferences synthesising findings and sharing insights. Additionally, experts outside the project have been consulted for specific issues and panel discussions have been held to include the different facets space traffic offers. The ultimate goal has been achieved by producing the Cologne Manual, a tangible and actionable document that integrates all relevant legal and practical perspectives on STM.

II. Significance of the Cologne Manual

The Cologne Manual on Space Traffic Management is envisioned as a pivotal contribution to the field of international space regulation.



The project aims to advance the academic and governmental discourse surrounding space regulations and to promote international dialogue on issues of space, air, and cyber law as well as sustainability. By institutionalising the exchange of knowledge among the four working groups, the Cologne Manual encapsulates a forward-thinking approach to STM, addressing the pressing challenges posed by increasing space traffic and the associated risks. It ultimately proposes concrete Guidelines, which can be directly implemented by space object operators as well as by national and international legislators. It thus hopes to provide foundational groundwork for a future comprehensive Space Traffic Management, which builds on existing ad hoc measures and the five United Nations Space Treaties.

III. Research Framework and Methodology

The project adopts a comprehensive legal and technical approach to STM, integrating various perspectives to address the central research questions that underlie the creation of a robust STM framework. Key legal principles from the Outer Space Treaty of 1967, the Registration Convention of 1975, and the Liability Convention of 1972 have served as foundational elements in the development of the Cologne Manual.

Furthermore, the project considered three elements essential to the research; firstly, the necessity of coordination between all stakeholders, including with international organisations, in particular the International Telecommunication Union (ITU) to mitigate harmful interferences; secondly, examination of emerging technologies in space debris remediation and their relevance to STM; thirdly, military uses of outer space, ensuring that the principles of transparency and safety are maintained without compromising security interests.

The project identified research questions, which have then been systematically categorised and assigned to the respective working groups, which have explored the nuances of space traffic regulations, the coordination of air and space traffic, and the implications of sustainability and cyber security in the context of STM. By fostering collaboration among more than 40 international experts in these fields, the project aims to generate a holistic understanding of the challenges and opportunities inherent in managing space traffic.

IV. Key Information regarding the Cologne Manual

Several points should be observed throughout the Cologne Manual.

First, the Guidelines should therefore be interpreted in a manner that ensures and maintains the freedom of access and usability of outer space, thus the “freedom of exploration and use” guaranteed by Article I of the Outer Space Treaty (OST), through facilitating the safe coordination and management



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of space traffic for secure and safe space operations, which are the aim of the Cologne Manual. Nothing in the Cologne Manual should consequently be interpreted in a manner that would unduly and legally restrict freedom of access to and use of outer space guaranteed by Article I of the OST for certain stakeholders or that would injure State sovereignty in space objects protected by Article VIII of the OST.

Second, all space actors should abide by the Guidelines. The Guideline on Non-Governmental Space Activities and Guideline on Military Space Activities are therefore relevant throughout the Cologne Manual and all Guidelines of the Cologne Manual are applicable to governmental as well as non-governmental actors, while military operators may in all instances deviate from the required level of transparency when required for purposes of State security.

Third, space object operator should be understood as both governmental and non-governmental space object operator including both launch operator and operator of space objects in-orbit unless specified otherwise.

V. Conclusion

The Cologne Manual on Space Traffic Management represents a significant step forward in the development of international legal frameworks governing outer space activities. By leveraging the strengths of the Institute of Air Law, Space Law and Cyber Law, the German Aerospace Center and all other participating experts and their institutions, this project produced a comprehensive and practical guide that addresses the complexities of contemporary space traffic management. With the publication of the project, it promises to enhance the scientific discourse surrounding space law and contribute to the establishment of a sustainable and secure regulatory environment for future space endeavours, addressing not just States but also operators.

All the information collated, and the references cited are cross-checked in line with the most recent data, as of May 2025.



The Imperative of Space Traffic Management: A Comprehensive Framework Rooted in the Principles of International Space Law

I. The Concept of Space Traffic Management

Space Traffic Management aims at the development of technical and regulatory guidelines for space traffic. Any use of outer space, be it the launch into outer space, the operation in and travel through outer space or the return from outer space should be undertaken in a manner that takes into account the unique nature of this province of all humankind. This is the expression of the spirit of the international space legislation, which does not explicitly mention Space Traffic Management, but which signals that the unique environment must be preserved for the further use of humankind today and for future generations. In that the concept of Space Traffic Management requests the adoption of measures to minimise collisions in outer space and thus the generation of space debris, it is the background of any sustainable use and thus ultimately a concept for the continues accessibility and usability of outer space.

Presently, STM already exists and is being performed by space object operators, including launch (i.e. rocket) operators as well as in-orbit space object (e.g. payload) operators, on an ad hoc basis. These coordinating and management efforts, however, suffer from lack of transparency, consistency, available instructions for emerging operators, break-downs in communication and a myriad of competing approaches to STM that prolong efficient space traffic coordination.¹ A systematic international STM is required and is already subject of discussions on national, regional and international level by a variety of actors and stakeholders, ranging from academia, to government, to private industry. For instance, STM has been introduced as UNCOPUOS Agenda Item in 2016.²

1) These fruitful discussions have proposed various definitions of the concept which elucidate several building blocks of STM concepts as an organisational and operational structure, composed of technical as well as legal or regulatory measures, including notification of dangers and execution of coordination among different actors. These measures are intended to minimise risks of loss of operations, physical collisions or other detrimental effects or interference, e.g. radiofrequency interference, between primarily space operations into, through, in and out of outer space. The latter therefore includes preventing physical collision or other detrimental effects and interference with or by non-

¹ See e.g. ESPI, Report 71 (2020).

² UN Doc. A/RES/71/90 (2016).



space operations in airspace, or on and from ground. These should be observed throughout all phases of space activity to assure safety of space operations, thus impacting planning and operation of space activities.

Practice illuminates that STM requires monitoring through appropriate space surveillance capabilities, coordination supported by proper information-sharing, and finally regulation enabling organised process of long-term accessibility and usability of outer space without detrimental interference through systematic, consistent and coordinated approach and synchronisation of space activities to enhance safety, stability and sustainability of space operations, including compliance with best practices and development of international standards. The discourse has illustrated that presently focus is placed on necessity to systematise the process of prevention collisions between physical objects, requiring reliable monitoring and coordinating capacities, which still face several obstacles. Discussions have portrayed that the development of an international synchronised STM adapted to this aim, therefore requires geo-political will, adoption of space “traffic rules” and mechanisms for implementation that will enable the efficient and quick functioning of a systematic collision avoidance process that identifies high probability of collision conjunctions and delivers conjunction data messages (CDMs) to an operator, who then acts in accordance with the space “traffic rules”.

It therefore ultimately amounts to a regime idea that would be able of guaranteeing accessibility and usability of outer space in an increasingly congested operational environment through facilitating safe, secure and stable space operations. It is the aim of STM consequently to facilitate and enable the implementation of the freedom of access and use of outer space and should not be misused in a manner that would unduly restrict these freedoms guaranteed by Article I of the OST or State jurisdiction in space objects guaranteed by Article VIII of the OST. Development and adherence to an international STM permitting the monitoring, notification, coordination and synchronisation of actionable collision avoidance – passive or active – to assure safety, security and stability of ever-increasing space traffic is consequently in the benefit of all as well as in the self-interest of space-faring nations and space object operators, and other stakeholders.

1. The Outer Space Treaty and Its Relevant Core Principles

As humanity’s presence in outer space intensifies, the urgency for an effective framework for Space Traffic Management (STM) becomes increasingly pronounced. This management is inherently linked to the established principles of international space law, particularly as articulated in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, known as the Outer Space Treaty of 1967. This treaty serves as



the cornerstone of the building blocks of the Cologne Manual, outlining fundamental norms that regulate the use and exploration of outer space.

The OST posits that outer space is the province of all humankind, encapsulating the dual tenets of freedom of exploration and use and the necessity for responsible stewardship of outer space. As the number of active satellites increases, along with the proliferation of space debris and the rising potential for collisions, the necessity to establish effective management becomes crucial to safeguarding and upholding these freedoms.

The OST has been drafted in general terms as a treaty on principles, in order to allow it to become a living instrument capable of incorporating the newest developments in space technology and activities, and thus not be outdated by the passage of time. In accordance with customary interpretational principles, treaty terms and the law evolve with time and technology, and must be interpreted in accordance with relevant contemporary factors. Therefore, the OST remains a vital foundational bedrock of all space exploration and use.

This section will elucidate the current legal framework (*de lege lata*) and how the fundamental principles of international space law underpin the establishment of a comprehensive STM system. The following will particularly focus on the OST and its innovative interpretations, providing insights into how these principles can inform the development of STM principles, as exemplified in the Cologne Manual. These principles decree that outer space is an area beyond national jurisdiction and shall be free for exploration and use by all States, without any discrimination, that it must be utilised for peaceful purposes, and that States bear responsibility for national space activities, including those conducted by non-governmental entities. The following will delve into these principles, their design and elucidate their significance for STM and their incorporation in the Cologne Manual.

1. Freedom of Exploration and Use

Article I of the OST stipulates that outer space shall be free for exploration and use as well as for scientific investigation to all States without discrimination of any kind, shall be undertaken for the benefit of all States and shall be the province of all humankind. By decreeing that outer space *shall be free for exploration and use by all States*, Article I establishes the right to do so and a duty to maintain conditions that technically enable the enjoyment of the freedoms. This principle thus predicts and necessitates the establishment of an effective and functional STM. The rapid proliferation of space objects such as satellites enabling communication, Earth observation, navigation, scientific research, provision of internet services and other, often crucial, services has resulted in an increasingly congested orbital environment. The evolution of large constellations of satellites, comprising



hundreds and even thousands of active space objects, has furthermore strained the orbital environment, rendering the possibility of collisions in-orbit at an all-time high. While the preceding activities are permitted to States and non-state actors under the freedom of exploration and use, and scientific investigation, it furthermore places obligations on the self-same actors to adopt measures for the preservation of the freedom of exploration and use. The current Space Traffic Coordination (STC) measures are being challenged by the exponential increase in orbital traffic and may no longer suffice to guarantee long-term access and freedom of exploration and use to all. Therefore, it is imperative that the principle of the freedom of exploration and use as well as scientific investigation is prominently represented in the Preamble of the Cologne Manual, highlighting its significance in the context of STM.

2. Non-Appropriation Principle

Article II of the OST, decrees that no State may claim sovereignty over outer space or the celestial bodies, ensuring that outer space remains an area beyond national jurisdiction. Read together with Article I of the OST, this provision therefore delineates outer space as a global common or *res communis*, similar to the High Seas, where freedom of navigation is complimented by duties of States to ensure continued freedom of navigation for all. This principle has been instrumental in preventing conflict in outer space and therefore, as echoed in Article 11 of the Moon Agreement,³ is fundamental for fostering an environment conducive to collaboration and shared exploration and use. To underscore its importance and support for STM, the Preamble of the Cologne Manual explicitly references this principle, reinforcing the notion that space activities must be conducted in a manner that respects the collective interests of all nations.

3. In Accordance with International Law

Article III of the OST clarifies that all space activities must be conducted in accordance with international law including the United Nations Charter. This not only clarifies that the principles of the OST must be interpreted with regard to all norms of international law but also means that norms of customary international law as well as general principles of law apply in outer space, such as the principle of “sustainable development”. The “no harm rule” as an international custom necessitates that all activities within a State’s jurisdiction are undertaken with a degree of due diligence and observe the required standards of care, in order to prevent damage occurring to areas beyond national jurisdiction, such as outer space. As this enables the application of soft-law instruments enshrining or elucidating

³ Art.11 Moon Agreement, in: Hobe/Schmidt-Tedd/Schrogl (eds.), *Cologne Commentary on Space Law*, Vol. II, Carl Heymanns, Cologne 2013, p. 389, mn 175.



international standards and best practices, such as the UNCOPUOS Space Debris Mitigation Guidelines, this principle will be underscored in the Cologne Manual as requiring that States and non-state actors comply with STM measures.

4. Military Activities

Following the preamble of the OST, the peaceful exploration and use of space is a vital element of international cooperation in outer space. Additionally, the preamble explicitly references the work done by the Committee on the Peaceful Uses of Outer Space,⁴ a Committee that has been “set up by the General Assembly in 1959 to govern the exploration and use of space for the benefit of all humanity”.⁵ Article IV of the OST adds to this a prohibition of the placement of nuclear weapons or other weapons of mass destruction in outer space. Many activities in outer space use technology supported by the military or utilise military resources. Military activity, like any other, must be in line with the framework of the OST. From an operational and technical aspect there is no difference between military and civil or commercial space traffic, therefore, universal adherence to measures of an effective and functional STM for safe coordination of space traffic is essential. Only through adherence of all actors to a global STM can continued access to and usability of outer space also for military purposes be assured (see Guideline 9).

5. Authorisation and Supervision

Article VI of the OST places the onus of responsibility on States for national activities in outer space and for assuring that these are carried out in conformity with the OST, including activities executed by non-governmental actors e.g. private entities, whose conduct must be authorised and supervised by the appropriate State. This principle has gained heightened relevance in light of the recent surge in commercial space activities, necessitating robust mechanisms for authorisation and supervision, and assuring compliance with the regulatory framework for outer space, normally adopted in national space legislation. In short, through this provision the OST ensures that non-governmental activity complies with its provisions and makes States responsible for ensuring and supervising compliance. Thus, States are accountable for their actions in outer space, including those carried out by private actors and should adopt national legislation to govern such activities via appropriate licencing and supervisory procedures. Considering the increasing participation of non-state actors in space activities, the effective implementation of STM Building Blocks as proposed in the Cologne Manual will

⁴ Committee on the Peaceful Uses of Outer Space, Report A/6431 (1966).

⁵ UNOOSA, “Committee on the Peaceful Uses of Outer Space”, <https://www.unoosa.org/oosa/en/ourwork/copuos/index.html> (last accessed 09.01.1025).



rely on the incorporation of this principle, particularly regarding the regulation and oversight of non-governmental space activities, in national space legislation (see Guideline 2).

6. Liability

Article VII of the OST, further elaborated on in the Liability Convention of 1972, addresses liability for damage caused by space objects. This international liability is tied to the concept of launching State, i.e. the State that launches, procures the launch or from whose territory or facility an object is launched.⁶ International space law determined that absolute liability should be borne for any damage caused on Earth or to aircraft in flight, while fault-based liability should be in place for any damage occurring in outer space as space actors willingly expose themselves to the possibility of damage being caused. While this principle does not occupy a standalone section in the Cologne Manual, it is essential for the overarching framework of STM.

Liability considerations are reflected in the Cologne Manual as it is understood that non-conformity with the due diligence STM requirements can be interpreted as constituting fault under the outer space liability regime. Besides the applicable rules of liability on an international level, liability is also an important concept of national legal systems. It is the recommendation that, in line with existing practice, any national liability of entities providing services relevant and crucial for STC and STM, including SSA activities, that may result in damage should be regulated contractually (see Commentary to Guidelines 8, 9 and 10).

7. Jurisdiction and Control

Article VIII of the OST affirms that a State, which registers an object launched into outer space on its national registry, retains jurisdiction and control over it and any personnel thereof, thus establishing a vital legal foundation for space activities. Under this principle all nationally registered space objects and any personnel thereof are subject to the exclusive legal authority of the registering State and in accordance with international law no other State may therefore interfere with these objects without consent of the registering State. State jurisdiction, as an instrumental element of State sovereignty, forms a foundational element of international law.⁷ Therefore, nothing in the Cologne Manual should be interpreted in a manner inconsistent with this principle.

⁶ Art. I Liability Convention.

⁷ *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986.



8. Registration of Space Objects

Article VIII of the OST furthermore mandates registration of space objects, further elaborated in the Registration Convention (REG) of 1975 and the United Nations General Assembly Resolution on Enhancing Registration Practices A/RES/62/101 (2007).⁸ Registration is essential for a functional STM as it introduces a level of transparency into space activities and as it represents the link between the object and the State's jurisdiction and control. Transparency of this jurisdictional link is an important prerequisite for the sustainable coordination and management of space traffic. Thereafter, the State of Registry retains jurisdiction and control over the object and its personnel. The Registration Convention predicted that the registration should be undertaken by one of the launching States and furthermore added an obligation to forward specified⁹ information to the Secretary General of the United Nations, as soon as practicable. This implicit transparency and information sharing requirement will help guide the creation and continued functioning of an efficient STM. Thus, it is crucial to highlight the importance of registration (see Guideline 3) as a starting point for an operational STM.

9. Due Regard, Harmful Interference and Environmental Protection

Article IX of the OST enunciates the principle of "due regard" and the necessity of undertaking consultations to avoid harmful interference with the activities of other States. It was conceived following potentially harmful experiments at the beginning of the space age resulting in the demand of space actors that all activities must be carried out with due regard for the activities of others, employing such international tools as cooperation and consultations. Due regard can most readily be explained as the requirement to observe the required standard of care or due diligence in space activities, by, for example, following the appropriate guidelines and international standards to avoid causing damage to and harmful interference with the activities of other space actors. Article IX of the OST should therefore be understood as encompassing the prevention of harmful interference and the promotion of safe practices in outer space, such as effective space traffic coordination (see Guideline 5). Ahead of its time, Article IX of the OST furthermore enshrined the agreement of States to conduct activities in a manner that does not cause harmful contamination of outer space or cause adverse changes in the

⁸ Convention on Registration of Objects Launched into Outer Space, 1023 UNTS 15, adopted on 14 January 1975, entered into force on 15 September 1976.

⁹ Article IV of the REG decrees that for each space object the following information should be forwarded to the Secretary General of the United Nations, as soon as practicable: Name of launching State or States; An appropriate designator of the space object or its registration number; date and territory or location of the launch; basic orbital parameters including nodal period, inclination, apogee, perigee and general function of the space object.



atmosphere of the Earth. Recognising that the safeness of the operational environment for space activities determines the viability of human activity in it, this provision aids in ensuring the freedom of space exploration and use guaranteed by Article I of the OST by keeping the space environment free from obstruction and danger. This principle must therefore be prominently featured in both the Preamble and the commentary sections of the Cologne Manual, signifying the importance of mutual consideration among States engaged in space activities to keep the space environment free of obstacles that could hinder the freedom of exploration and use (see Commentary Guideline 11).

This alignment supports the establishment of norms and guidelines for STM that are consistent with the treaty's objectives. The Cologne Manual, therefore, advocates for best practices that reflect this obligation, underscoring the importance of peaceful coexistence and cooperation in outer space.

10. International Cooperation

Moreover, to ensure the objectives of the OST as enumerated in the illuminated principles of the OST, Article IX of the OST encourages States to engage in international cooperation and mutual understanding underscoring that all space activities should be undertaken in the spirit of cooperation. It thus builds the foundations for respectful cooperation between nations. International cooperation, as enshrined in the OST, is paramount for establishing a comprehensive STM framework and a vital tool guaranteeing its success. Collaborative efforts among States, intergovernmental organisations, and the private sector can facilitate information sharing, the development of best practices, and the establishment of common operational standards crucial to space traffic coordination. STM encompasses the processes and systems governing the movement of space objects to ensure safe and sustainable operations in outer space, including tracking, monitoring, and coordinating of space activities to prevent collisions and effectively manage space debris (see Guidelines 7, 8, 9 and 11) and as such relies on the efficient and comprehensive international cooperation.

11. Information Sharing

Article XI of the OST explains one of the preferred modes of international cooperation as an obligation of information sharing, specifically referencing that State Parties “agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results” of their space activities. Requiring the sharing of relevant information for space traffic coordination and STM will feature prominently in the Cologne Manual (see Guidelines 4 and 5). Article XI of the OST and information exchange are essential for a functional space traffic coordination and STM.



12. The Role of International Organisations

Overall, the OST encourages international cooperation in the peaceful exploration and use of outer space, recognising that the challenges and opportunities in outer space transcend national boundaries. International cooperation therefore also includes the development of international guidance on space activities such as the UNCOPUOS Space Debris Mitigation Guidelines¹⁰, the UNCOPUOS Long-Term Sustainability Guidelines¹¹, capacity building measures, etc. (see Guidelines 3 and 11). This is not just the overarching theme of the OST, but also the foundation for a practicable STM. For these reasons the role of international organisations, in particular the Organisation of the United Nations with its Office for Outer Space Affairs (UNOOSA) and the United Nations Committee on the Peaceful Uses of Outer Space as sub organ of the UN General Assembly, the International Telecommunication Union (ITU) as well as International Civil Aviation Organization (ICAO), transcend national boundaries, with launches transitioning through national and often international airspace, is vital in facilitating discussions on STM, coordinating efforts, developing and sharing best practices, and promoting compliance with international norms.

2. Conclusion

Having outlined the core principles of the OST, it is essential to understand that these principles interrelate, especially within the context of the Cologne Manual. For instance, while the principle of freedom of exploration and use is paramount, it must be interpreted in accordance with the responsibilities of States to prevent harmful interference with the space activities of others. This duality necessitates innovative regulatory approaches that address the complexities of an increasingly crowded operational environment. The foundational principles of international space law, particularly those enshrined in the OST, provide a solid legal basis for developing an effective framework for STM. To explain, it should be understood that the principles were adopted using broad language in order to be able to encompass any future technologies, development or trend in space activities. By interpreting these principles in accordance with international law and the customary rules of interpretation, thus in light of contemporary challenges, the increasing complexity of contemporary and future space

¹⁰ Space Debris Mitigation Guidelines of the United Nations Committee on the Peaceful Uses of Outer Space, endorsed by the United Nations General Assembly in its Resolution 62/217 of 22 December 2007.

¹¹ Guidelines for the Long-term Sustainability of Outer Space Activities (LTS Guidelines), adopted by the United Nations Committee on the Peaceful Uses of Outer Space in 2019.



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PRINCIPLES OF INTERNATIONAL SPACE LAW



activities can be adequately addressed and these principles are confirmed to require and set the foundations for a functional STM in the conduct of space activities. To ensure the continued freedom of exploration, use and access of outer space for all States, it is imperative that the interpretation of these principles evolves to incorporate the latest *de lege ferenda* considerations. This progression is articulated in the Guidelines of the Cologne Manual, which build upon established principles and State (best) practices while developing necessary guidance to navigate the increasingly congested operational environment for space activities.

Recognising the common interest in managing the space environment is essential for the future of space exploration and use. The sustainability of space activities hinges not only on technological innovations, but also on the collective ability and willingness to cooperate and implement effective governance mechanisms for the benefit of all. The development of a comprehensive STM framework is not merely a legal obligation; it is an ethical imperative to ensure that outer space remains a shared domain for all humanity.

In sum, the complexities of space traffic can only be effectively navigated through concerted efforts that emphasise collaboration and adherence to established international norms. By fostering a culture of responsibility and respect for the shared nature of outer space, the integrity of this vast frontier can be safeguarded for generations to come. Only through unity and shared commitment to responsible stewardship, the heavens as a domain accessible to all can be preserved, ensuring that the exploration and use of outer space will benefit all of humanity.



Guidelines of the Cologne Manual on Space Traffic Management

Space Traffic Management aims at the development of guidelines for the safe use of outer space during all phases of the space travel. During launch, on orbit and end of life phases these guidelines aim to avoid collisions and to enhance efficient space traffic as well as the sustainable access to, transit through and use of outer space.

Preamble

The Cologne Manual on Space Traffic Management has at its core the safety, sustainability and transparency of space traffic. Its overall goal is to assure safety in outer space in times of considerably heavy space traffic. It does not debate, question or contest existing space treaties and is based on the existing international and national space law and practices as well as on other relevant international instruments. The Manual does not restrict access to outer space but instead seeks to support and guarantee access and usability for all actors.

One key theme is ensuring the freedom of space exploration and use, guaranteed by Article I of the OST whereby the Cologne Manual recognises that the freedom of exploration and use entails responsible exploration and use. Responsible exploration and use mean the enjoyment of the freedoms in a manner that enables the continued exploration and use, taking into account the freedom of other actors and assuming responsibility for preserving the accessibility and usability of outer space.

To this end, access to outer space, the safety and security of on-orbit space operations as well as the safe return from outer space must be guaranteed to ensure space sustainability and use of outer space for future generations. This requires a look at the accompanying obligations, because the freedom of one limits the freedom of others. To respect the rights of others, the increased traffic in Earth orbits (especially in the LEO and GEO regions), necessitates coordinating and managing of space traffic in an international manner. Space objects need to be operated in a way that does not unreasonably impair the freedom of space exploration and use of other space actors. This means, that space object operators must take reasonable steps to be aware of and actively mitigate collision risks. This could be achieved by setting up standard communication and coordinating procedures, including cybersecurity protection measures.

All Guidelines of the Cologne Manual consider the immense importance of space technology for the development of humankind and its potential to meet global challenges.



The Guidelines are based on existing international space law, according to which outer space is free for exploration and use for the benefit of all and a province of all humankind while space objects remain under the jurisdiction and control of the State that registered them in its national registry as expression of the State's sovereignty over them.

The Cologne Manual is an assembly of guidelines. These Guidelines are rooted in international space law but themselves lack the legally binding quality. They are a collection and systematisation of existing best practices grounded in international law and as such offer States and non-state actors a guiding hand in space traffic management. Adherence to them is entirely voluntary and an offer to – through voluntary behaviour – contribute to the future accessibility and usability of outer space.

Space Traffic Management - Definitions

Space Traffic Management encompasses proactive measures to pay due regard for the common interest in the traffic of space objects without harmful interference. These include aspects of safety, security and sustainability.

Safe, secure and sustainable Space Traffic Management should be achieved through responsible management of national space activities, the transparent and timely coordination of all space activities and international cooperation.

States that launch or operate space objects are deemed capable of participating in Space Traffic Management.

States that launch or operate space objects are deemed capable to participate in Space Traffic Management.

The following Guidelines are not legally binding. States and non-state actors are encouraged to voluntarily consider them.

For an adequate understanding of the Cologne Manual and for the purpose of this Manual the used terms will be defined as follows:

Air Traffic Management (ATM): ATM includes the dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions. (See ICAO Doc. 4444 PANS-ATM)



Conjunction: Conjunction is a close approach between two space objects that is predicted to occur because the secondary object passes within a chosen geometric or statistical safety volume about the primary (protected) asset. (See NASA Spacecraft and Collision Avoidance Best Practices Handbook)

Mitigation: Mitigation for purposes of the Manual is an act of reducing the danger of collisions in orbit. In space operations these are normally implemented during the planning, manufacturing and design of space objects and operations. Such acts involve e.g. the limit the long-term presence of spacecraft and launch vehicle stages in the Low Earth Orbit region after the end of a mission or to minimise the potential for breakups during operational phases. (See IADC Space Debris Mitigation Guidelines 5 Mitigation Measures)¹²

Operator: Operator for the purpose of this Manual is a natural or legal person carrying out space activities that has effective control over of the space object.

Orbit: Orbit describes the path, relative to a specified frame of reference, described by the centre of mass of a satellite or other object in space subjected primarily to natural forces, mainly the force of gravity. (See ITU definition of ‘orbit’, ITU (RR Art. 1.184))

Space activity: Space activity includes the launch, operation, guidance, and re-entry of space objects into, in and from outer space and other activities essential for the launch, operation, guidance and re-entry of space objects into, in and from outer space. (See ILA Model Law)

Space debris Are all human made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional. During the operational phases, a spacecraft or orbital stage can be considered as functional. (See IADC Space Debris Mitigation Guidelines 3.1 Space Debris)¹³.

Space Situational Awareness (SSA): SSA refers to the knowledge and characterisation of space objects and their operational environment to support safe, stable and sustainable space activities.

Space Surveillance and Tracking (SST): SST is the surveillance and tracking of space objects and to predict and alert about risks of collision.

Space traffic: The movement of all space objects, including parts thereof and debris, during all phases of flight, including launch, on-orbit and end-of-life, not including frequencies.

¹² The latest edition: IADC-02-01 Rev. 4 (January 2025).

¹³ The latest edition: IADC-02-01 Rev. 4 (January 2025).



THE COLOGNE MANUAL ON SPACE TRAFFIC MANAGEMENT GUIDELINES



Space Traffic Coordination (STC): STC refers to technical means and operative procedures to ensure safe and stable operations in the space environment especially through e.g. the use and exchange of SST information as well as collision avoidance measures.

Space Traffic Management (STM): STM refers to the coordinated international efforts, policies, legal rules, norms, technologies and strategies designed to ensure the safe, sustainable and efficient operation of objects in outer space, and in particular in Earth orbits. It is the safe use of outer space, including launch, on-orbit and end-of-life phases, avoiding collision and enhancing efficient space traffic and aiming at a sustainable access to, transit through and use of outer space. It includes STC, SSA and SST.



Guideline 1 – Pre-launch Activities and Notification

Throughout all operational stages of space activities including the launch, in-orbit and end-of-life phases, operators should issue a notification before every launch, on-orbit manoeuvre or end-of-life activity such as re-entry. It should be notified to all relevant operators, States and other stakeholders. It can be public or directed to specific actors but must inform all relevant players to minimise the risk of collision. Space missions should be designed so that they do not unduly interfere with space traffic, especially human space flight, or endanger life and property on Earth or in the airspace.

1. Pre-launch

Launches should be conducted in a manner that does not interfere with the safe operation of other objects in outer space or airspace, and when relevant on the ground in immediate vicinity of the launch site or directly impacted by the launch. Pre-launch obligations of operators include performing pre-launch activities and issuing a pre-launch notification.

Before launch, a conjunction analysis, an orbit insertion analysis and a space debris modelling should be performed and considered. Before launch, information on on-orbit manoeuvres and end-of-life activities such as re-entry, information about space traffic including space situational awareness, air traffic as well as ground situation immediately surrounding the launch site should be obtained and considered, and measures taken for paying due regard to the safety of air and space traffic and to minimise the risk of collisions.

Pre-launch notification should include information on the launch site, the trajectory, the planned orbit, the launch date as well as time and location of the launch and any other relevant information.

Any changes to the launch date, timeline or planned orbit should be notified immediately.

2. In-orbit

Pre-manoevre notification should at the minimum include information about the trajectory of the object, the timeline and the planned orbit.

All planned changes of trajectory, e.g. planned manoeuvres, should be notified beforehand, in the same acceptable and reliable manner as pre-launch notification.

3. Re-entry

All planned re-entry activities should be notified beforehand, in the same acceptable and reliable manner as pre-launch notification. Pre-re-entry notification should include at minimum expected re-entry trajectory, location, date and time, and when relevant landing.



Guideline 2 – Non-governmental Activities and Licensing

States should ensure that any non-governmental space activity complies with space traffic management, thus, are conducted in a manner that ensures that outer space remains free for exploration and use by all countries and with due regard to the corresponding interests of all other States.

Non-governmental space activities are subject to authorisation and supervision of the appropriate State.

Bearing international responsibility for national space activities, whether carried out by governmental or non-governmental actors, and for ensuring compliance with international norms, States should enact national space legislation to regulate authorisation and supervision procedures via appropriate licensing and oversight.

Guideline 3 – Registration

National space object registries should be made publicly available and easily accessible to interested parties and should be regularly updated. National space object registries are essential for the identification of space objects.

In addition to the requirements of the REG and international guidance as contained in UNGA Resolution 62/101 of 17 December 2007 on Recommendations on enhancing the practice of States and international intergovernmental organisations in registering space objects and the Long Term Sustainability guidelines of the United Nations Committee on the Peaceful Uses of Outer Space of 2021, States should clarify through national regulatory frameworks what kind of information, and through what procedures and communication channels, operators are required to provide necessary information to the competent national authority responsible for space activities for the complete and comprehensive registration of space objects. Operators should provide States the specified information without undue delay. Operators should provide regularly updated information on their space objects and their status to the relevant national authorities.

Registration should be made no later than six months after the launch of the space object with an operational lifetime of more than six months. Space objects with an operational life-time of less than six months should be registered within one month from the time of the launch. Information on the national registry, the objects and any changes in the status of the objects should be communicated to the Secretary-General of the United Nations immediately after their inclusion in the national registry.



Guideline 4 – International Cooperation, Coordination and Consultation

States and operators should communicate, liaise, consult and coordinate with each other during all stages of space activity.

This includes coordination and communication with Air Traffic Management systems, the International Telecommunications Union and other relevant international organisations.

Guideline 5 – Space Traffic Coordination

Space traffic coordination on an international level is necessary to ensure the safety of space operations.

1. The operator of a space object
 - a. should display the point of contact that must be publicly identifiable and available. The operator must be in a position to take responsibility for decisions regarding the space object.
 - b. should establish procedures and proper channels of communication to enable timely responses to a conjunction between two space objects and to consider the necessity of performing a collision avoidance manoeuvre.
 - c. should share and discuss their approaches to determining the likelihood of a collision between their space object and an approaching object, as well as the risk determination and risk threshold to trigger a collision avoidance manoeuvre.
2. Providers of SST information should provide information to operators covering collision avoidance, re-entry analysis and fragmentation analysis.
3. Collision avoidance:
 - a. Operators of space objects should respond to critical conjunction warnings with appropriate collision avoidance manoeuvres.
 - b. In order to ensure effective collision avoidance procedures, States should consider establishing an internationally agreed standard for priorities to minimise the risk of collision. Priorities should include the following:
 - i. Conjunctions involving non-maneuvrable objects: non-maneuvrable objects should be evaded by manoeuvrable objects to avoid collision.



- ii. Conjunctions involving multiple manoeuvrable objects: Objects in distress or otherwise malfunctioning should be given (primary) priority as their manoeuvrability may be impaired. Rescue missions, whether manned or unmanned, should be given priority over all other missions. Human (crewed) space objects should be given priority over non-human (non-crewed) objects.
- c. States and operators are encouraged to enter into agreements regarding space traffic priorities and collision avoidance measures.

Guideline 6 – Space Situational Awareness

States and non-state actors should cooperate at all times to acquire, collect, improve, validate and share SSA information to the extent necessary to ensure safe space operations. They are encouraged to cooperate, develop and further improve SSA capabilities and capacities, including monitoring and tracking capabilities. It is in the interest of the international community to make SSA information available and accessible to the maximum extent possible and practicable.

Space actors should aim towards the establishment of a worldwide SSA information base including information about critical conjunctions, orbital traffic, space weather, and the risk of an operation. Until a global information base is established, space actors – including governmental and non-governmental – owners and operators should cooperate and share SSA information, building an international SSA network chain for the quick and efficient exchange of all necessary and vital information, including critical conjunctions alerts and analysis, orbital traffic, space weather, and the risk of an operation.

Guideline 7 – Information Acquisition and Dissemination

Throughout all phases of space activity, operators:

1. should exchange and contribute information.
2. should acquire space situational awareness information before becoming active and should share space situational awareness information.
3. should stay informed of the status of their space objects and should inform the appropriate authority about any relevant changes regarding the space object, its operator or owner, and its status.

All unforeseen events such as catastrophic events, large disposals, satellite transmission issues, and other special events that affect other space flight participants should be reported in a timely manner.



Guideline 8 – Cyber Security

States should ensure the cyber security of infrastructures including ground-based networks and space links and digital data that support Space Traffic Management or the guidance and control of space objects in accordance with current best practices and state of the art.

1. These infrastructures should be considered of high criticality and of international interest and subject to protection, either by international or national legislation.
 - a. Organisational procedures and technical measures should be implemented against cyber security threats for the protection of infrastructures and digital data.
 - b. States should obligate the operators of space objects or infrastructures of their responsibility for the implementation of appropriate organisational and technical measures for cyber security.
 - c. Relevant personnel should be trained to ensure their awareness about potential cyber threats and their knowledge about avoidance and appropriate response.
 - d. Operators of space objects or infrastructures should respond to incidents promptly and report these without unnecessary delay to established centralised bodies or relevant authorities.
2. International efforts should be undertaken to develop standards for minimum organisational and technical cyber security requirements specific to infrastructures and digital data.
3. Operators of space objects or infrastructure should develop cyber security strategies, perform cyber vulnerability evaluations, and implement best practices for the protection of infrastructures and digital data.

Guideline 9 – Military Activities

1. In all their space activities military operators should follow the space traffic management Guidelines as contained in the Cologne Manual as far as practicable.
2. If, for national security reasons, the desired level of transparency required for the active management of space traffic cannot be ensured, operators
 - a. may deviate from these requirements as long as they guarantee the same level of space traffic safety and,



- b. must take the necessary manoeuvres at their own expense and bear full liability and responsibility in the event of collision.

Guideline 10 – Communication Systems and International Technical Advisory Body

Operators of space objects should connect and communicate through designated reliable communications systems and interoperable information exchange systems in support of effective space traffic coordination. It should be encouraged to do so by using a single universal and dedicated Communication System and an international technical advisory body to ensure standardised and frictionless operations.

1. Communication System

The Communication System should accommodate information on the operator, its point of contact, and necessary SSA information. Additionally, it should provide information on the following components associated with SSA capabilities engaged with the Communication System: (1) surveillance and tracking capabilities, (2) entities gathering STM relevant information, (3) data centres receiving and analysing information, and (4) third actor using the information for conjunction analysis and collision warnings. Ideally, it should be the aim to centralise this information in a dynamic system.

SSA service providers should be engaged with the Communication System in order to establish the dependable backbone of the Space Traffic Management system including a harmonised space object catalogue, standardised message format, and information sharing parameters. The operators should utilise and collaborate with any of the SSA service providers supporting the Communication System.

Information technology systems in support of Space Traffic Management should be interoperable with machine-to-machine interfaces and be designed and operated to warrant their continuity, availability and integrity.

2. International technical advisory body

Space actors should be encouraged to establish an international technical advisory body to advise operators of space objects, space activities and recommend collision avoidance measures. The objective of the international technical advisory body should be to develop common protocols and standards for effective space traffic coordination.



Guideline 11 – Ensuring long-term accessibility and operational usability of the space environment

Recognising the forward-looking approach of Space Traffic Management, it is necessary to ensure the long-term accessibility and operational usability of outer space by implementing sustainable solutions to space debris and other comparable risks to space traffic.

1. Mitigation of Space Debris

Space actors able to participate in space traffic shall be deemed capable of implementing space debris mitigation measures and should therefore comply with relevant international standards, in particular the Space Mitigation Guidelines set out by the United Nations and the Inter-Agency Space Debris Coordination Committee. Space debris mitigation measures should be implemented during the mission planning, design, manufacturing and operational (launch, mission and disposal) phases of spacecraft and orbital stages. The implementation of mitigation measures should be regularly reviewed and adapted to best legal and technical practices.

2. Remediation of Space Debris

Remediation of space debris should be considered of common interest to be carried out for the benefit of all. All remediation activities should comply with the Guidelines of the Cologne Manual.

3. Environmental Provisions

International environmental standards related to space activities should be respected and observed.

4. Capacity Assessment and Planning

States are encouraged to cooperate in space traffic capacity assessment and planning in critically congested regions of outer space.



Underlying Principles underscoring the Cologne Manual

This section describes the development of the Guidelines through the consultation and research processes in each Working Group. This component is intended to provide a comprehensive overview of the procedures that produced the Cologne Manual, in addition to the underlying principles that have directed the development of the Guidelines. Below, the Space, Air, Cyber and Sustainability Working Groups provide background information, including methodology and the general thoughts underlying the Cologne Manual.

Working Group Space

The Working Group Space (WG Space) was the first pillar in the development of the Cologne Manual on Space Traffic Management. It was created to research, investigate, discuss and ultimately propose crucial research questions of space law and technology relevant for STM. This entailed the examination of the existing international and national regulatory framework (i.e. the *lex lata*), identifying the principles and practices relevant for STM as well as identifying potential loopholes and open questions in space law. WG Space was thus able to conclude that, *first*, existing space law supports STM and *second*, that space traffic is already being coordinated on an *ad hoc* case-by-case negotiation basis. However, absence of global coordination means, lack of clear, unified and standardised guidelines and instructions is prolonging the process and endangering quick, easy and safe coordination, thus presenting a non-sustainable option for the future as space traffic increases with unprecedented speed.¹⁴ This is emphasised by the disruptive changes (e.g. deployment of large constellations, increasing commercialisation).¹⁵ Building on its analysis, WG Space proceeded to develop proposals for future evolution of space law helpful to or even required for an efficient functional STM (i.e. *lex ferenda*). Finally, judging from both *lex lata* and *lex ferenda*, and taking account of risks, opportunities and best practices, WG Space developed proposals for STM guidelines to systematically regulate space traffic coordination and management. By employing a novel and dynamic Approach (I.), the WG Space identified overarching principles for the development of a comprehensive STM during its

¹⁴ E.g. re-entry traffic has increased to >1000 spacecraft and upper stages per year, while contribution from failures and anomalies still present a significant source of fragmentation events, see ESA, ESA's Annual Space Environment Report, 2025.

¹⁵ Ibid.



Discussions (II.) and finally developed crucial principles to be observed for the Development of the Guidelines (III.) and ultimately by a future and innovative STM.

I. The Working Group's Approach

The WG Space was established as a central component to the Cologne Manual on Space Traffic Management project. Its main task was to evaluate existing space law, identify potential open questions and best practices relevant to STM in order to develop proposals and building blocks for an efficient and systematic STM capable of safely managing high numbers of space traffic in a complex international setting.

WG Space was the largest of the four WGs making up the Cologne Manual project and was composed of experts from all relevant backgrounds (operational, technical, legal, military, academic and commercial industry), including experts from the German Aerospace Agency (DLR), the European Space Agency (ESA), the Japanese Aerospace Exploration Agency (JAXA), the Brazilian Space Agency and the Kenya Space Agency (KSA).

The WG Space employed interactive and collaborative methods, facilitated by regular online meetings and individual research accompanied by written results and drafting efforts. Each member gathered information, cases and research to ascertain topics that need to be addressed for an efficient and systematic STM system, recording these in written form and sharing with other members of the WG. These were then discussed in online meetings or individual meetings between individual members and the WG leader as needed. The complete discussions and work of WG Space, including the aforementioned individual research results and materials, were recorded in an extensive Working Paper, which served as an interactive platform for drafting and exchange of ideas, in between online meetings of the WG.

This created a dynamic and efficient exchange of ideas and enabled in-depth analysis of the identified relevant topics, discerning challenges, risks and opportunities of the analysed concepts as well as record-keeping of both accepted and rejected concepts and the reasons behind the acceptance or rejection. Additionally, coordination and discussion with experts from other WGs as well as consultations with external experts from technical and legal background, from practice and academia, ensured in-depth comprehensive analysis and alignment with the overarching goals of the Cologne Manual. Representatives of WG Space were appointed for WG Sustainability, WG Cyber and WG Air to facilitate exchange of information, ideas and to thus ensure seamless synergy between the WGs and a successful final transformation of their work into the Cologne Manual.



II. The Working Group's Discussions

WG Space identified 12 topics relevant to an efficient, functional and systematic STM. It divided the topics into a first set required as base-line support for STM such as State sovereignty; registration; liability; non-governmental space activities; military space activities; sustainability, as well as a second set that forms the building blocks of a global STM, which were developed with the aid of extensive research into existing State practice and stakeholder research on requirements and challenges. Principles of the second set include: space situational awareness (SSA); pre-launch/pre-manoeuve activities and notifications; collision avoidance standards/measures; duty to acquire, share, know and inform; STM system (communications system) and technical advisory institution; and cyber security. Cyber security and sustainability were discussed shortly but ultimately left to WG Cyber and WG Sustainability respectively to discuss and develop in detail. On the remaining topics WG Space often collaborated and consulted with WG Air, to ascertain potential useful lessons learned from ATM, as well as to examine correlations and insight into how the now vibrant and still growing aviation industry developed and regulated air traffic in its infant years, and how it communicates with the space sector today.

With regard to the first set of principles, the clarification of these as well as of the *lex lata* and proposals for *lex ferenda*, serves to underpin the principles required for a systematic and global STM and acts as an incentive on States and other stakeholders to enact the second set of more specific principles required to establish a viable global STM. Analysis showed that first and foremost, for success of STM, continued respect for State sovereignty must be assured. State sovereignty has been evaluated as an important aspect of international law often cited as a concept central to international law.¹⁶ Two baseline understandings therefore underpin the Cologne Manual:

1) Outer space is an area beyond national jurisdiction and therefore beyond any single State's sovereignty akin to the high seas. Under the concept of State sovereignty, every State must assure that activities under its jurisdiction do not harmfully interfere with area beyond national jurisdiction. This coupled with the central paradigm of space law that the exploration and use of outer space shall be free to all States without any discrimination, in accordance with international law and shall be the province of all humankind, which may not be appropriated by any means. WG Space analysed that the freedom to explore and use outer space entails tacit responsibilities to conduct these rights in a manner that does not harm the rights of others and that keeps outer space safe for exploration and

¹⁶ See e.g. *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986.



use. This is the foremost baseline principle requiring the implementation of STM in order to preserve the freedom of exploration and use and accessibility of outer space for all States without any discrimination.

2) Via the concept of registration, space objects are placed under the jurisdiction of the State performing the registration on national level and thus under its State's sovereignty, entitling the State of Registry to require other States from interfering with the object and to return it, if it is found beyond the territorial limits of the State of Registry.¹⁷ While the existing registration system is a static system with limited direct value for STM, WG Space evaluated that respect for the State jurisdiction in space object is paramount to ensure success of STM while the registration system is a necessary component of STM as a baseline for transparency in space activities that ultimately enable space traffic coordination and thus a functional STM.

Finally, throughout WG Space was aware of the inherently dual-use nature of outer space and space objects. The question of dual-use objects was, however, not considered sufficiently relevant to be specifically addressed. Regardless of whether used for civil, scientific, commercial or military purposes all space objects function in the same manner (e.g. are restricted by the same physical constraints). For purposes of STM, therefore, regardless of which use a space object is serving due to its participating in space traffic, it should abide by the Cologne Manual and ensure the required level of transparency for efficient STM. If such transparency is not desired due to the object's States security function, then it should follow the Cologne Manual's recommendations for military space objects. WG Space also recognised that space traffic consists of a physical and non-physical component (e.g. communications traffic), whereby each can impact the other. Due to this and the fact that communications traffic is controlled by the ITU, WG Space recognised the imperative that space actors, in particular, operators should communicate and cooperate with the ITU. Equally, recognising that information regarding launches should be effectively shared with all relevant actors, it was analysed that at minimum this must include active communication and cooperation with relevant air traffic authorities and, to assure best result for the in-airspace segment, the ICAO. Building on these first two recognitions, the Cologne Manual encourages widespread cooperation and effective information sharing, as well as the placement of an obligation on operators and other space actors to cooperate

¹⁷ See e.g. *Lachs*, *The Law of Outer Space*, Martinus Nijhoff, Leiden, 2010, pp. 65-75; *Cheng*, *Studies in International Space Law*, Oxford University Press, Oxford, 1997; *Schmidt-Tedd/Mick*, "Article VIII", in: *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009.



and communicate with relevant national, regional and international authorities, which is clarified, emphasised and detailed throughout the Cologne Manual.

III. Formulating the Guidelines

WG Space adopted several parameters for Guidelines of the Cologne Manual.

First, respect for the five UN space treaties, especially the fundamental Outer Space Treaty, is of paramount importance for seamless STM as well as success of the Cologne Manual. Therefore, the space treaties are not and have at no point been questioned or compromised by deliberations or recommendations of WG Space and its members, and nothing in the Cologne Manual should be understood or interpreted as contesting or in any manner compromising the existing space treaties.

Second, practicality, predictability and logic are paramount to any future guiding instruments on STM and have therefore been considered throughout the work on the Cologne Manual. In particular, WG Space emphasised the necessity to consider only technically as well as geo-politically viable and realistic options. Considering the plethora of studies on STM analysing ideal scenarios and proposing abstract best options that have not been implemented in practice, it has become – especially in view of the high growth of space activity, including launches and space objects in orbit – critical to adopt proposals that will be implemented in practice so as to at minimum begin a process of creation of a global STM and facilitate a safe and systematic STC and communication between, at minimum, space object operators. Nonetheless, WG Space analysed all options and while only proposals viable in the short- and middle-term were proposed for text of the Guidelines, the long-term goals and options were included alongside existing State practice, best practices and relevant legal instruments in the Commentary section to the Guidelines.

Third, it was decided that for success of STM and the Cologne Manual, the Cologne Manual Guidelines must be timeless to avoid being easily and quickly outdated by the rapid evolution of technology. Therefore, the Guidelines have been formulated with a degree of abstractness supported only in commentary with specific propositions and examples. This approach was evaluated to be in line with the thought method of having a concrete use and cases identified and working from those unto a more abstract rule akin to law-making methods of many civil law countries. These would be formulated at abstract level with concrete examples and in-detail explanation in a commentary section accompanying individual Guidelines. The level of abstractness logically varies depending on each individual Guideline with those of a more general character more abstract and those of a more specific character



more detailed. Abstractness was evaluated as necessary by WG Space in order to assure the timelessness of the Cologne Manual, which should not be easily or quickly outdated by the progressive development of technology. The ultimate goal of WG Space was to formulate Guidelines, which would propose high-level/abstract guidance and leave it to States and other stakeholders (including operators) to add necessary detail to implement these. Furthermore, the Guidelines adopt a general language, often more legal in nature, than technical. For example, the language frequently used in the Cologne Manual refers to space object operators, distinguishing between in-orbit objects and launch vehicles. For these same objects, operators normally adopt different terms such as payload and rocket (also rocket body).

Fourth, it has been decided that the Cologne Manual should formulate general Guidelines that will be capable of being implemented regardless of mission objective or selected orbit – whether Low Earth Orbit, Medium Earth Orbit, Geostationary Orbit or simply transiting Earth orbits for missions in orbits of celestial bodies or Lagrange Points or deep space etc. While Earth orbits are presently of main urgency, the Guidelines look beyond immediate urgency to propose building blocks of an innovative, future oriented and practical STM. In other words, the urgency for STM is most notable in orbital traffic around the Earth, and is therefore the immediate concern of the Cologne Manual. Nonetheless, other orbital environments (around celestial bodies or Lagrange Points) and trajectory areas are noted as well and may need to be considered in future regulation, therefore, the Cologne Manual utilises open-ended language that permits application of measures to any space activity regardless of space object location.

Furthermore, in pursuing that same goal, decision has been taken against incorporating at any point differentiating responsibilities akin to e.g. the principle of common but differentiated responsibilities found in international environmental law. The decision was adopted for the same reasons of practicality. The Cologne Manual seeks to ensure and guarantee continued accessibility and usability of outer space, for which international action involving all actors is required. Differentiation is discouraged in ultra-hazardous activities such as space activities and is internationally criticised.¹⁸ Practice revealed that several emerging space-faring nations for example adhere to space debris mitigation practices despite their emerging status as a space-faring nation, or any protentional technological and/or financial situations.¹⁹ For interests of strengthening national space sectors, some States adopt transition periods to achieve full compliance for their actors to reduce impact of norms. Therefore,

¹⁸ See e.g. Viikari, *The Environmental Element in Space Law*, Martinus Nijhoff, 2008.

¹⁹ For more see e.g. Mejia-Kaiser, *Geo-Stationary Ring*, Martinus Nijhoff, Leiden, 2020.



and in the interest of safety of space traffic where all objects are subject to the same physical forces and limitations, no differentiation is proposed by the Cologne Manual and the Guidelines are instead grounded in existing practice, thereby not placing exorbitant new requirements on actors or necessitating new capacities.

Fifth, through its discussions on the content of these WG Space tacitly adopted that a combination of a bottoms-up approach with a tops-down approach would be the best approach forward, with the bottoms-up approach serving as the immediate first step of creating building blocks of an international STM and a tops-down approach supplementing the bottoms-up approach via adoption of best standards and other governance and policy documents and following up in future with further (hard-)legal instruments in support of STM on national, regional and international level. In future, States may wish to adopt the Guidelines in an international legal instrument, preferably hard-law or in absence of such a soft-law instrument clarifying the required information to be shared and elements to be developed. Such an instrument could be proposed in the United Nations as the most universal international organisation with an outer space dedicated committee and office, i.e. the United Nations Committee on the Peaceful Uses of Outer Space and the United Nations Office for Outer Space Affairs. In absence of an international legal instrument, regional instruments could be adopted along geo-political allies. However, with regard to such actions the dangers of fragmentation should be kept in mind.²⁰ Establishing STM along geo-political lines runs the risk of creating numerous STM frameworks with potentially competing content that will ultimately defeat the purpose of STM as it will again diminish predictability and through it, safety. Regional entities are advised to follow same or similar STM and STC approaches as a unified approach to STM is the highest assurance of predictability and safety, which is ultimately more cost-effective than replacing any lost or damaged satellite or in worst case scenario engaging in orbit sanitation.²¹ To regulate non-governmental actors or in absence of international and regional instruments, States should adopt national legislation on STM with due regard to best practices and national legislation or regional practice of other States to avoid fragmentation and through it, lower risk mitigation efforts.

Finally, WG Space emphasised that STM is in the common interest of all, to guarantee safety and ensure cost-efficiency, therefore ultimately pursuing simply the mitigation of risk in all phases of space activity. Nothing in the Cologne Manual should therefore be understood as negatively impact-

²⁰ UN Doc. A/CN.4/L.702 (18 July 2006); Report of the ILC, UN Doc. A/CN.4/L.682 and Add.1 (13 April 2006).

²¹ See also IAA, Space Traffic Management: A Roadmap for Implementation, 2018.



ing the freedom of exploration and use of States or the jurisdiction of States in their nationally registered space objects, but rather as ensuring safety of space operations and continued access to outer space for all States without any discrimination.

Working Group Air

The Working Group Air (WG Air) served as the second pillar in the development of the Cologne Manual on Space Traffic Management. It was established to provide a comprehensive overview of the current Air Traffic Management system while also addressing key concepts and questions raised by the WG Space. WG Air focused on leveraging established ATM practices to inform the development of a functional and sustainable STM framework that can effectively interface with current operations in all levels of airspace, including integration of launches into airspace, transition of space objects through airspace and exit out of airspace, and associated challenges.

I. The Working Group's Approach

The WG Air was assigned the responsibility of addressing the complexities associated with the potential integration of ATM principles into the emerging domain of STM. WG Air subsequently adopted a balanced approach, providing a thorough description of the ATM framework while assessing its relevance to STM. Recognising the unique characteristics of airspace and outer space, the WG Air aimed to emphasise parallels where appropriate while simultaneously acknowledging the fundamental differences between the two domains.

The WG Air employed an iterative and collaborative methodology, which included regular discussions interspersed with detailed drafting phases. This dynamic exchange enabled a more in-depth exploration of ATM concepts and their applicability to outer space operations. Continuous coordination with the WG Space ensured that considerations related to air law were consistently aligned with the broader objectives of the Cologne Manual.

II. The Working Group's Discussions

The WG Air's discussions revolved around the foundational principles of ATM and their potential adaptation to STM. According to ICAO Doc 4444 PANS-ATM, ATM is defined as:

‘The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management – safely, economically and efficiently – through



the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.’

The WG Air highlighted three primary services of ATM:

1. Air traffic services (ATS): ATS ensure safe and orderly air traffic flow through air traffic control (ATC) and provide essential information to flight crews, especially in emergencies. Mainly performed by air traffic controllers, ATS aims to prevent collisions by applying separation standards and issuing clearances and instructions. This includes accommodating crew requests, ensuring continuous climb and descent operations, and reducing holding times. ATS relies on direct communication and tactical interventions throughout the flight.
2. Air Traffic Flow Management (ATFM): ATFM aims to efficiently regulate aircraft movement to prevent congestion in control sectors. It focuses on balancing supply and demand by staggering demand over time and space and planning control capacities accordingly. This can involve imposing restrictions on specific traffic flows, such as assigning Coordinated Take Off Time/Calculated Take Off Time (CTOTs) or requiring certain routes for flights. Additionally, supply can be increased by managing sectors more effectively, like increasing the number of active air traffic controllers. ATFM measures are considered pre-tactical, as they address upcoming demand rather than the immediate situation.
3. Airspace Management (ASM): ASM aims to optimise the use of airspace, a limited resource, to meet the needs of both civil and military users. It involves allocating airspace through routes, zones, and flight levels, as well as structuring it to provide effective ATS.

Comparing these to the space domain, the WG Air identified three distinct challenges:

1. Key challenges discussed included the absence of sovereignty in outer space, a principle that defines airspace and consequently ATM, but cannot and should not be replicated in the space domain. Associated challenges identified were a lack of geopolitical agreement and the absence of a centralised authority managing space traffic. The WG Air also emphasised logistical differences, such as the lack of (mainstream) refuelling options in outer space and the distinct nature of space manoeuvres compared to air traffic.
2. Furthermore, the WG Air examined the coexistence of military and civil activities in outer space, drawing parallels to the flexible use of airspace. The WG Air also addressed the liability of private actors and Article IV of the OST, highlighting the need for a unique regulatory framework for STM that accommodates non-governmental activities.



3. Moreover, the WG Air discussed integrating launch and re-entry operations into airspace, emphasising the importance of risk assessment, safety measures, and international harmonisation to ensure the safe coexistence of air and space traffic.

III. Formulating the Guidelines

The WG Air concluded that ATM is a successful concept, which, however, cannot and should not directly be transferred to outer space due to distinctions in the regulatory frameworks as well as environmental mechanics of airspace and outer space. Nonetheless, space object operators can learn from experiences and regulation in ATM and should furthermore develop procedures for systematic and easy communication with air traffic controllers for safe integration into and transit of space objects through airspace.

The WG Air's efforts therefore culminated in the formulation of Guidelines that reflect the integration of ATM principles into STM while addressing the unique challenges of space operations.

Key points highlighted in the Guidelines include:

1. Integration of ATM Principles: Leveraging ATS, ATFM, and ASM to inform STM development with necessary adaptations to address the distinct dynamics of space traffic.
2. Sovereignty and Jurisdiction: Acknowledging that the principle of airspace sovereignty cannot be replicated in outer space and proposing alternative frameworks for regulating space activities.
3. Military and Civil Coexistence: Applying the flexible use of the airspace model to support the coexistence of military and civil operations in outer space, with modifications to address the absence of sovereignty.
4. Liability and Licensing: Emphasising the importance of establishing clear liability frameworks and licensing requirements for STM operators, considering the legal implications of non-governmental space activities.
5. Integration of Launch and Re-entry Operations: Proposing coordinated approaches for managing launch and re-entry activities, including risk assessments and safety measures to protect airspace and public safety.
6. International Collaboration and Information Sharing: Advocating for global cooperation and information exchange to ensure the efficient and safe management of both air and space traffic, particularly in non-nominal scenarios.



Through these Guidelines, WG Air aimed to provide a comprehensive framework for integrating ATM principles into STM, ensuring the safe, efficient, and sustainable use of both airspace and outer space, including coexistence of air and space traffic.

Working Group Cyber

The Working Group Cyber (WG Cyber) was the third pillar in the development of the Cologne Manual on Space Traffic Management. The WG Cyber was created to address the dual role of cyber aspects in STM, encompassing both opportunities and risks. On the one hand, cyber capabilities such as communication and (automatic) collision avoidance systems have the potential to improve space operations' sustainability, efficiency, and safety. However, these same technologies may be the source of cyber-related vulnerabilities, such as data manipulation and unauthorised access. Balancing these two dimensions – leveraging technological innovation while mitigating risks – has been central to the WG Cyber' efforts, which reflect a commitment to establishing a framework that secures the benefits of cyber systems for all space actors while addressing the challenges they pose.

I. The Working Group's Approach

The WG Cyber adopted a two-pronged approach, balancing the development of both an explicit cyber-related Guideline and its seamless integration into the broader STM regulatory framework. This strategy was motivated by the recognition that neither a complete separation nor a complete integration of cyber aspects into the general STM Guidelines would be practical or effective.

The WG Cyber's work was characterised by an iterative and collaborative methodology. Regular online discussions alternated with written drafting phases, creating a dynamic exchange of ideas and fostering deeper exploration of cyber-related challenges. Additionally, frequent coordination with external experts ensured that cyber considerations were consistently aligned with the overarching goals of the Cologne Manual.

II. The Working Group's Discussions

The discussions of the WG Cyber revolved around the integration of cyber aspects into STM, with a particular focus on their significance, challenges, and potential implications. The WG emphasised that cyber systems, including information technology (IT) and artificial intelligence (AI), are indispensable for STM as they underpin critical functionalities such as SSA, (automated) collision avoidance, and the coordination of space traffic. These systems ensure the safe and sustainable use of space



operations by enabling accurate information collection, processing, and dissemination, thereby supporting informed decision-making in space operations as well as safe and secure operation (e.g. control) of space objects. The necessity of ensuring interoperability among these systems was a recurring theme, as seamless communication and coordination are vital for managing the increasing complexity of space activities and enabling safe operation.

The WG Cyber also highlighted key challenges, including the safeguarding of infrastructures from cyber threats such as unauthorised access, data breaches, and manipulation. Developing internationally recognised standards for cyber security measures, especially for emerging technologies and actors, was identified as a priority. In this regard, existing (e.g. EU) regulations on cyber security issues were taken into account. Furthermore, the WG Cyber acknowledged the importance of balancing accessibility with security, ensuring that all space actors, regardless of their technological capabilities, could participate equally in space activities.

A key aspect of the WG Cyber's discussions was the distinction between safety and (cyber)security. While safety refers to the operational reliability and functional integrity of the utilised systems, cyber security focuses on protecting these systems from malicious external activities. The WG Cyber recognised that these concepts are deeply interdependent, with cyber security measures often forming the foundation for ensuring operational safety in a broader way. For example, robust protection of infrastructures, such as SSA databases, not only prevents potential cyber incidents but also supports reliable collision avoidance and therefore space debris mitigation.

In addition to technical measures, the WG Cyber finally discussed the broader implications of integrating cyber security into the STM framework. Aligning proposed measures with existing international agreements such as EU Regulations or Directives was emphasised as crucial for ensuring coherence and global applicability. The WG Cyber also stressed the importance of fostering international collaboration, particularly in addressing the needs of emerging space actors and ensuring that cyber security measures do not become barriers to entry but instead enable broader and safer participation in space activities.

III. Formulating the Guidelines

The WG Cyber's efforts culminated in a Guideline explicitly addressing cyber security within infrastructure (Guideline 8). This Guideline emphasises the necessity of cyber security measures with regard to STM.



The Guideline highlights that infrastructure such as SSA databases should be recognised as assets of international interest (critical infrastructure) and protected accordingly through national or international technical measures and legislation. States should therefore adopt best practices and state-of-the-art standards to safeguard these systems. Furthermore, the Guideline calls for international collaboration in developing cyber security standards specific to space systems and operations, and urges operators to implement cyber security strategies and conduct regular vulnerability evaluations.

Finally, additionally to Guideline 8, the WG Cyber provided support for the formulation of the other Guidelines in cases where cyber expertise was required. As a result, the dual strategy of the WG Cyber (no complete separation as well as incorporation, see above) is reflected throughout the Cologne Manual.

Working Group Sustainability

The Working Group Sustainability (WG Sustainability) was the fourth pillar for the development of the Cologne Manual on Space Traffic Management. The central role of sustainability *in* and *through* outer space was to be reflected by an independent WG. The first task was to explore and analyse certain aspects of sustainability and their implications for STM within the group. The second task was to support the other WGs in ensuring that sustainability is considered as one of the overarching concepts and objectives of STM. This dual-function of the WG Sustainability is reflected in its basic approach (I.), the discussion of the various issues (II.), and the final form of the guidelines (III.).

I. The Working Group's Approach

The dual role of the WG Sustainability characterised its work and the Cologne Manual from the outset. There was an early agreement that neither a separation nor a complete integration of sustainability and the other aspects of STM is possible and purposeful. The WG Sustainability therefore adopted a three-element approach, which allowed for a combination of explicit provisions for sustainability aspects and the simultaneous integration of sustainability aspects into the other Guidelines.

This three-element approach included developing a general understanding of sustainability (element one) and a distinction between core aspects (element two) and other aspects of sustainability (element three). Since STM serves to ensure a sustainable use of outer space, the general understanding of sustainability is both the starting and end point of all considerations. Based on this, the aspects that should be included in a specific "sustainability"-Guideline (core aspects) could be distinguished from other (general) Guidelines. While the WG Sustainability leads the way in terms of core aspects, the



WG Sustainability was in an advisory role in terms of other aspects. However, the emphasis on sustainability was not intended to ignore other central aspects of STM (e.g. security, safety or transparency). On the contrary, in line with its mandate, the WG Sustainability cooperated with the other WGs to include and emphasise the sustainability perspective of these aspects.

II. The Working Group's Discussions

During its meetings, the WG Sustainability addressed the general significance of sustainability *in and through* outer space (1.) and focused on the identification of core as well as other aspects (2.) of sustainability for the concrete STM infrastructures of the Cologne Manual.

1. Sustainability *in and through* Outer Space

The WG Sustainability recognised that dealing with sustainability is complex in many ways. It was quickly agreed that sustainability had to be understood in a broader sense. This broader sense includes not only aspects like SST, SSA and STC, but also the aspects of applicability and capability, which relate to the questions of accessibility to and usability of outer space. The latter also, but not exclusively, concerns the perspective of emerging or future space actors.

In recognition of its fundamental importance and widespread acceptance, the UN Brundtland Report's understanding of sustainability played a central role. According to the report, “[h]umanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own.”²² This fundamental idea of sustainability as meeting the needs of today's generations without compromising the needs of future generations is also becoming increasingly relevant for the use of outer space. In this respect, the WG Sustainability relied on the Long-term Sustainability (LTS) Guidelines²³ adopted by UNCOPUS in 2019, according to which:

“The Earth's orbital space environment constitutes a finite resource that is being used by an increasing number of States, international intergovernmental organizations and non-governmental entities. The proliferation of space debris, the increasing complexity of space operations, the emergence of

²² UN, Report of the World Commission on Environment and Development: „Our common future“ (Brundtland Report), New York 04.08.1987, UN-Document A/42/427.

²³ On the LTS-Guidelines see Martinez, Implementation of the UN COPUOS Space Sustainability Guidelines: Early Implementation Experiences and Next Steps in COPUOS, in Secure World Foundation Preprint Series PP23/01 (https://swfound.org/media/207643/pp23_01_a-implementation-of-the-un-copuos-space-sustainability-guidelines-early-implementation-experiences-and-next-steps-in-copuos.pdf).



*large constellations and the increased risks of collision and interference with the operation of space objects may affect the long-term sustainability of space activities.*²⁴

Based on these considerations the primary focus was placed on identifying such aspects which may lead to a sustainable use of outer space. In line with the three-element approach, a distinction was made between core aspects and other aspects.

It should be noted that sustainable use of outer space is not an end in itself. This is reflected in the immense importance of space technology for the development of humankind and for meeting global challenges. For example, “more than 50 % of climate variables can only be measured from space”.²⁵ However, space technology is not only important for the mitigation of climate change or other global challenges, but also indispensable for the protection and support of critical infrastructure on Earth. Generally spoken, sustainability of human activities in outer space and sustainability of human activities on Earth are interlinked. Therefore, the Cologne Manual focuses on sustainability *in* outer space as well as *through* outer space.

Nevertheless, the WG Sustainability was aware of the fact, that sustainability may be understood in different ways and could be interpreted as an obstacle to new actors engaging in outer space endeavours. Therefore, the WG Sustainability considered the needs of emerging or new space actors and the Cologne Manual highlights the character of sustainability as an enabling concept. By ensuring the long-term access and usability to outer space for present and future generations, sustainability is not an obstacle, but the basis for the freedom of use and exploration of outer space in the interest of all humankind.

2. Identifying relevant aspects of sustainability

In preparing the Guidelines the WG Sustainability identified the relevant aspects of sustainability. One major core aspect of a sustainable use of outer space is the handling of space debris. Whilst this was an issue that was debated across all WGs, the mitigation and remediation of space debris was a central concern of the WG Sustainability. The WG Sustainability agreed that from a sustainability perspective any STM must include not only guidelines for the mitigation but also for the remediation or active debris removal (ADR). In this regard, it should be understood that sustainable use of outer space has a technical side. Therefore, aspects of design and equipment (reusability, automatic distance

²⁴ *UNCOPUS*, Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, 20.06.2019, UN-Document A/74/20, Annex II, p. 50.

²⁵ <https://www.airbus.com/en/sustainability/respecting-the-planet/climate-monitoring>.



warning, etc.), but also uniform software (and communication) standards were debated and are included in the Cologne Manual. In addition to these core aspects, the WG Sustainability was also in constant exchange with the other WGs in relation to other aspects, such as registration, licensing, information exchange and cooperation as well as the implementation of the guidelines in future.

During the discussions, the WG Sustainability considered the situation of emerging new space actors. With the common goal of ensuring accessibility and long-term usability for all in mind, the WG Sustainability opted for uniform basic requirements that would apply equally to all space actors or objects. Any actor capable of participating in space traffic must be able to meet the basic requirements of sustainability in the interest and for the benefit of all. At the same time, the WG Sustainability emphasised the possibility to voluntarily meet higher standards. In this context, possible incentives and forms of co-operation were discussed. The WG Sustainability saw the increasing economic use of outer space as an opportunity to consider the market principles in the sense of a “more economic approach”, but at the same time to link them closely to the idea of sustainability.

Finally, the WG Sustainability debated the immense importance of space technology for the development of humankind and its potential to meet global challenges. Environmental impacts are not stopped by a national border but instead affects the global community. Space has been recognised as essential for Earth sustainability.²⁶ Therefore, standards of international environmental law were also taken into consideration, in further accordance with national State practice.

III. Formulating the Guideline(s)

In formulating the Guidelines, care was taken to ensure that the WG Sustainability’s three-element approach did not lead to friction and/or lack of applicability between the specific and general Guidelines. In general, the WG Sustainability emphasised the need for Guidelines that are precise and practical. However, the Guidelines are also future-oriented, i.e. open to future (technical) developments.

The work of the WG has been incorporated in the Preamble and in particular in Guideline 11, which deals with the long-term accessibility and usability of outer space. Finally, in line with its dual role, the WG Sustainability provided support for the formulation of the other Guidelines.

²⁶ See e.g. UN GA resolution A/RES/70/1: Transforming our world: the 2030 Agenda for Sustainable Development.



Commentary

Commentary to Guideline 1 – Pre-launch Activities and Notification

Throughout all operational stages of space activities including the launch, in-orbit and end-of-life phases, operators should issue a notification before every launch, on-orbit manoeuvre or end-of-life activity such as re-entry. It should be notified to all relevant operators, States and other stakeholders. It can be public or directed to specific actors but must inform all relevant players to minimise the risk of collision. Space missions should be designed so that they do not unduly interfere with space traffic, especially human space flight, or endanger life and property on Earth or in the airspace.

1. Pre-launch

Launches should be conducted in a manner that does not interfere with the safe operation of other objects in outer space or airspace, and when relevant on the ground in immediate vicinity of the launch site or directly impacted by the launch. Pre-launch obligations of operators include performing pre-launch activities and issuing a pre-launch notification.

Before launch, a conjunction analysis, an orbit insertion analysis and a space debris modelling should be performed and considered. Before launch, information on on-orbit manoeuvres and end-of-life activities such as re-entry, information about space traffic including space situational awareness, air traffic as well as ground situation immediately surrounding the launch site should be obtained and considered, and measures taken for paying due regard to the safety of air and space traffic and to minimise the risk of collisions.

Pre-launch notification should include information on the launch site, the trajectory, the planned orbit, the launch date as well as time and location of the launch and any other relevant information.

Any changes to the launch date, timeline or planned orbit should be notified immediately.

2. In-orbit

Pre-manoevre notification should at the minimum include information about the trajectory of the object, the timeline and the planned orbit.

All planned changes of trajectory, e.g. planned manoeuvres, should be notified beforehand, in the same acceptable and reliable manner as pre-launch notification.



3. Re-entry

All planned re-entry activities should be notified beforehand, in the same acceptable and reliable manner as pre-launch notification. Pre-re-entry notification should include at minimum expected re-entry trajectory, location, date and time, and when relevant landing.

I. Introduction

In order to ensure safety of space traffic it is imperative that operators communicate with one another and efficiently share certain operational information that enable all relevant stakeholders' timely adoption of necessary measures for the safety of involved objects and persons. In this regard the Guideline is closely linked with Space Traffic Coordination and International Cooperation, Coordination and Communication as part of risk mitigation measures.

Moreover, the Guideline requires safe, secure and reliable SSA information thus necessitating observance of Guidelines touching on and elaborating on SSA as well as careful object design and mission planning thereby touching on Guideline on Space Traffic Coordination as well as on Guideline on Ensuring the Long-term Accessibility and Usability of Outer Space. The analysed legal sources as well as State practice confirm the importance of utilisation of reliable SSA throughout all phases of space activity, careful mission and space object design pre-launch, coordination of launch with relevant stakeholders, information-sharing through all phases of space activity particularly with regard to more impactful planned changes (e.g. launch, on-orbit change of orbit or re-entry) or anomalies (e.g. unforeseen events). There is therefore sufficient support to not only mandate pre-launch and pre-manoeuve activities and notifications, but to furthermore enable extrapolation of best practices to standardise the pre-launch, pre-manoeuve and pre-end-of-life activities and notifications.

II. Structure of the Guideline

The Guideline recognises that under all phases of space activities, including, but not limited to, development phase, launch phase, in-orbit operational phase and end-of-life operations phase, in particular re-entry phase, certain activities must be undertaken to assure functionality of any STM system and to assure safety and security of space traffic. To facilitate easy understanding and implementation the terminology already accepted in practice (i.e. pre-launch, pre-manoeuve and pre-re-entry)²⁷ has

²⁷ Some terminology may nonetheless vary in the Cologne Manual. The Cologne Manual seeks to adopt an easy terminology that repeats throughout and is often primarily legal in nature rather than technical. For example, launch vehicle is a term most notably used in space law while its equivalent in practice is denoted with rocket, rocket-body, upper



been adopted and the Guideline divided into only three phases. The latter means that all phases and activities that come before launch have been joined into one pre-launch phase, all in-orbit activities into one in-orbit phase, singling out only re-entries as their own phase since re-entry includes elements of in-orbit activities as well as (pre-)launch activities. The other methods of end-of-life phases, such as for example moving an object into a graveyard orbit, is logically included under in-orbit phase as it is in fact performed as a transit of orbits.

The Guideline therefore in first paragraph addresses and proposes general and minimal requirements for guaranteeing safety of space traffic for all space activities that should be observed through all phases of space activity. The second paragraph then adds additional detail for the pre-launch phase, whereby emphasis is primarily on the actual launch and the time immediately preceding the launch. The third paragraph adds detail for in-orbit phase and the fourth for re-entry.

III. Rationale of the Guideline

Analysed legal sources, e.g. Articles IX and XI of the OST, as well as State practice confirm the proposed and elaborated measures of the Guideline as appropriate and necessary for the achievement of the goal set for the Cologne Manual to propose timeless guidance in broad enough strokes to not be easily outdated by evolving technology yet be specific enough to help build the foundation of an effective international STM.

The Guideline differentiates between obligations that should be observed throughout the different phases of space activity. Some are the same for all identified phases (mentioned in first paragraph of the Guideline) (1.) and some are different for the three identified phases (mentioned in the three subparagraphs). The Guideline is therefore structured into four paragraphs. The second paragraph in this manner specifies additional detail for the pre-launch phase (2.), the third paragraph does the same for the in-orbit phase (3.) and the fourth for re-entry (4.).

stage or launch system. For some legal terms, especially in instances of translation issues may arise, for an analysis see *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Moro-Aguilar/Popova* (assist. ed.), *Commentario de Colonia al Derecho del Espacio*, 2021. With regard to Pre-Launch Activities and Notification, pre-launch, pre-maneuver and pre-reentry have been analysed as generally accepted and will therefore be utilised for all phases of space activity. On further discussions on terminology see *Rapp*, *The Spationary*, Martinus Nijhoff, Leiden, 2025; *Secure World Foundation, A Guide to Space Law Terms* (USA), 2012.



It should be noted that in all phases special consideration should be paid to large constellations, evaluating whether specialised, more specific measures or variations of the more generalised approach specified herein, should be taken due to the heightened risk posed by large constellations.²⁸

1. General obligations

In the first paragraph, the Guideline emphasises three elements: 1.1. information-sharing, 1.2. development and design, and 1.3. notification.

1.1. Information-sharing

The Guideline begins with stressing the importance of information-sharing for STM purposes by declaring that sharing of information as part of STM is relevant at all operational stages of space activities including the development and design, launch, in orbit- and end-of-life phases. This information, among other, includes SSA data, specifically about one's own space object. This means that operators must keep informed about the location and status of their own space objects and share this information in as far as necessary and when necessary, with other operators. This includes launch operators as well as operators of space objects in-orbit. The sharing of all SSA information in one's possession is furthermore encouraged, without prejudice to commercial entities engages in SSA or SSA-related activities. The attainment, possession and consideration of SSA data is imperative and indeed crucial to success and safety of space traffic in all three phases.²⁹ SSA data is necessary before every scheduled event, e.g. launch, orbital insertion, change of orbit, end-of-life measure. Therefore, SSA data should be attained and consulted before every major event, e.g. launch, in-orbit manoeuvre that transitions or changes orbits, re-entry. Operators should therefore develop or otherwise acquire SSA before beginning with a space activity. In other words, operators and States with SSA capabilities should consult these before every major event, while operators and States without their own SSA capabilities, should acquire this information from other providers, e.g. via contractual means.³⁰

²⁸ This is for example confirmed by IADC (see e.g. the IADC Statement on Large Constellations (Rev. 3)) as well as NASA (Large constellations should coordinate with NASA, consider adoption special more stringent measures than those proposed for other operators and should consult with NASA regarding more difficult or complex cases. See the NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2020.)

²⁹ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2020; ESA Annual Space Environment Report 2025; EC, Joint Communication: An EU Approach for Space Traffic Management – An EU contribution addressing a global challenge (2022).

³⁰ For more information see also Guidelines on SSA and Information Acquisition and Dissemination as well as associated Commentaries.



Legal provisions as well as State practice confirm that information-sharing should not be objectionable.³¹ For example, Article XI of the OST, Article V of the REG or UNCOPUOS Long-term Sustainability Guidelines³² require information-sharing. Several national space acts already require non-state actors to provide information on their space objects to the national space authorities (at minimum for purposes of national registration).³³ Many national space laws furthermore require non-governmental actors to periodically inform the national space authorities of the status of their space object, especially about unforeseen events or those that could potentially cause danger.³⁴ Support for requiring information-sharing about events that could impact other space objects or endanger the population on Earth such as changes of orbits or re-entry events can therefore be found in State practice. Furthermore, information-sharing is already being performed by numerous space actors, including space agencies, on an ad hoc basis. For example, European actors such as the German Aerospace Centre (DLR) normally perform pre-launch collision assessment, with aid of the EU SST (including DISCOS (Database and Information System Characterising Objects in Space)). In a further example, the ESA Space Debris Office, that operates many European capacities, is contacted, notifies and is in turn notified every time when orbital manoeuvre is undertaken by ESA space objects (e.g. de-orbiting, changing orbits, manoeuvring). The Space Debris office coordinates any orbital manoeuvres from a technical perspective, including operating a conjunction risk assessment system for ESA and third parties, making orbital manoeuvre recommendations to the supported missions from a technical perspective, while the ESA Legal Department liaises with the Space Debris Office and exchanges information when necessary or so requested.³⁵ NASA equally advocates high level of cooperation and coordination with USSPACECOM through all phases of space activity.³⁶ Operators should for example share e.g. mission information, spacecraft design, orbital maintenance strategy and predicted ephemeris including any planned manoeuvres. During on-orbit phase operators should undergo the

³¹ See e.g. IDA, *Global Trends in Space Situational Awareness (SSA) and Space Traffic Management (STM)*, 2018.

³² The UNCOPUOS 2018 Long-Term Sustainability Guidelines recognise this practice and the imperative to improve on it for purposes of space traffic safety and STM. In section B the LTS in this manner recognise necessity for exchanging contact information and sharing information on space objects and orbital events (B.1), sharing orbital information (B.2), performance of conjunction assessment (B.4), and pre-launch conjunction assessment (B.5).

³³ For a full analysis of national space legislation see *Gillet/Grünfeld/Ramuš Cvetkovič, Lex Ad Astra – Non-State Actor Accountability for Space Pollution*, Martinus Nijhoff, Leiden, 2025. See also Annex on National Space Acts.

³⁴ *Gillet/Grünfeld/Ramuš Cvetkovič, Lex Ad Astra*, 2025. See also Annex on National Space Acts.

³⁵ See e.g. Merz et al., *Current collision avoidance service by ESA's space debris office*, 7th European Conference on Space Debris, Proceedings of the conference 2017.

³⁶ *NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook*, 2023.



USSPACECOM process of e.g. arranging for conjunction analysis data exchange including manoeuvre notification reports and CDMs.³⁷ Equally any anomalies or difficulties in operating a space object should be reported.

Therefore, standardisation and education of new actors is primarily required.³⁸ Even logically there should be no real objection to information-sharing of information necessary for assuring safety of space traffic as well as air traffic as majority launches as well as space objects are traceable. Operators are not requested to disclose their data or mission data, simply information that is necessary to assure safe management of space traffic.

1.2. Development and design

The Guideline continues by stating that space missions should be designed so that they do not unduly interfere with space traffic, especially human space flight, or endanger life and property on Earth or in the airspace. The Guideline thereby specifically recognises the importance of the development and design phase, as part of the pre-launch phase as well as its general importance for in-orbit and end-of-life phases, as some space object may only be able to implement collision risk mitigation as well as space debris mitigation measures during the development and design phase.³⁹ JAXA for example relies primarily on the development and design phase for risk mitigation, including for mitigation of risk during launch, such as appropriate object design, low-risk orbit selection and development of several environmental models taking SSA information into account.⁴⁰ During launch JAXA launch vehicles are not trying to avoid all objects, but rather concentrate on aircraft and human spaceflight by calculating so-called the COLA evaluations, or pre-launch COLA evaluation in order to avoid collision with any crewed or human spaceflight.⁴¹ NASA also advocates use of development and design phase to ensure launch, in-orbit and re-entry safety and risk mitigation.⁴²

Operators of space objects without manoeuvrability capability should, for example, consider possible collision risk mitigation measures that could be implemented via mission planning, proper choice of

³⁷ Ibid.

³⁸ The Secure World Foundation has for example issued Handbook for New Actors in Space (2nd ed.), 2024, adapted to the US space architecture.

³⁹ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022.

⁴⁰ See Annex on State practice.

⁴¹ Ibid.

⁴² For more information see Annex on State practice.



material, selection of appropriate orbit etc.⁴³ In a further example, it is inadvisable to place objects without manoeuvrability capability in an orbit with systematic and regular conjunction events frequency, e.g. high frequency of conjunction warning alerts. Furthermore, all operators should implement space debris mitigation measures during development and design, as well as mission planning phase, including but not limited to selection of appropriate material and calculating sufficient fuel quantities to ensure success of end-of-life phases, e.g. passivation and removal of space objects from operational orbit either via re-entry or by their relocation into the graveyard orbit.⁴⁴

To elaborate on the aforementioned, to ensure subsequent safety of on-orbit operations several mitigation measures have been developed in practice and are advised as elemental in assuring success of the launch phase as well as on-orbit operational phase. It is most influential during the launching phase and is therefore repeated under the Pre-launch subtitle. The aforementioned measures include mission planning, part of which is orbit selection. The latter should include analysis of space debris numbers and density via consultation of appropriate space debris models, space object density and close conjunction events frequency in the selected orbit.⁴⁵ If the operator itself does not possess capability to perform the aforementioned analysis, reliable analysis should be acquired contractually or through other means.⁴⁶

In instances where the selected parking orbit is densely populated, as for example the Low-Earth-orbit (LEO), and high magnitude of close conjunction events is expected, another orbit should be considered instead. However, if the selected parking orbit is not changed, the operator should reach out to other users of the orbit and adopt in cooperation with said users a space traffic coordination plan, communication and collision risk mitigation procedure and measures. These should be standardised and determined in advance to save on time and avoid unnecessary collision risk. These should moreover include the collision avoidance measures and priorities. In simpler terms, this should include which operator performs the evading manoeuvre and which space objects keeps its course, how often this sequence is repeated and if the operator's obligation to evade switch or not. To regulate these measures, it might be advisable to determine or at least address the question of possible compensation for manoeuvre. Compensation could be financial or non-financial e.g. manoeuvre for manoeuvre. Even the question of liability for instances of collisions or damage to space objects could be

⁴³ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; see inter alia also IADC Statement on Large Constellations of Satellites in Low Earth Orbit, 2021.

⁴⁴ See also Guideline on Accessibility and Operational Usability of the Space Environment and associated Commentary.

⁴⁵ See also Annex on National Space Acts.

⁴⁶ See also Guideline on Information Acquisition and Dissemination and associated Commentary.



addressed in such discussions or determining at the very least specific future dispute resolution methods.

Further, space object design should be considered, selection of material(s) appropriate for the mission objective and the selected orbit. Design and selected materials should moreover comply with Space Debris Mitigation Guidelines as laid down by UNCOUOS.

Moreover, special considerations should be made for large constellations of satellites. Due to large constellations being composed of numerous, sometimes hundreds or even thousands of satellites, flying in close formation and often manufactured low-cost and in short production time-frame, these pose a significantly higher risk to space operations and the orbital environment than single satellite missions.⁴⁷ If one satellite suffers an engineering flaw it is likely that the rest of the space objects manufactured simultaneously will include the same flaw and the result will be simultaneous deorbiting or partial or complete loss of function in numerous space objects. Even at normal operation, it is expected that several hundred objects will be deorbited every year as large constellations increase. Therefore, special recommendations are advised. Constellation design should consider launching no more objects than necessary for the mission and should plan flying these in sufficient altitude separation to minimise collision risk. The latter is especially important at intersections between orbital planes of a constellation.

Additionally, it should be noted that space objects should be designed:

1) in accordance with space debris mitigation measures, including ensuring structural integrity, capabilities that will ensure post-mission disposal as well as monitoring technologies that will enable monitoring of those capabilities during the object's orbital lifetime as well as passivation. (A large percentage of debris has been evaluated to be the result of accidental on-orbit explosions, sometimes resulting from such structural design as e.g. anomalies resulting from reactions in batteries to nominal and non-nominal orbits.⁴⁸ As some of these anomalies and reactions to orbital pressures cannot be planned on Earth,⁴⁹ it has been considered whether it should be advisable, especially in instances of

⁴⁷ See e.g. IADC Statement on Large Constellations of Satellites in Low Earth Orbit, 2021; *Blount/Hofmann* (ed.), *Space Law in a Networked World*, Martinus Nijhoff, Leiden, 2023.

⁴⁸ The IADC also recommended that space objects should be designed in a manner to allow for anomalies and some failures, permit and ensure passivation and post-mission disposal, including monitoring of those capabilities during space object lifetime, as well as, if possible, active collision avoidance during the in-orbit phase which should be maintained throughout the end-of-life phase (i.e. post-mission disposal).

⁴⁹ See Zero Gravity Research on e.g. NASA (<https://www.nasa.gov/mission/station/research-explorer/>) and/or ESA ([https://www.esa.int/ESA_Multimedia/Keywords/Description/Zero-gravity_research_and_experiments/\(result_type\)/videos](https://www.esa.int/ESA_Multimedia/Keywords/Description/Zero-gravity_research_and_experiments/(result_type)/videos)) websites.



large constellations where systematic anomalies might manifest in numerous satellites of one generation, to include a test-phase during which some of the satellites are tested in low altitude orbits that enable easy and trackable deorbiting without posing a major threat to space traffic. Additionally, research and use of new technologies that might allow automatic passivation of space craft after loss of contact is encouraged.)

2) to permit certain for sufficient on-board redundancies of all functions (e.g. functions involved in post-mission disposal),

3) trackability and monitoring, by e.g. adding onboard active or passive component to improve orbit determination and prediction and aid in conjunction analysis in this manner of the object to improve,

4) if possible, active collision avoidance capabilities during the in-orbit and maintained throughout the end-of-life phase (in absence of active collision avoidance capabilities, passive collision avoidance capabilities should be considered and planned during the space object and mission design phase including e.g. sharing space object collision avoidance capabilities with relevant SSA provider and establishing collision avoidance plans with other user of the selected orbit).

Finally, during the launch phase, information sharing and active cooperation and coordination – especially with impacted Earth population and air traffic control, including ICAO, as well as potentially impacted space object operators (e.g. operators operating space objects in the crossed orbits and in the selected orbit around the time of launch and orbital insertion, ascertainable via SSA data) is vital to assure safety and security. Part of these efforts should be careful selection of launch facility and launcher. In event of operators of launch facilities special care should be paid to protection of the site, security of launch facilities and may be affected via providing proper education to launch facility personnel regarding coordination and cooperation procedures as well as security concerns. The notification should include at minimum launch time and date, location and flight path (trajectory) and target orbit.

1.3. Notification

It is generally accepted that acquiring SSA information is not in itself sufficient to mitigate risk of collision. Information must be shared and to ensure effectiveness of information-sharing, the Guideline highlights the importance of appropriate notifications being issued before each of the identified events e.g. launch, in-orbit manoeuvre or end-of-life activity by recognising that a notification should be issued before every launch, on-orbit manoeuvre or end-of-life activity such as re-entry. Operators



should furthermore endeavour to issue notifications about any further event that may have an effect or impact on space traffic and present potential for collision risk.

With regard to in-orbit manoeuvre, negligible regular adjustments of space object trajectory that do not pose any heightened risk to space traffic may not necessitate notification, but should be accounted for. Major on-orbit events such as changes of orbit or (larger or impactful) alterations of the space object trajectory, course and orbital parameters should be notified in interest of space traffic safety.

The Guideline furthermore emphasises that the notification be issued to all relevant operators and States. For these measures to be effective the notification should alert all relevant operators and States, whereby operator should be understood as primarily space object operator operating in the same orbital plane or otherwise potentially affected by the event, e.g. launch operator delivering payload into the same orbit, as well as SSA operator or other STM-relevant services operator (e.g. entity processing CDMs or SSA data, or the International Technical Advisory Body⁵⁰). This obligation implicitly includes an obligation on operators to actively identify potentially impacted subjects (e.g. declare whose airspace will be crossed by the launch vehicle during the launch phase or other space object operators operating in orbits transited during launch, orbital insertion or end-of-life events, or operating in the same orbit as the space object in question).

Finally, the notifications have to be efficient, meaning it must efficiently alert all potentially impacted parties. Therefore, the Guideline proposes that the notification can be public or directed to specific actors, but must inform all relevant players to minimise the risk of collision. This means it can be made using public information sources or otherwise effectively communicated to all relevant actors, via other means and methods. For example, the launch of the James Webb telescope was scheduled and publicly announced on television and internet to the general public. Additionally, during the launch phase it seems generally accepted practice that in instances of launches, at the very least the national ATM is notified and the airspace closed if the respective ATM deems this necessary, either by taking up direct telephone contact with the local Air Traffic Controller or via other methods such as making use of ICAO NOTAM system.⁵¹

Informing publicly about the planned events must be included so that other operators can look into the event and perform collision analysis evaluations or may raise concerns that they might be affected by the event. For example, many launches are already being announced so assessment predicts that a

⁵⁰ Explained in the Guideline on Communication System and International Technical Advisory Body and associated commentary.

⁵¹ See also Guideline on International Cooperation, Coordination and Communication.



notification requirement could be easily accepted as part of STM system and not a revolutionary addition. The aim of the Cologne Manual is to clarify, systematise and standardise the notification, making it more reliable. Main objective is making the information easily and quickly available in ideally one place so that States, launchers, operators and other interested and potentially impacted parties could access it beforehand. Proposals from US industry have for example called for the establishment of some kind of practical standardised scheme for the *notice to space operators* notices, akin to the air law concept called notice to air missions (abbreviated NOTAMs).⁵² For example, if there are military activities planned, for instance missile tests, notification designates certain areas as danger areas. Or if other actors are planning manoeuvres, they should be aware of already scheduled activities (in a certain area), especially launches.

Standardised mechanisms or procedures for notifications on scheduled events should be developed. Un-scheduled events, e.g. uncontrolled re-entry or anomalies and difficulties in space object operations, loss of control in space objects should be reported to all relevant actors including all potentially impacted parties as well as national space authorities as soon as the information becomes known to the operator and in case without unnecessary delay in the interest of space traffic safety. The States should then forward this information to the UN in the interest of ensuring maximum safety level. Any other operator (including space object operators, whether in-orbit or launch operators) as well as SSA providers and other comparable actors) or State that receives or becomes aware of such information should notify the space object operator as well as any other potentially impacted parties, or best the international community. An ATM comparison for all notifications is the NOTAM system of the ICAO, or the Notification to Air Missions.⁵³

It is important to note that notification must be flexible and capable of quick and easy amendments. As shown by State practice, e.g. launches are often postponed. For example, the launch of the German Herz Settler scheduled for the evening of the July 5th, 2023, was by then already delayed twice. It should therefore also be noted that the value of pre-launch information may be limited for collision avoidance in-orbit if notifications are not easily and quickly updated as only a few seconds of delay in a launch will result in a significantly different situation in-orbit. This furthermore means that the notifications and operators/launchers would have to have an ability to update their notification frequently and would require 24/7 staff, either at facility or on call, to ensure that the “notification” or

⁵² For more information on NOTAMs see Annex on Air Law and Air Traffic Management.

⁵³ For more information on the NOTAM see Annex on Air Law and Air Traffic Management.



“system” is working properly. In any case, operators should be permanently and quickly available for any inquiries.

2. Pre-launch

The sub-paragraph on pre-launch pertains first and foremost to launch activities.⁵⁴ For these several measures should be undertaken by both operators of launch vehicles as well as operators of other space objects to guarantee safety of space operations. These include pre-launch activities and the issuing of a pre-launch notification.

The sub-paragraph specifies that before launch attainment of information and adoption of appropriate measures is required. For launch operators this information includes information on planned orbital manoeuvres, re-entries as well as information on air traffic and ground activity in the direct vicinity of expected impact or otherwise potentially directly impacted should be acquired and taken into consideration when planning a launch. For the former two, SSA information should be acquired and consulted, while for the latter, e.g. the local air traffic control can be contacted or ICAO NOTAM system consulted. For operators of other space objects (e.g. objects that are being launched into outer space) can aid by attaining SSA information during the development and design phase as well as during mission planning phase to assure passive risk mitigation measures, such as selection of an appropriate orbit as elaborated above under development and design point (see point 1.2.).

Following attainment and consultation of relevant information, appropriate measures should be taken to pay due regard to the safety of space traffic and to minimise collision risk. Due regard has been interpreted as a requirement to apply a standard of care or attention to avoid infringing upon the rights of others.⁵⁵ Standard of care has regularly been understood as adoption of due diligence measures.⁵⁶

⁵⁴ Although the pre-launch phase includes space object and mission design as well as orbit selection in addition to the launch phase itself, i.e. development and design as well as mission planning, the sub-paragraph is focused on the phase immediately preceding the actual launch because the development and design as well as mission planning is also addressed in the general part of the Guideline.

⁵⁵ See e.g. *Fishers Jurisdiction Case (UK vs. Iceland)* (Merits) 1974 I.C.J. 29 (Jul. 25); S. Marchisio, “Article IX”, in Hobe, Schmidt-Tedd, Schrogl (ed.) Goh (assist. ed.), *Cologne Commentary on Space Law: Volume I*, Carl-Heymanns Verlag, Cologne, 2009, p. 175.

⁵⁶ See e.g. *Corfu Channel case*, Judgement of April 9th 1949, I.C.J. Reports 1949; *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Reports 2010.



Therefore the due regard requires adoption of due diligence measures to minimise probability of harm being caused to activities of others.⁵⁷

This is confirmed by the following sentence of the Guideline that declares launches should be conducted in a manner that does not interfere with operation of other objects. For this is predicts performance of certain activities before launch and a notification about the planned launch. One of the appropriate activities has already been indicated as the attainment of SSA data for the launch vehicle launch trajectory, i.e. transited orbits and the orbit selected for orbital insertion of payload. Practice confirms that this is done by performing, prior to launch, a conjunction or collision avoidance analysis, an orbit insertion analysis, a fragmentation analysis and/or space debris modelling.⁵⁸ Logically, safety measures include gathering information about air traffic along the planned launch vehicle launch trajectory in airspace and being aware of the immediate surroundings of the launch site, and adopting appropriate measures to assure safety of all potential impacted parties on ground, in airspace and in outer space.

Other space object operators (e.g. operators of space objects in-orbit or those about to be launched into orbit) should again perform and account for the aforementioned measures during development and design as well as mission planning, among others by conducting as mentioned a conjunction analysis, an orbit insertion analysis and a space debris modelling and other possible measures indicated in the development and design (see point 1.2.).

Among the most important safety measures for conducting a launch, the Guideline accentuates the issuing of an efficient pre-launch notification, which it clarifies should include information on the launch site, the trajectory, the planned orbit, the launch date as well as time and location of the launch and any other relevant information. As mentioned in the general part, the notification should be issued to all potentially impacted parties. This includes potentially affected population on the ground, e.g. in the immediate vicinity of the launch site, air traffic controllers or pilots of aircraft in flight and other objects present in the crossed airspace, as well as operators of space objects in transited orbits

⁵⁷ See e.g. Application of the Convention on the Prevention and Punishment of the Crime of Genocide (Bosnia and Herzegovina v. Serbia and Montenegro), Judgement, I.C.J. Reports 2007; Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua) and Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), Judgement, I.C.J. Reports 2015.

⁵⁸ See Annex on State Practice. For further information see e.g. EU SST, Service, accessible at: <https://www.eusst.eu/services/>; NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; NASA Orbital Debris Engineering Model, ORDEM 3.2; Chen et al., Orbital Data Applications for Space Objects, Springer, Beijing, 2017.



and in the planned selected orbit. The notification should be issued in the same reliable manner as elaborated in the general part of the Guideline, e.g. publicly via contemporary information methods.

To ensure effectiveness of such a pre-launch notification, any changes to the launch date, timeline or planned orbit should be notified immediately. The latter is of vital importance as launches are subject to many factors including atmospheric conditions and are in practice often postponed or altered. A reliable, quickly adaptable system of communications should be developed in future. In the short term, efficient communication channels between relevant actors has been proposed,⁵⁹ while in the long-term, the development of an electronic platform analogous to the ICAO NOTAM system has been hoped for.⁶⁰

Additionally, as the number of launches and the variety of launch systems increases,⁶¹ it is imperative that pre-launch notification encompasses the potential for cross-border launches, as these may impact various entities. Currently, there are no automated passage rights pertaining to different national airspaces, with reliance instead being placed on private agreements between States.⁶² This aspect should also be given due consideration during re-entries.

Finally, special mention should be made at this point of space objects impacting population on the ground (2.1.) and aircraft in flight while crossing airspace (2.2.).

2.1. Impacting population on the ground

Launches and re-entry events that have the potential to harm humans on Earth should also be publicised to the potentially impacted population via television or other widely publicly utilised media or information channels. This tacitly includes the obligation to evaluate and calculate space object trajectory and potentially impacted population to determine target audience that needs to be made aware of the danger via best option information method.

Additionally, for launch operators, national legislation of the territorial or jurisdictional States may include provisions on protection of the Earth environment that will need to be considered when performing a launch.⁶³ The latter is specific and unique to launch activity.

⁵⁹ See also Guideline on Cooperation, Coordination and Communication as well as Guideline on a Communication System and International Technical Advisory Bod

⁶⁰ For more on the NOTAM system see Annex on Air Law and Air Traffic Management.

⁶¹ See e.g. BryceTech, *Global Space Launch Activity in 2024*; BryceTech, *Orbital and Suborbital Launch Sites of the World 2025*; *Teofilatto*, *Trajectories of Launch and Reentry Systems*, Springer, Heidelberg, 2025.

⁶² Rule 115, MILAMOS.

⁶³ For an analysis see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra – Non-State Actor Accountability for Space Pollution*, Martinus Nijhoff, Leiden, 2025, Chapter 5. See also Annex on National Space Acts.



It is furthermore imperative to acknowledge the obligations that encompass the necessity to respond to unforeseen occurrences. Such events may include, but are not limited to, catastrophic incidents, substantial asset divestitures, satellite transmission challenges, and other unique occurrences that exert an influence on the launch and re-entry phases. Additionally, it is crucial to recognise the impact of such events that influence on-orbit activities.

2.2. Impacting aircraft in flight while crossing airspace

Launches to orbit and re-entries from orbit are operations of global scope and scale. The vehicles cross territorial, national and airspace boundaries on their way to and from space. While it may take a vehicle just a few seconds to move across these boundaries, the effects on the airspace below can linger for minutes or even hours in the event of a non-nominal occurrence. The former special event of a space launch has become daily business. Due to the nature and physical requirements of space operations, the impact of a non-nominal situation cannot always be limited to national boundaries and jurisdictions. This must be considered when adapting processes that simultaneously permit a rapid response capability to incidents to ensure safety, while maintaining the necessary airspace capacity for air traffic. With regard to international collaboration and information exchange from the air sector provides an insight that most launch and re-entry operations (to or from orbit) involve multi-stakeholder international/cross border coordination. Efficient and reliable provision of all information required for this purpose is crucial. Due to the global nature of spaceflight events, national solutions are not sufficient in this respect today. Affected and involved stakeholders must be included in future concepts for addressing this issue in a cross-border and interoperable manner.

Timely, efficient and effective information sharing across participating entities therefore is a critical enabler to effectively prepare and execute their responsibilities for safe and efficient airspace management, particularly in non-nominal scenarios. On the foundation of a cooperative agreement, the FAA and DLR have demonstrated that U.S. and European ANSPs can respond adequately to a non-nominal event during a launch or re-entry operation that presents a hazard to the airspace system.⁶⁴ The outcome of the project leveraged existing international data standards and infrastructures by using a data exchange approach based on System Wide Information Management (SWIM). It has been

⁶⁴ See e.g. *Kaltenhaeuser/Kluenker/Schmitt*, “Interoperable data exchange for safe and efficient launch and re-entry operations in an international environment”, *Acta Astronautica* Vol. 214, 2024; *Niles*, FAA Preemptively Clears Airspace For SpaceX Launch, 2025, accessible at: <https://avweb.com/aviation-news/faa-preemptively-clears-airspace-for-spacex-launch/>.



shown, that the systems on both sides of the Atlantic could be connected via standardised protocols and used successfully for exercises in different scenarios.⁶⁵

Regarding air traffic, pre-launch notifications will therefore be especially relevant and appropriate standardised communication channels and procedures should be developed between space launch operators and ATM for duration of launch and re-entry (controlled and uncontrolled).⁶⁶ Safety in airspace should therefore be achieved via active and systematic communication with Air Traffic Management and ICAO. Guideline on International Cooperation, Coordination and Consultation therefore proposes establishment and determination of direct and open channels with ATM and ICAO. This should include determination of not only communication processes and procedures, but also specification of information that should be provided for each launch and re-entry as specified in this Guideline. To save on time, a simple standardised template could be developed for Space to Air communications. In event of computer systems and cyber communication methods should be employed, necessary cyber security and education should be ensured to prevent data manipulation or loss.

From point of view of ATM space objects are normally considered as aircraft for their duration in airspace and obligations on space objects operators may in future arise or be complemented by air law and the method of integration of launch and re-entry into air domain should be known to space object operators, specifically launch operators.⁶⁷ Air operations are heavily regulated with the aim to unify, or at least harmonise, all conditions for aircraft operations to enable them to operate in various national jurisdictions under the same conditions. Such requirements and conditions can be divided

⁶⁵ The EU has recognised the need to understand launch and re-entry events as part of a group of new technologies, mission types and vehicle types whose integration into the air transport system requires novel operational procedures and regulations.⁶⁵ These new higher airspace operations will be conducted generally above FL550 and are expected to be deployed globally. The European Commission in cooperation with EUROCONTROL, the European Union Aviation Safety Agency (EASA), the SESAR Joint Undertaking (SJU), the European Defence Agency (EDA) and the European Space Agency (ESA) organised the European Higher Airspace Operations Symposium in April 2019. The symposium concluded that two actions were required to further advance the development and introduction of new entrant operations in HA: the development of a European Concept of Operations for Higher Airspace and the exploratory work of a regulatory framework underpinning such operations.⁶⁵ As a consequence, the EU had launched a two-year project as part of the European SESAR research program, called ECHO, which delivered a comprehensive Demand Analysis, User Requirements and a Concept of Operations (ConOps) for Higher Airspace Operations (HAO), to allow safe, efficient and scalable operations in this evolving environment. The ECHO conops has been published as a deliverable of the project in January 2023. In parallel EASA had set up a regulatory task force to explore the regulatory aspects of higher airspace operations. The Task Force has developed a Proposed Roadmap on Higher Airspace Operations which has been published by EASA on March 10th 2023.

⁶⁶ It is not the goal of the Cologne Manual to propose detailed procedures, but rather to propose the necessary elements to be developed in more detail nationally and/or internationally by international and/or national legislators with appropriate technical procedures developed and adopted by space object operators. For more information see the Guideline on International Cooperation, Coordination and Consultation and its associated Commentary.

⁶⁷ For a detailed analysis of launch integration into ATM see Annex on State practice/Air Law.



into the following broad categories that provide helpful guidance for future development of space activity regulations: (i) conditions in respect of the aircraft and other technology involved; (ii) conditions in respect of the type of operation; (iii) conditions in respect of the personnel involved; (iv) conditions for the actual operations. Space objects, like space shuttles or spaceplanes, are subject to space law; however, this does not automatically preclude the application of air law while such object operates in airspace. Generally, space objects need to pass through the airspace over continents and/or the high seas to enter outer space, thus posing the question of what legal regime and when should apply to avoid interference with civil aviation given that the legal realms of outer space and air space differ significantly and no universally agreed and established legal boundary exists between the two.⁶⁸ These questions could be clarified in future to provide legal certainty. For purposes of the Cologne Manual it suffices to say that all of relevant objects should abide by the proposals made by the Cologne Manual for safe operation.

Domain of integration of launch and re-entry operations into the airspace concerning safety informs that space operations such as launch and re-entries do not meet aviation safety standards. Furthermore, the risk in certain areas cannot be considered a "background risk" compared to other daily risks for people on the ground. Therefore, safety measures must be taken to protect aircraft and the public in general. The first option to increase safety should be to increase technical reliability. Other options are operational safety measures, such as excluding air traffic from high-risk areas, in other words operating launch sites in areas of low air traffic or virtually none. This requires a risk assessment to identify areas where safety criteria are not being met. These areas are then communicated to aviation and should be kept clear of air traffic during the launch. The launch operator must monitor these areas, as in international airspace entry cannot be prohibited. If these areas are not clear at time of launch, the launch must be aborted. There is no international standard for carrying out the risk assessment to identify hazardous region to aircraft. The safety criteria that the operator must comply with also vary from country to country. Both aspects could compromise safety and prolong the licensing process. International harmonization of handling launches and re-entry risks in spaceflight would simplify the access to space and the required planning and certification processes while ensuring safety. Legal aspects of launching from or over the high seas as well as higher airspace operations are currently being discussed and may become relevant in future⁶⁹.

3. In-orbit

⁶⁸ See Annex Air Law and Air Traffic Management.

⁶⁹ For a description of the current efforts and challenges see Annex on Air Law and Air Traffic Management.



For events in-orbit, a pre-manoeuve notification should be issued, whereby as mentioned negligible regular adjustments of space object trajectory that do not pose any heightened risk to space traffic may not necessitate notification, but should be accounted for. Major on-orbit events such as changes of orbit or (larger or impactful) alterations of the space object trajectory, course and orbital parameters should be notified beforehand in interest of space traffic safety, in the same acceptable and reliable manner as pre-launch notification and should at minimum include information about the trajectory of the object, the timeline and the planned orbit.

The aforementioned together with the general obligations from paragraph 1 of the Guideline means that during the in-orbit phase, it is, *first*, imperative to keep track of one's space object and share information on its status, especially any problems or difficulties in the operation of the space object. These should be reported to SSA provider(s) and national space authorities, which should forward the information to the UN in accordance with the REG.

Second, when planning an on-orbit manoeuvre, SSA should be utilised (acquired) and if orbits are changed, the new orbit selection process should be undertaken as the one described under pre-launch phase (e.g. selected orbit should be screened for space debris with use of space debris models and for magnitude of close conjunction events. If the high number of conjunction events is expected, another orbit should be considered or a risk mitigation plan adopted in cooperation with other users of the new selected orbit.) It should be considered that upper (rocket) stages may operate near space objects or constellation altitude, and should be accounted for as part of in-orbit space traffic for their duration in-orbit.

Third, operators should inform the relevant stakeholders, especially those whose space object come into close proximity of the affected space object, of planned manoeuvres. Operators should evaluate and calculate as close as possible, which operators might be impacted; if orbit transitions shall be affected, which objects might be in those orbits; users of the transitioned orbits and the new parking orbit. Following evaluation, potentially impacted operators should be notified of the manoeuvre sufficiently in advance to enable precautions to be taken. Alternatively, public notifications could be comparably effective. In events of unplanned on-orbit manoeuvres such as malfunction or loss of control over a space object.



Fourth, efficient and open communication as well as timely sharing of relevant information with SSA networks and operators is required, especially in instances of large constellations.⁷⁰

4. Re-entry

The importance of post-mission disposal has been emphasised and should be ensured (e.g. end-of-life measures should be planned during space object and mission design phase as mentioned above).⁷¹ Shorter disposal timelines than 25 years are encouraged, in line with emerging practice, and if possible, controlled re-entry should be ensured. Re-entry has been evaluated as preferred to disposal into a higher orbit as orbital drag and natural decay may yet cause collision and cascading effects in events of disposal into higher orbit. If a space object possesses active collision avoidance, these capabilities should be maintained throughout the end-of-life phase and should be regularly monitored with disposal initiated as soon as reliability of objects drops to critical level even if design lifetime has not been reached.

In accordance with the general obligations specified in paragraph 1 of the Guideline, SSA information should be acquired and consulted prior to end-of-life activities, and SSA operator informed of the planned manoeuvre. Logically, if a space object is being moved into the graveyard orbit, procedures for an on-orbit manoeuvre under the third paragraph of the Guideline should be followed. If a space object is performing re-entry, procedures for launch should be followed in reverse and in combination with relevant elements of on-orbit manoeuvre. For this purpose, paragraph 4 of the Guideline specifies that all planned re-entry activities should be notified beforehand, in the same acceptable and

⁷⁰ For further recommendations from existing State practice see e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; see inter alia also IADC Statement on Large Constellations of Satellites in Low Earth Orbit, 2021.

⁷¹ The IADC furthermore studied orbital traffic determining that crucial to safe orbital environment is the post-mission disposal or end-of-life phase. For this the IADC made recommendations, emphasising the need for stringent adherence by large constellations of satellites that pose a heightened risk and specifically for space objects flying in higher orbits above, for example, 1000 km due to the natural atmospheric drag induced orbital lifetimes increasing with orbital altitude. The IADC therefore recommended not only adherence to the IADC/UNCOPUOS Space Debris Mitigation Guidelines, but added in the IADC Statement on Large Constellations (Rev. 3) that efforts should be undertaken to ensure controlled re-entry (preferred over uncontrolled) and preferably post-mission disposal should plan for disposal rather than removal into a higher orbit, as the latter might nonetheless due to natural decay and drag, cause collision and cascade effects endangering space traffic, e.g. deep-space missions crossing the so-called graveyard orbits.



reliable manner as pre-launch notification, whereby the notification should include at minimum expected re-entry trajectory, location, date and time, and when relevant landing site. Some object will burn up in the atmosphere, in which case there will be no landing site, however, some objects may survive re-entry and land, in which case the operator should calculate the approximate expected landing site and alert the appropriate authorities of such landing. Many re-entries end on the high seas. However, several re-entries have been observed in recent years whether during re-entry from orbit or post-test, which have necessitated abrupt closure of airspace such as the 2025 failed test of SpaceX's Starship.

The aforementioned should be observed for controlled as well as uncontrolled re-entries. In instances of un-controlled re-entry, the operator should share the information at their disposal and best evaluations, and should cooperate with SSA providers or other relevant entities to optimise re-entry and potential landing predictions, thus maximising safety of Earth populations as well as aircraft in flight. In instances of controlled re-entry, the planned trajectory and landing site if applicable should be shared. Additionally, cooperating with any interested SSA providers or other relevant parties is encouraged.

As with other notifications, potentially impacted parties should be informed via appropriate channels. For aircraft the appropriate channels are ICAO automated notifications system and the localised (regional) air traffic management. For potentially impacted human population, the appropriate local authorities should be alerted. It is furthermore advisable to alert at minimum the local population via popular media such as television, news or social media. For recovery, appropriate measures should be undertaken in cooperation with the State of Registry (e.g. its national space authorities) as well as the State under whose jurisdiction the space object lands, if it does not land in an area beyond national jurisdiction such as the high seas. The latter could be contacted by the State of Registry via diplomatic channels in accordance with Article VIII of the OST and Article 5 of the Rescue and Return Agreement.⁷² In events of human space object re-entry, Rescue Agreement requires that appropriate search and rescue is organised by the launching authority and with assistance of the territorial State or any other State in a position to lend assistance.

As space exploration continues to expand, the number of space objects in orbit is increasing, which raises concerns about re-entry. The potential for uncontrolled re-entries, such as rocket bodies, is growing. The implementation of a functional STM system, inclusive of a sophisticated notification

⁷² For an analysis see *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. II*, Carl Heymanns Verlag, Cologne, 2013.



mechanism, is crucial in mitigating the risk of inadvertently crossing borders and violating the sovereignty of another State. Furthermore, it can report on the liability for damages and potential violations, thereby fostering a more secure and regulated environment for space activities.⁷³

IV. Future developments

In future, States might elect to specify the safety measures and information-sharing, including the timeframe for delivery of information important for STM, in international, regional or national legal instruments, thus harmonising the practice and proposed approaches in more detail than tackled in the Cologne Manual.

Presently an abundance of State practice testifies to the necessity of the mentioned measures and notifications specified in the Guideline. Therefore, the main difficulty is not expected to be acceptance of such obligations, but rather the main task for future operators as well as national and international legislators will be systematisation of these measures to maximise efficiency and safety, as well as cut down on time-delays and associated costs. The latter is expected to incentivise State as well as non-State actors as it is in the interest of the entire space sector, including industry and its end-users. Additionally, the Cologne Manual and any subsequent instruments on aforementioned obligations will help educate emerging actors and new operators.

For example, States could in future clarify the above-mentioned safety measures in more detail or specify other safety measures in addition to the aforementioned measures. For instance, by requiring space object operators to observe technical requirements and conditions inspired by air law, such as e.g. (i) conditions in respect of the aircraft and other technology involved; (ii) conditions in respect of the type of operation; (iii) conditions in respect of the personnel involved; (iv) conditions for the actual operations.

In a further example, standardisation of notifications should be a priority task for the future. In the long-term it is proposed that implementation is affected via the single dedicated STM communications system and/or technical institution specified in the Guideline on Communication System and Technical Institution. For example, operators could feed necessary information into the Communication System, in this manner creating a system akin to ICAO's online platform of notifications available to all interested parties that have a legal and vested interest in possessing the information. Keeping and sharing information on launch, manoeuvre and end-of-life activities should not prove too

⁷³ Settlement of Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by "Cosmos 954" (Released on April 2, 1981, para 21.



objectionable considering national practices, often codified in several national space laws, as well as the existence of SSA systems and several online websites that offer SSA-like information to the public. An example of the latter is the LeoLabs website registered in the USA.⁷⁴ The level and manner of information can be easily controlled via membership requirements, offering the basic information to the public and more detailed information only to registered users.⁷⁵ In the short-term, a linkage of existing capacities is advised. For example, as the OST relies on States to authorize and supervise any non-governmental space activity, and as many States already have in place national SSA centres (or even regional ones), it might be possible and useful to utilize these centres as interfaces. To clarify, operators could be required by national space legislation to provide relevant information to their national SSA centres. The national SSA centres would be responsible for having adequate information to share with international partners and would also be responsible for contacting the relevant operators once they have learned of a risk/manoeuvre in close proximity to a space object of their nationality. In this manner, a reliable network or database could be established with these national SSA centres as the interface.

In the alternative, several other theoretical models have been examined as possible, including but not limited to: 1) Entry into a system or database, or using a certain platform as a type of exchange between interested parties, 2) Public notice on the website of a launch service and on operator's website, 3) General public announcement on television, 4) Notice to UNOOSA,⁷⁶ 5) establishment and use of an UNOOSA database. Whichever avenue is taken, inspiration can be drawn from ATM experiences and ICAO system. It should again be emphasised that the information required for such information-sharing is limited to those necessary for the safe management of space traffic in an orbital as well as airspace environment and should therefore not raise concerns with regard to mission data. The system proposed is in the benefit of all and in the interest of safety.

Commentary to Guideline 2 – Non-governmental Activities and Licensing

⁷⁴ LeoLabs, Low Earth Orbit Visualisation, accessible at: <https://platform.leolabs.space/visualization>.

⁷⁵ See e.g. *ibid*; Aerospace, Aerospace Space Governance Database, accessible at: <https://aerospace.org/space-governance-database>.

⁷⁶ It has been proposed that Article XI could be used to submit information prior to on-orbit manoeuvres to the UN,⁷⁶ however, there is currently no practice to support this. Between January 2020 and January 2025 only 30 notifications have been submitted by States to the UN pursuant to Article XI of the OST (see <https://www.unoosa.org/oosa/en/treatyimplementation/ost-art-xi/index.html>). Furthermore, the UN has been evaluated as lacking the reactionary speed to meet the often (near) immediate needs of STM. The system would therefore require modernisation to allow for timely distribution and dissemination of the information.



States should ensure that any non-governmental space activity complies with space traffic management, thus, are conducted in a manner that ensures that outer space remains free for exploration and use by all countries and with due regard to the corresponding interests of all other States.

Non-governmental space activities are subject to authorisation and supervision of the appropriate State.

Bearing international responsibility for national space activities, whether carried out by governmental or non-governmental actors, and for ensuring compliance with international norms, States should enact national space legislation to regulate authorisation and supervision procedures via appropriate licensing and oversight.

I. Introduction

This Guideline clarifies that non-governmental actors are bound to observe space traffic management, including the established Guidelines of the Cologne Manual, to the same extent as States. Additionally, the Guideline highlights that each State has the responsibility to ensure that space activities, including those of non-governmental actors, do not seriously endanger the accessibility of outer space. This requires the respect for limited orbital capacity (see Guideline 11) as well as international cooperation (see Guideline 4).

The Guideline is anchored in Article VI of the OST, which dictates that States bear international responsibility for all activities in outer space and must authorise and continuingly supervise non-governmental actors and ensure their compliance with the provision of the OST.⁷⁷ This provision illustrates the State-oriented nature of space law, which mandates that non-governmental actors are regulated by States.⁷⁸ This does not indicate an absence of legal norms, but rather that non-state actors are bound by the same subject-content, and the details of their compliance must be regulated by States in national regulation. The Guideline follows the established *status quo* clarifying that any STM, in particular the hereby established Guidelines of the Cologne Manual, must be observed by State and non-State actors alike, and States should regulate the binding nature of STM on their non-governmental actors via national mechanisms.

⁷⁷ For an analysis see Gerhard, “Article VI”, in: *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl Heymanns Verlag, Cologne, 2009.

⁷⁸ For more see *ibid*; *Hobe*, *Space Law* (2nd ed.), Nomos, Baden-Baden, 2023; *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, Martinus Nijhoff, Leiden, 2025.



This clarification is foundational to the success of any STM as non-governmental actors already in 2025 make up more than half of all space traffic.⁷⁹ With the increasing number of space objects being of non-governmental nature, it is more than necessary that they respect and follow the management of space traffic.

While specific guidelines for national activities may not be necessary, they should be integrated into other guidelines, as responsibility for national space activities rests with the States. Consequently, all Guidelines of the Cologne Manual should also apply to non-governmental activities, and it is the responsibility of States to ensure compliance with these Guidelines.

II. Structure of the Guideline

The Guideline begins by reaffirming the existing international obligations of States in an international dimension, which clarify that States bear international responsibility for ensuring that non-governmental space activities adhere to the established legal framework. It proceeds to extend this obligation to explicitly encompass compliance with STM, emphasising that both governmental and non-governmental activities are subject to STM Guidelines. This is irrespective of which STM instruments or organisations develop in the future but rather serve as a necessary underpinning explicitly clarifying that the management of space traffic is an obligation incumbent on all space actors, regardless of governmental status or absence thereof.

Additionally, the principle of “due regard” is introduced to elucidate the interpretation of fault in this context, as the Liability Convention lacks specific clarification on this matter.⁸⁰

The second paragraph of the Guideline shifts the focus to the national dimension. It advises that national mechanisms should elaborate on the ways in which States should authorise and supervise non-governmental space activities. This should be achieved through the enactment of national space legislation, as well as through the implementation of appropriate licensing and oversight mechanisms.

⁷⁹ See e.g. Keep Track, accessible at: <https://keeptrack.space/deep-dive/who-owns-satellites/>.

⁸⁰ Fault is not defined in the Liability Convention. In international law, the concept of fault is often interpreted with the use of the due diligence concept and the application of appropriate standards of care (e.g. est practices, soft-law instruments etc). Thereby, the concept can be closely associated with the concept of due regard, which established similar duties of care with regard to the activities of other States. The concept can therefore help elucidate one another, understanding that due regard is a legal principle, which is closely connected to operational principles based on common sense and observance of best practices guidelines to assure safety. Both should thereby consider changes in space traffic and aim at preserving a safe space operational environment. For more information see *Flohrer*, Due regard and the need for space traffic coordination, 2025; *Marchisio*, “Article IX”, 2009; *Aoki*, “The Standard of Due Diligence in Operating a Space Object”, in: *Jorgensen* (ed.), Proceedings of the International Institute of Space Law 2012, Eleven International Publishing, The Hague, 201; *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgment, I.C.J. Reports 2010. *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, I.C.J. Reports 1996.



This approach reflects current State practice, as an increasing number of States are drafting and enacting national space laws. UNOOSA evaluated that in 2024 approximately 50 States have adopted a form of national governance instrument on space activities (among these only around 25 are evaluated as comprehensive national space laws with a wide range of detailed provisions).⁸¹ However, not all of these instruments have been comprehensive national space laws detailing authorisation and supervision procedures. Therefore, the Guideline draws attention to this national dimension in an effort to bridge the gap and ensure States adequately and precisely regulate their non-governmental space activity, ensuring its compliance with international space law norms. This is particularly crucial in preserving outer space as an area beyond national jurisdiction via compliance with Article II of the OST and by ensuring continued accessibility of outer space and safety of space operations via compliance with Article I of the OST. For the latter it is crucial that these legislative efforts do not overlook the importance of integrating relevant mechanisms pertaining to STM, as outlined in the Cologne Manual. This has been inspired by practice of States in space debris mitigation, for which States have often adopted into national laws an obligation for operators to follow international standards on space debris mitigation or specific space debris mitigation instruments such as e.g. the UNCOPUOS Space Debris Mitigation Guidelines.⁸²

III. Rationale of the Guideline

According to customary international law on State responsibility, as articulated in the 2001 Articles on State Responsibility,⁸³ any internationally wrongful act committed by a State incurs international responsibility and may necessitate compensating the injury (e.g. liability for damage).⁸⁴ Any questions with regard to the content and scope of the concept of State responsibility should be resolved by a study of customary international law on State responsibility and respective jurisprudence.⁸⁵

⁸¹ For an in-depth analysis of national legislation see *Hobe*, *Space Law: A Handbook*, Nomos, Baden-Baden, 2023; *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra: The Accountability of Non-State Actors for Space Pollution*, Martinus Nijhoff, Leiden, 2025, Chapter 5; *von der Dunk* (ed), *National Space Legislation in Europe*, Martinus Nijhoff, Leiden, 2011; *Wheeler* (ed.), *The Space Law Review* (4th ed.), Lexology, London, 2023.

⁸² For an in-depth analysis see UNCOPUOS, *Compendium on space debris mitigations standards and measures adopted by States and International Organisations*; M. Gillet, K. Grünfeld and I. Ramuš Cvetkovič, “Lex Ad Astra: The Accountability of Non-State Actors for Space Pollution”, Brill, 2025; M. Cairns, “Orbital Debris Prevention and Mitigation Efforts among Major Space Actors”, Brill, 2023.

⁸³ UN General Assembly resolution 56/83 of 12 December 2001 and corrected by document A/56/49(Vol. I)/Corr.4.

⁸⁴ For more see *Articles on Responsibility of States for Internationally Wrongful Acts*, UN General Assembly, UN Doc. A/RES/65/83 (12 December 2001), corr. A/56/49(Vol. I)/Corr.4; *Crawford*, *State Responsibility*, Cambridge University Press, Cambridge, 2013.

⁸⁵ Examples include e.g. *Case Concerning the Factory at Chorzow*, Judgement, P.C.I.J.(Series A.) 1928; *Gabčíkovo-Nagymaros Project* (Hungary/Slovakia), Judgement, I.C.J. Reports 1997.



On-going discussions as to the nature and scope of Article VI of the OST, i.e. on whether it results in direct and automatic attribution of non-governmental activity to the State as *lex specialis* to the customary rules on attribution, enshrined in the 2001 Articles on State Responsibility (this would amount to a more thorough responsibility of States that need to answer for the activity throughout), or whether it amounts only to an obligation on States to authorise and supervise an activity, checking primarily whether the activity complies with all provisions of the OST and whether it is safe, can for purposes of STM be set aside. As a pre-requisite for safe space object operation, STM needs to be accounted for under both views on Article VI of the OST and States should require non-governmental actors to comply with STM.

This is due to the wording of Article VI of the OST, which mandates that States shall authorise and continually supervise non-governmental activity and its compliance with the provisions of the OST. Should they fail to do so, they face international responsibility. Article III of the OST, for example, mandates compliance of space activity with international law. The latter entails a due diligence obligation on States, which encompasses the establishment of a regulatory framework for activities before these begin in order to assure safety as well as to ensure that a standard of care was observed to prevent activities under State jurisdiction from causing harm to other States or to area beyond national jurisdiction. This could involve considerations of such customary concepts as the 'no harm' principle, particularly in relation to environmental impacts, akin to the principles established in the context of the International Court of Justice rulings.⁸⁶

An analysis of existing national space legislation revealed that States consider national activity to constitute all activity 1) originating from its territory, 2) performed by its nationals (natural or juridical) at home or abroad, 3) activity originating from its jurisdiction (e.g. from its registered spacecraft, ships or other registered platform).⁸⁷ Nationality of a juridical person (i.e. legal entity) is normally determined by its registration or papers of incorporation, or the seat of its headquarters, in accordance with the paradigm accepted in the Barcelona Traction case.⁸⁸

⁸⁶ Corfu Channel case, Judgement of April 9th 1949, I.C.J. Reports 1949; Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgement, I.C.J. Reports 2010; Gabčíkovo-Nagymaros Project (Hungary/Slovakia), Judgement, I.C.J. Reports 1997; Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua) and Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), Judgement, I.C.J. Reports 2015; The Case of the S.S. Lotus (France v. Turkey), Judgement, 1927 P.C.I.J. (Ser. A) No. 10 (Sept. 7).

⁸⁷ See e.g. French Space Operations Act No. 2008-518; Belgian Law of 17 September 2005 on the Activities of Launching, Flight operation or Guidance of Space Objects; Law of the Russian Federation No. 5663-I (20 August 1993) "On Space Activities. For a full analysis see *Gillet/Grünfeld/Ramuš Cvetkovič, Lex Ad Astra*, 2025, Chapter 5.

⁸⁸ Barcelona Traction, Light and Power Company, Limited, Judgement, I.C.J. Reports 1970.



Regarding jurisdiction, it is important to reiterate that in accordance with Articles I and II of the OST, outer space is designated as an area free from national sovereignty, belonging to all humankind, and classified as a *res communis omnium*.⁸⁹ This categorisation positions outer space beyond the jurisdiction of any single nation, similar to the high seas or the deep seabed. However, Article VIII of the OST stipulates that space objects, including satellites, spacecraft, and rockets, remain under the jurisdiction and control of the State that registers them in its national register. This provision effectively establishes a quasi-territorial jurisdiction of the registering State in its space objects and any personnel thereof, thereby creating a form of State sovereignty in relation to these objects and any personnel thereof.⁹⁰ Such sovereignty confers various rights upon the registering State, including the right to require other States from interfering with its space objects as well as the right to apply and prolonging its national legislation extra-territorially to their space objects and any personnel thereof.⁹¹ States should therefore be aware that they are responsible for the actions of their nationals via Articles VI and VIII of the OST, and should enact appropriate legislation to govern space activities. Especially, Article VI of the OST, has been read as a direct requirement on States to enact specifically national space laws that address authorisation and supervision of national space activity.⁹²

Currently, out of around 80 space-faring nations, approximately 25 States worldwide have established comprehensive national space laws detailing authorisation and supervision procedures, albeit to varying degrees of detail and comprehensiveness.⁹³ Approximately 25 more States have enacted national space policies or laws governing select aspects of space activity.⁹⁴ Meaning that together around 50 States have some form of national space legislation in place.⁹⁵ Some more States, such as India, are currently in the process of drafting national instruments.⁹⁶ In Europe, majority space active States have implemented legal regimes governing aspects such as liability, responsibility, authorisation, and

⁸⁹ Hobe, *Space Law*, 2023; Hobe, “Article I”, 2009; Freeland/Jakhu, “Article II”, 2009.

⁹⁰ Lachs, *The Law of Outer Space*, Martinus Nijhoff, Leiden, 2010, pp. 65-75; Cheng, *Studies in International Space Law*, Oxford University Press, Oxford, 1997; Schmidt-Tedd/Mick, “Article VIII”, in: Hobe/Schmidt-Tedd/Schrogl (ed.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009; Vereshchetin, “International Space Law and Domestic Law”, *Journal of Space Law* 31, 1981.

⁹¹ Lachs, *The Law of Outer Space*, 2010. For more generally on State sovereignty see *Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986; Crawford, *Browlie’s Principles of Public International Law*, Oxford University Press, Oxford, 2019.

⁹² Hobe, *Space Law*, 2023.

⁹³ Hobe, *Space Law*, 2023.

⁹⁴ Hobe, *Perspectives for Space Law in the 21st Century*, upcoming with the Hague Academy of International Law.

⁹⁵ For an overview see UNOOSA, *National Space Law Database*, accessible at: <https://www.unoosa.org/oosa/en/our-work/spacelaw/nationalspacelaw/index.html>. For more information see the *Commentary on Pre-Launch Activities and Notifications*.

⁹⁶ For India see e.g. *Abhijeet*, *National Space Legislation for India*, Springer, Heidelberg, 2020.



supervision of space activities, however, worldwide many States still lack specific national legislation governing space activities, despite having satellites in orbit, e.g. China.⁹⁷ Some of these States have national space agencies that must navigate a complex array of national laws regulating various activities, i.e. instruments and norms, which are not specifically tailored for space activity.⁹⁸ While many of these jurisdictions may possess a relatively developed technical framework for licensing and authorisation, the ambiguity surrounding governmental structures hampers the efficiency, speed, and uniformity of the processes and approaches to authorising space activities, including STM and related issues.⁹⁹

It is first and foremost recommended that national space legislation should be implemented as uniformly as possible, therefore, be developed and implemented in accordance with the helpful guides of the International Law Association (ILA) Model Law on National Space Legislation,¹⁰⁰ as well as the United Nations General Assembly (UNGA) Resolution 68/74 (2013). Both the endorsed UNGA Resolution and the ILA Model Law serve as valuable references for the content and structure of national space legislation, delineating essential components such as authorisation procedures that guarantee the safety of space activities.

The Cologne Manual adds to this a specific requirement to enact explicit references and obligations for national space actors to implement STM. STM refers hereby to any STM measures, with recommendation to enact and consider the Guidelines of the Cologne Manual as representation of best practices supported by international law. The emphasis on STM specific provisions within the Cologne Manual is critical for ensuring that non-governmental actors conform actively pursue STC and STM, and that furthermore national frameworks align with international best practices.

It is important to acknowledge that some States may continue to operate without enacting national space laws. The absence of such legislation should not hinder the establishment of a uniform STM system or implementation of STM measures by non-governmental entities. It remains an obligation of States how these are to be guaranteed in absence of comprehensive national laws.

In national space legislation or in addition to it, analysis has revealed that the roles and functions within a national governmental structure must be clearly defined to facilitate effective inter-agency

⁹⁷ For an analysis see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5.

⁹⁸ *Ibid.*

⁹⁹ See e.g. *Carns*, *Orbital Debris Prevention and Mitigation Efforts Among Major Space Actors*, Martinus Nijhoff, Leiden, 2023. See also Annex on National Space Acts.

¹⁰⁰ ILA, Resolution No. 6/2012, Sofia, Bulgaria.



communication and coordination.¹⁰¹ The latter is a precondition to effective implementation of STM measures.

In essence, the Cologne Manual advocates for the adoption of national space legislation, including detailed licensing and supervisory procedures, to enhance legal certainty concerning space activity including liability issues. The Cologne Manual furthermore advocates for clear governmental structures and the explicit assignment of roles and responsibilities at the national level, in alignment with UNGA Resolution 68/74 (2013). A clear national structure and easy to identify duties of non-governmental actors are crucial to overall compliance with national and international norms as well as for attracting investments in the national space sector. It should therefore be in the interests of both States and non-governmental actors to promote clear organisational structures and easy to identify legal duties incumbent on non-governmental space actors to promote prosperity of the national space industry. Such efforts are furthermore paramount for the effective functioning of STM as a lack of organisational clarity and transparency within national governments can complicate the identification of roles and responsibilities, impeding cooperation and coordination.

National legislation should compel private entities to implement best practices and adhere to international standards regarding space safety and debris mitigation. Several States, including Australia, Luxembourg, the United Arab Emirates, the Russian Federation and the United States, have already established such provisions in their national laws.¹⁰² In response to the growing volume of space traffic, national legal frameworks should furthermore include provisions that explicitly mandate non-state actors to adhere to STM protocols, incorporating specifications for prioritisation and coordination as for example detailed in Guidelines on Pre-launch Activities and Notifications, Space Traffic Coordination and Communication System and International Technical Advisory Body.

The Cologne Manual recommends the incorporation of specific elements, such as the IADC/UN-COPUOS Space Debris Mitigation Guidelines (SDMG), which encompass collision avoidance measures, into national space legislation in accordance with United Nations General Assembly Resolution 60/74 (2013).

¹⁰¹ Some States provide some guidance on governmental websites to help domestic space actors through the process, see e.g. US FAA, accessible at: https://www.faa.gov/space/legislation_regulation_guidance.

¹⁰² For an analysis see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5. See also Annex on National Space Acts.



Moreover, it is essential to consider the implementation of supervisory measures that require non-governmental operators to provide continual updates on the status of space objects and maintain an accessible point of contact.¹⁰³

Finally, national space laws should address the issue of national registration of space objects. Analysis showed that several non-governmental actors are uncertain what national registration means or what it requires from them. The Cologne Manual therefore underscores the importance of a standardised national space object registry that records STM-relevant information, which is vital for ensuring space traffic safety and sustainability, as proposed under the Guideline on Registration.¹⁰⁴ This registry is essential for operationalising Article VI of the OST.

In addition to the preceding general requirements which should be enacted for regulation of non-governmental actors, some specific characteristics of space traffic should be regulated explicitly and additionally.

Article IX of the OST decrees that space activity should be undertaken with due regard to the corresponding interests of other States Parties to the OST. In international law due regard is associated with due diligence requirements, which are normally understood as compliance with a certain standard of care that aims to assure that no damage is caused to areas beyond national jurisdiction or to activities of other States.¹⁰⁵ This has been interpreted as adopting national regulatory frameworks before an activity is undertaken and complying with relevant international standards and soft-law instruments.¹⁰⁶

Read together with Article VI of the OST, this article therefore mandates States should, firstly, refrain from authorising the launch of space objects in numbers that exceed their capacity for effective supervision. Secondly, considering that large satellite constellations, especially constellations made up of small satellites that may not have manoeuvrability capability and may furthermore not be compli-

¹⁰³ This has been developed in analogy to REG, Art. IV as well as the national legislation of several States that requires non-governmental actors to periodically update the national space authorities on space object status, ownership status, operator status, see e.g. Slovenia Space Activities Act of 2022. For further analysis see Guideline on Registration and associated Commentary.

¹⁰⁴ See Guideline on Registration and associated Commentary.

¹⁰⁵ *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Reports 2010. See also *Marchisio*, “Article IX”, 2009; *Aoki*, “The Standard of Due Diligence in Operating a Space Object”, in: *Jorgensen* (ed.), Proceedings of the International Institute of Space Law 2012, Eleven International Publishing, The Hague, 2013.

¹⁰⁶ *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, I.C.J. Reports 1996; *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Reports 2010. For further reading see Besson, *Due Diligence in International Law*, Hague Academy of International Law/Martinus Nijhoff, The Hague, 2023.



ant with space debris mitigation measures (e.g. as specified in the UNCOUOS Space Debris Mitigation Guidelines), place a heavier burden on the orbital traffic, States that permit the launch of large numbers of space objects should contribute to the establishment of appropriate infrastructure, including global tracking stations and communication systems for collision warnings, as well as the collection and assessment of surveillance data for conjunction analysis (e.g. SSA capabilities). A potential avenue for achieving this could involve discussions within the framework of the UN, whereby technical institutions coordinate the development of infrastructure to ensure adequate SSA prior to the launch of large constellations of space objects. States could also create specific national regulatory frameworks and requirements for launch of large numbers of satellites, especially those flying in formation, considering the specific characteristics of these constellations, including their vulnerability to cyber-attacks. Specific risk assessments could be required as well as pre-launch negotiation and establishments of collision avoidance and disposal plans, specifying communication means and space object design and operational specifics. The latter is supported by e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook.

Initially, the feasibility of establishing a dedicated international authorisation and licensing system for STM was investigated. This system would necessitate effective communication with private sector stakeholders and operational entities, facilitating the collection of critical information for STM purposes, such as real-time location data and points of contact. However, after further analysis, it was concluded that the current conceptual framework, firstly remains too ambiguous and secondly, would be difficult to implement in the current geo-political setting¹⁰⁷ and is therefore more suited for long-term implementation rather than immediate action.

The ambiguity was, for example, highlighted when discussions revealed that such a system could be used to centrally gather information directly from space object operators to aid in centralising STM efforts or it could be utilised to provide an STM licence or authorisation to the STM provider or SSA and other relevant services provider. Focus was placed on licensing STM operators, suggesting that a STM licence for operators could serve as a certification or evaluation of the reliability of a particular STM or SSA provider. The critical role of licensing, including prerequisites and liability, within the context of STM should nevertheless be highlighted. Currently, licensing is mandated from a commu-

¹⁰⁷ A recurring theme throughout the Cologne Manual, geo-politics is an inavoidable topic, for more on the present con-
tonours see e.g. *Doboš*, *Geopolitics of the Outer Space*, Springer, Heidelberg, 2019; *Aliberti/Cappelli/Praino*, *Power, State and Space*, ESPI/Springer, Vienna, 2023.



nications perspective within the private sector (e.g. national authorisation by the US Federal Communications Commission) and at the international level (e.g. frequency assignment by the International Telecommunication Union).¹⁰⁸ Nonetheless, it is crucial to avoid segmenting outer space into zones governed by disparate STM regimes to prevent complications akin to those encountered in ATM with Aeronautical Service Areas (ASAs). While there are commonalities between the air and space sectors, significant functional differences exist, and a simplistic approach of transferring practices from one domain to another is inadvisable.¹⁰⁹

Due to the preceding and the geo-political setting, which may in the short term preclude a high level of centralisation, it may be more effective in the short term to recommend alignment with State practices and UNGA Resolution 60/74 (2013), and the adoption of STM Guidelines, for example as those set out in the Cologne Manual, and other helpful international standards, e.g. the UNCOPUOS Space Debris Mitigation Guidelines, within national legislation. Licensing of space object operators should remain in the hands of the national authorities, whereby the Cologne Manual stresses that explicit duties with regard to STM should be adopted in national space regulation to ensure the beginning of a comprehensive STM system. Thereby the Cologne Manual emphasises the importance of establishing rules that mandate operators to remain informed, notify others regarding all space objects about which they have pertinent information, maintain safe distances between objects, avoid creation of debris, implement collision avoidance strategies, ensure controlled and coordinated re-entries and adopt cyber security strategies.¹¹⁰

Subsequently, it has been determined that information regarding the point of contact must be incorporated into the licensing and authorisation process. A pertinent example of such practice can be seen in the recently revised Japanese national regulations, which outline guidelines for licensing satellites for on-orbit servicing. These Guidelines require operators to designate a point of contact for both the public and the international community, along with stipulating collision avoidance requirements. This is an integral part of Japan's licensing framework, governed by its space activities law. In the event of an on-orbit transfer of ownership or a change in operator, it is imperative that the point of contact is updated, and the relevant State authorities are notified. An examination of State practices reveals that several countries require owners and/or operators of space licences or authorisations to report

¹⁰⁸ See e.g. FCC, How to Prepare a USA ITU filing, accessible at: <https://www.fcc.gov/space/how-prepare-usa-itu-filing>.

¹⁰⁹ For further reading see Annex on Air Law and Air Traffic Management.

¹¹⁰ For more on cyber security see the Guideline on Cyber Security. For further reading on cyber security see *Blount/Hofmann* (eds.), *Space Law in a Networked World*, Martinus Nijhoff, Leiden, 2023.



any changes in the operation or ownership of a space object, as well as any alterations in the organisational structure that may affect the operation or ownership of the space object. All nations should incorporate such provisions into their national space laws as part of the licensing procedure.

Technical Guidelines from ATM could be consulted for relevant experiences, however, due to the differing mechanics of air and space travel, their applicability to STM is limited.¹¹¹ STM encompasses a broad spectrum of activities, involving numerous institutions that collect data on the high-speed movement of various space objects across multiple orbital planes around the Earth. This scenario is not directly comparable to ATM, which is confined to the airspace of individual States or regions. The fundamental principles underlying air law include (i) sovereignty of airspace, (ii) aircraft nationality, and (iii) the certification of aircraft, crew, and other stakeholders involved, including manufacturers or Air Traffic Service (ATS) providers.¹¹² Nonetheless, a comparable assessment of “space-worthiness” of a space object (including launch vehicles) would be advisable to develop.¹¹³ The technical soundness of the space object and its compliance with relevant international guidelines on debris mitigation as well as STM could be requested by national space acts.¹¹⁴ This is in the interest of national States as responsible under Article VI of the OST and liable as launching States under Article VII of the OST and the Liability Convention,¹¹⁵ as well as in the international community and space object operator, for whom viability of the object and compliance with STM will be more cost-effective than repairing or replacing a space object.

At this stage, however, the primal concern is to focus on conjunction and collision warnings, as well as SSA in general as minimum requirements for securing the safety of space traffic. Current national space legislation primarily grants licences or authorisations to operators of space systems. Non-governmental entities that provide conjunction and collision warnings are typically incorporated within a State's framework, which often does not recognise these warnings as part of space activity. This

¹¹¹ For more see Annex on Air Law and Air Traffic Management.

¹¹² For more see Annex on Air Law and Air Traffic Management.

¹¹³ For more see *Hobe*, Space Law, 2023.

¹¹⁴ Very often existing national space legislation already requires proof of the technical and financial ability of the operators, see e.g. ILA, Resolution No. 6/2012, Sofia, Bulgaria; Austrian Outer Space Act, BGBl. I No. 132/2011 of 27 December 2011. For more see *Hobe*, Perspectives for Space Law in the 21st Century, upcoming with the Hague Academy of International Law; *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5. See also Annex on National Space Acts.

¹¹⁵ For more on liability see *Kerrest/Smith*, “Article VII”, in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009; *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. II*, Carl-Heymanns Verlag, Cologne, 2013; *Kerrest*, “The Concept of the ‘Launching State’ in Commercial Launch Ventures”, in: *Wouters/De Man/Hansen*, *Commercial Uses of Space and Space Tourism*, Leuven Global Governance Studies, Edward Elgar, 2017.



should be altered to recognise the crucial importance of creating a more comprehensive and systematic system of STM, capable of supporting STC for high density orbital traffic.

IV. Future developments

The significance of drawing on aviation experiences to evaluate private and commercial entities at an international level should be emphasised.¹¹⁶ This assertion can be supported by the observation that non-governmental actors in the space sector are currently governed by national laws, reflecting the State-centric approach of international space law, as exemplified by Article VI of the OST, the liability regime, and the associated principles of State responsibility. In contrast, international air law is inherently more private in nature.

The feasibility of establishing a global agency for STM, akin to the ICAO, has been evaluated as the ideal goal in the long-term. Should such an agency eventually come to pass, it might be possible for the agency to issue recommendations, guidelines and evaluations regarding non-governmental activity. Additionally, the establish of a supra-national regulatory framework that could regulate non-governmental actors (admittedly impacting the authority of States to issue licenses) or State activity (and through the State its non-governmental actors), analogous to the allocation of radio frequencies, should be kept in mind. While frequencies are coordinated at the international level, but licensed nationally according to an international framework, a similar approach could be considered for STM as a long-term development goal. The ITU can serve as an example for such a system, should it become feasible in future to regulate STM in the same centralised manner.¹¹⁷

In the short-term, the Cologne Manual encourages States to connect their existing national capacities relevant to STM, including non-governmental entities, into an efficient chain as explained in the Guideline on Communication System and International Technical Advisory Body and its Commentary. For the efficiency of these national capacities, however, the national regulatory landscape is paramount. The predictability and legal certainty derived from a well-established licensing and supervisory procedure are essential for a functional global STM regime. As non-governmental activities can only directly be legally bound under their respective national jurisdictions – rather than by UN

¹¹⁶ For an analysis of transferable concepts from air law, see IAA document on Space Traffic Management (2018, pp. 77-81); Annex on Air Law and Air Traffic Management.

¹¹⁷ For more on the ITU see *Lyll*, *International Communications*, Routledge, London, 2016; *Allison*, *The ITU and Managing Satellite Orbital and Spectrum Resources in the 21st Century*, Springer, Cham, 2014; *Balbi/Fickers* (eds.), *The History of the International Telecommunications Union (ITU)*, De Gruyter, Berlin, 2020. For short overview see *Wheeler*, *Space Law*, accessible at: <https://www.lexology.com/library/detail.aspx?g=b5be7a4e-06c4-4f19-b68c-a5fb09b6a6a4>.



space treaties – the adoption of national regulations is increasingly pertinent in light of the growing number of non-governmental operators.

Commentary to Guideline 3 – Registration

National space object registries should be made publicly available and easily accessible to interested parties and should be regularly updated. National space object registries are essential for the identification of space objects.

In addition to the requirements of the Registration Convention and international guidance as contained in UNGA Resolution 62/101 of 17 December 2007 on Recommendations on enhancing the practice of States and international intergovernmental organisations in registering space objects and the Long Term Sustainability guidelines of the United Nations Committee on the Peaceful Uses of Outer Space of 2021, States should clarify through national regulatory frameworks what kind of information, and through what procedures and communication channels, operators are required to provide necessary information to the competent national authority responsible for space activities for the complete and comprehensive registration of space objects. Operators should provide States the specified information without undue delay. Operators should provide regularly updated information on their space objects and their status to the relevant national authorities.

Registration should be made no later than six months after the launch of the space object with an operational lifetime of more than six months. Space objects with an operational life-time of less than six months should be registered within one month from the time of the launch. Information on the national registry, the objects and any changes in the status of the objects should be communicated to the Secretary-General of the United Nations immediately after their inclusion in the national registry.

I. Introduction

The Guideline for registering space objects is crucial for promoting sustainable and responsible practices in outer space. By enhancing transparency, facilitating timely information-sharing and fostering international cooperation, the international community can work towards a more organised and secure space environment. This Guideline is firmly rooted in established international legal frameworks, most notably the OST and the REG.



According to Article VIII of the OST, the State that registers an object launched into outer space in its national register retains jurisdiction and control over it and any personnel thereof.¹¹⁸ Article IV of the REG adds to this regulatory framework a mandate that States should promptly notify the United Nations of nationally registered objects.¹¹⁹ This regulatory framework underscores the importance of registration in ensuring accountability and responsible stewardship of space activities.¹²⁰

The registration Guideline is closely linked to the Pre-launch Activities and Notification Guideline, which highlights the importance of timely communication prior to the launch of space objects or manoeuvring of objects on-orbit. It furthermore entails obligations on non-state actors and is thus associated with the Guideline concerning Non-Governmental Activities and Licensing, which delineates the legal responsibility of private entities involved in space exploration to comply with STM. Finally, this Guideline is vital for SSA and Space Traffic Coordination Guidelines, as registration provides information that can be leveraged for SSA activities and Collision Avoidance strategies, thereby mitigating risks associated with space debris and operational space objects.

Registration thus serves a pivotal role in the safe utilisation of outer space by providing a reliable source of information about space objects.¹²¹ By enhancing transparency and accountability among States regarding space objects, this Guideline contributes significantly to safety and security of space traffic.

Moreover, by granting jurisdiction, i.e. the legal authority of States to direct and control their space objects, registration ensures legal protection of one State's objects in respect to other States.¹²² The Guideline thereby also seeks to assure States that nothing in the Manual shall or should be interpreted in a manner to grant unauthorised interference into space objects under their jurisdiction, safeguarding the State's as well as non-State actor's legitimate interests.

Finally, the Guideline seeks to clarify and facilitate the evolution of space law (*lex ferenda*) in response to uncovered contemporary challenges. For instance, existing space treaties do not specify a timeline for registration or the communication of information to the UN, often resulting in uncertainty

¹¹⁸ *Schmidt-Tedd/Mick*, "Article VIII", 2009; *Lafferranderie*, "Jurisdiction and control of Space objects and the Case of an International Intergovernmental Organisation (ESA)", ZLW, 2005.

¹¹⁹ For more see *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. II*, Carl-Heymanns Verlag, Cologne, 2013.

¹²⁰ This is especially important with regard to non-governmental space activity whereby this might form the legal link between the activity and a State authority, see e.g. *Vereshchetin*, "Space Activities of Nongovernmental Entities: Issues of International and Domestic Law", 26 *PROC. INT'L INST. SPACE L.*, 1983; *Schmidt-Tedd/Mick*, "Article VIII", 2009.

¹²¹ *Hobe*, *Space Traffic Management: Some Conceptual Ideas* (2016), ZLW, 65 (1).

¹²² *Lachs*, *The Law of Outer Space*, 2010; *Schmidt-Tedd/Mick*, "Article VIII", 2009.



among States and other space actors regarding the appropriate timeframe and procedures for registration. By addressing these gaps, the Guideline aims to create a more coherent and effective regulatory framework for future of space activities and offer educational assistance to emerging space actors seeking guidance.

II. Structure of the Guideline

The Guidelines encompass four key content areas: jurisdictional links, national registries, essential information for registration, and the timeframe for registration. The overarching significance is underscored in the opening statement of the Guideline: only through comprehensive registration can questions such as liability, jurisdiction, and control be effectively addressed.

The initial focus addresses the jurisdictional link between a State and a space object, which represents a primary legal concern.¹²³ In this context, jurisdiction refers to a State's legal authority over a space object, encompassing its power to regulate the object's operation in outer space as well as to direct the object thus representing the legal cornerstone of the more factual concept of control.¹²⁴ Registration denotes the official documentation of a space object by a State in a national register, thereby establishing jurisdiction and control not only over the object itself, but also over any personnel thereof. Jurisdiction in this manner protects space objects from unauthorised interference and is therefore of primary legal concern.¹²⁵ To further protect legitimate interests of States, it is essential to submit registration information to the United Nations Secretary-General for inclusion in the UN Space Object Register, which ensures safety of space activities by introducing a basic level of transparency.¹²⁶

The second focus emphasises the importance of national registries, which must be “publicly available and easily accessible.” This highlights the challenge that many national registries do not provide

¹²³ *Lafferranderie*, “Jurisdiction and control of Space objects and the Case of an International Intergovernmental Organisation (ESA)”, *ZLW*, 2005.

¹²⁴ *Lachs*, *The Law of Outer Space*, 2010, pp. 65-75; *Cheng*, *Studies in International Space Law*, 1997. For more on jurisdiction of States in general see *Military and Paramilitary Activities in und against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986; *Crawford*, *Browlie’s Principles of Public International Law*, Oxford University Press, Oxford, 2019; *Military and Paramilitary Activities in und against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986.

¹²⁵ *Lachs*, *The Law of Outer Space*, 2010, pp. 65-75; see inter alia also *Military and Paramilitary Activities in und against Nicaragua (Nicaragua v. United States of America)*. Merits, Judgment. I.C.J. Reports 1986.

¹²⁶ In accordance with REG, Art. IV. For more see UNOOSA, *United Nations Register of Objects Launched into Outer Space*, accessible at: <https://www.unoosa.org/oosa/en/spaceobjectregister/index.html>. UNOOSA furthermore provides a template form for UN Notification, see UNOOSA, *Resource and Reference Material for States and Organizations*, accessible at: <https://www.unoosa.org/oosa/en/spaceobjectregister/resources/index.html>.



timely access to information, making it difficult to obtain necessary information without delay. Efficient access to this information is crucial for other operators or States that may need to contact the responsible entity (State or operator) regarding a launched object. Such needs may arise in contexts like collision avoidance measures, liability considerations or remediation activities. Access to the registry and its information should be seamless, ideally achieved through an internationally standardised format. However, new technologies will provide new possibilities to enhance the accessibility.¹²⁷ Furthermore, regular updates are essential to ensure that the information remains current. This necessitates a mechanism for promptly recording any changes in launched objects' status which should be followed up without any processing delays which is currently the case for submissions to the UN.¹²⁸

The third focus outlines the information which should be recorded, and through these the responsibilities of operators and the need for States to clarify these obligations concerning information sharing. In practice, some confusion has been noted with regard to what are the obligations of States and what are the obligations of operators. It is therefore necessary to clarify that, on the one hand, a State must nationally register an object launched and must thereafter forward information about this national registration to the UN for transparency and safety purposes. On the other hand, it is the obligation of the operators and launchers to provide prompt and full information to the State's national space authorities, so as to enable the State to perform its obligation of registration and information-sharing with the UN. As the international space law does not detail which information must be documented in national registries or which information should be attained by the State during the authorisation of non-governmental space activities procedures, it is upon States to provide the instructions and the necessary level of detail to its operators. Analysing the required information, specific note was taken of contemporary challenges associated with the exponentially increasing space traffic. Therefore, the Guideline recommends gathering information that will not only enable national registration of space objects and satisfy the requirements of Article IV of the REG, but also information that will support STM. In this regard, national registration should encompass comprehensive object

¹²⁷ Several States are making use of Information Technology to make Space Object registers more accessible, see e.g. Finland, The Registry of Space Objects, accessible at: <https://spacefinland.fi/en/the-registry-of-space-objects>; Australia Space Agency, Register of space objects, accessible at: <https://www.space.gov.au/register-space-objects>; UK registry: outer space objects, accessible at: <https://www.gov.uk/government/publications/uk-registry-outer-space-objects>; Luxembourg Registry of Space Objects, accessible at: <https://space-agency.public.lu/dam-assets/publications/2024/luxembourgregistryofspaceobjects-v8-may2024.pdf>.

¹²⁸ Several States are mandating in domestic space legislation that operators notify the national space authorities of any significant changes in space object status, e.g. Slovenian Outer Space Act 2022 (for an analysis see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5; Annex on National Space Acts). The provision of this information to the UN is requested in REG, Art. IV. For more on the REG see *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. II*, Carl-Heymanns Verlag, Cologne, 2013.



details, including material, mass, function, launch date and location, launching State(s), operator name, operator contact point (with contact details), additional relevant contacts, designators, procedures, timelines, orbit, possible re-entry date or end-of-life measures and approximate location and flight path.¹²⁹ Voluntary information may also be included, along with orbital data. Given the dynamic nature of this data, an online catalogue should be established to facilitate rapid and easy updates.¹³⁰ Furthermore, States should include information on any changes in space object status (e.g. new operator, new contact information, difficulties in operation on-orbit, de-orbiting process) in their submissions to the UN pursuant to Article IV of the REG. Finally, references to the REG, Registration Practices Resolution (RegPractRes)¹³¹, and LTS¹³² underscore the necessity for a cohesive system at both national and international levels.

The fourth and final focus pertains to the timeframe within which information should be submitted to the registry. To address the existing disparities in registration practices, the Guideline proposes a standardised timeframe for notifications based on the type of space object. A suggested timeframe of six months for satellites with an operational lifespan exceeding six months, and one month for those with a shorter lifespan, could significantly improve the registration system's effectiveness and usefulness. However, registration should be conducted as early as possible to benefit both the State and the operator. The aforementioned is supported by State practice. The timeframe for registration has been the subject of considerable discussion. Practicality must be considered; for instance, certain objects like CubeSats may have operational lifespans as brief as two months in orbit. However, the European Space Agency (ESA) has demonstrated that objects are typically registered and notified within a timeframe of four weeks to three months. Historically, the USA, Russia, and China have regularly updated the UN, with the USA transitioning from annual notifications to quarterly updates in response to the increased volume of launched objects.¹³³ Thus, the timeframe specified in the Guidelines represents the maximum duration permitted for registration, with the aspiration being to register as expeditiously as possible.

¹²⁹ For information recorded in current national registries, see Annex on State Practice.

¹³⁰ Several catalogues already exist such as Space-Track (<https://www.space-track.org/auth/login>); EU SST (<https://www.eusst.eu>); Space Data Association (<https://www.space-data.org/sda/space-data-center/>). Several more sources provide visualisation tools, see e.g. LeoLabs (<https://leolabs.space>).

¹³¹ Recommendations On Enhancing the Practice of States and International Intergovernmental Organisations In Registering Space Objects, A/RES 62/101 (2007).

¹³² The Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, UN Doc. A/74/20 2019.

¹³³ See e.g. UNOOSA, United Nations Register of Objects Launched into Outer Space, accessible at: <https://www.unoosa.org/oosa/en/spaceobjectregister/index.html>.



The national registration process must be accessible and clearly identifiable on publicly available websites housing national registries, complete with contact information, or through the United Nations Office for Outer Space Affairs website so that operators can quickly get acquainted with their responsibility. The latter should include the obligation to promptly communicate any and all relevant changes in space object status (e.g. change of operator, change of operator point of contact, anomalies in operation of the object on-orbit, de-orbiting events and other events that might affect other space users or the population on the Earth). States are furthermore encouraged to provide timely notifications to the UN, including updates on any changes in the object status.

III. Rationale of the Guideline

The registration system established by the space law treaties is inherently static, and its utility for STC is largely confined to identifying the registering State for jurisdictional and control purposes, as well as the launching State for liability considerations. Consequently, it is essential to address the role of national registries and to propose content for *lex ferenda* that can enhance and standardise State practices, thereby improving transparency and aid STM.

Article VIII of the OST stipulates that the State which registers an object launched into outer space retains jurisdiction and control over that object and any personnel thereof. The legal effect of such registration is the establishment of the jurisdiction of the registering State over the object and any personnel thereof.¹³⁴ Jurisdiction, representing the pinnacle of legal authority and a fundamental aspect of State sovereignty,¹³⁵ empowers a State to compel other States to refrain from interfering with the operation of their space object. Any unauthorised interference with the jurisdiction of another State is deemed a violation of international law.¹³⁶ This has significant implications for STM activities, such as manoeuvring for collision avoidance purposes, space debris remediation, and on-orbit servicing, where encroachment upon a State's jurisdiction may become necessary. In such cases, notification and authorisation from the registering State is requisite. The OST does not specify which State is responsible for registering a launched object, leaving the determination to the States. The REG under Article II clarifies that it is one of the launching States that must fulfil this obligation, thereby linking the concepts of the registering State and the launching State. (While majority State

¹³⁴ Schmidt-Tedd/Mick, "Article VIII", 2009.

¹³⁵ See e.g. Military and Paramilitary Activities in and against Nicaragua (Nicaragua v. United States of America). Merits, Judgment. I.C.J. Reports 1986.

¹³⁶ Lachs, The Law of Outer Space, 2010.



Parties to the OST are also State Parties to the REG, there may nonetheless still arise instances where a State is Party only to the OST.)

Jurisdiction is the international law equivalent of the concept of ownership in national law. The act of registration is therefore the act of declaring to all States that a State owns and operates a certain space object. From the point of registration onward, no State can or may therefore claim that it was not aware of the legal status of the space object as belonging to the State of Registry and must refrain from all actions that would interfere with the registered object or with the State of registry's ability to operate its property as it deems appropriate. The concept of jurisdiction is in this sense a guarantor of State sovereignty in space objects and over any personnel thereof. Therefore, registration is in favour and in the interest of the State to internationally protect its property and property of its non-governmental actors. This is clarified by international instruments such as Article 2 of the UN Charter or the Friendly Relations Declaration¹³⁷, as well as by international jurisprudence as for example the decisions of the International Court of Justice in the 1949 Corfu Channel case¹³⁸ of the 1986 Military and Para-Military Activities in and Around Nicaragua case¹³⁹, where the Court explained that any unauthorised intrusion into the jurisdiction of another State is a violation of State sovereignty, the respect for which lies at the heart of international law.

As previously emphasised, it is essential that contact information is made readily available on a publicly accessible website, thereby enabling the prompt resolution of queries without unnecessary delays.¹⁴⁰ This information should delineate the relevant information on and the contact information for the State of Registry, the launching State and the authorising and supervising State in instances of non-governmental activities, if these are not all one State, as well as any other information which may be necessary for determining the legality of specific actions or situations, which have been outlined above.

Article II of the REG underscores that States are responsible for establishing national space object registries. Effective registration practices are vital for fostering transparency and accountability,

¹³⁷ Declaration on Principles of International Law concerning Friendly Relations and Cooperation among States in accordance with the Charter of the United Nations, UN General Assembly (25th Sess. 1970), UN Doc. A/RES/2625(XXV).

¹³⁸ Corfu Channel case, Judgement of April 9th, 1949, I.C.J. Reports 1949.

¹³⁹ Military and Paramilitary Activities in und against Nicaragua (Nicaragua v. United States of America). Merits, Judgment. I.C.J. Reports 1986.

¹⁴⁰ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022.



which are crucial in preventing unauthorised interference with space activities, as highlighted by international law. Article IV of the REG imposes a further obligation on the State of registry to provide the Secretary-General of the United Nations with “information concerning each space object carried on its registry (...) as soon as practicable”. The information required includes the following: the name(s) of the launching State(s), an appropriate designator for the space object or its registration number, the date and location of the launch, basic orbital parameters (including nodal period, inclination, apogee, and perigee), and the general function of the space object. Additionally, the State should notify the Secretary-General of the United Nations when a space object is no longer in orbit. It is important to note that this notification to the Secretary-General does not constitute a second registration equivalent to that in a national register, nor does it confer jurisdiction over the space object to the State. Rather, it serves to enhance transparency.

The UN Register comprises these notifications submitted as verbal notes by the respective States of registry. The United Nations Office for Outer Space Affairs (UNOOSA) also provides an Index of Notifications by States and Organisations regarding the Establishment of National Registries of Objects Launched into Outer Space¹⁴¹, which includes notifications pursuant to Article II, paragraph 1, sentence 2 of the REG. Moreover, to improve the accessibility of registration information, UNOOSA maintains “The Online Index of Objects Launched into Outer Space”¹⁴². This online index consolidates the notifications from States alongside other publicly available information and is offered as an informal service by UNOOSA.

Analysed State practice, at present shows that there exists no definitive timeline for the national registration of space objects or for submitting information about national registrations to the UN.¹⁴³ The act of nationally registering such objects is a responsibility of the State, conducted in accordance with international law. However, the act of national registration of a space object entails a relationship between the operator and the State. Therefore, it is upon the State to clarify what information must be supplied by operators to the State’s national space authorities and when. However, neither the OST nor the REG delineates when such registration in a national registry should occur, nor does it specify

¹⁴¹ Accessible at: <https://www.unoosa.org/oosa/en/spaceobjectregister/national-registries/index.html>.

¹⁴² Available here: https://www.unoosa.org/oosa/osoindex/search-ng.aspx?lf_id.

¹⁴³ See e.g. *Pippo*, “Registration of Space Objects with the Secretary-General”, presented at the “40 Years of Entry into Force of the Registration Convention”, IISL/ECSL Symposium, Fifty-fifth UNCOPUOS Legal Subcommittee, 4-15 April 2016; *Schmidt-Tedd/Soucek*, “Registration of Space Objects”, Oxford Research Encyclopedia of Planetary Science, 30 June 2020. See also e.g. Report of the Committee on the Peaceful Uses of Outer Space at the Sixty-seventh session, 19-28 June 2024, UN Doc. A/79/20, 2024; UNOOSA, The Registration Project, accessible at: <https://www.unoosa.org/oosa/en/ourwork/spacelaw/capacitybuilding/registrationproject/index.html>.



the information that ought to be recorded. While the REG stipulates the information to be submitted to the Secretary-General of the United Nations, thereby partially assisting the States in which information they should require for all space objects on its national register, it similarly fails to clarify the timing of such submissions.¹⁴⁴ The aforementioned ambiguity has resulted in a range of divergent practices, prompting the United Nations General Assembly (UNGA) to introduce the RegPractRes in an effort to encourage further ratifications of the REG and to seek a degree of standardisation in an otherwise inconsistent registration landscape.

Despite these efforts, registration practices remain fragmented. Certain States, such as the United Kingdom, Australia, and Finland, maintain their registries in the form of online databases, whereas many others lack readily accessible online registries. Consequently, a significant number of space objects continue to go unregistered. Moreover, as of January 2025, the REG comprises 76 State Parties while the OST includes 115, creating a scenario in which some States may be obliged to adhere solely to Article VIII of the OST and not to Article II of the REG. Such States may reference UNGA Resolution 1721(XVI) (1961), Part B, when providing information about objects launched into outer space.

Several actions are still necessary to assure safety of space traffic. First, there is a pressing need for capacity-building initiatives and educational efforts directed towards States – particularly emerging space-faring nations – as well as their operators. To bolster international efforts and avoid fragmentation of legal instruments as well as practices, support for the LTS and RegPractRes is essential.

Second, despite the existence of a clear legal framework, challenges endure due to the disparate national practices concerning registration and notifications. While some States have implemented online registries for public access, others have not, resulting in a fragmented system. The Cologne Manual advocates for the harmonisation of practices in alignment with RegPractRes, which aspires to enhance registration practices on a global scale. National registries should be publicly accessible, regularly updated, and contain comprehensive information regarding space objects. Furthermore, States are encouraged to designate specific points of contact for inquiries related to registration to facilitate information-sharing and utility of the national registers. Furthermore, to facilitate STM and guarantee

¹⁴⁴ <https://www.unoosa.org/oosa/en/ourwork/spacelaw/capacitybuilding/registrationproject/index.html>.

¹⁴⁴ *Hobe*, Perspectives for Space Law in the 21st Century, upcoming with the Hague Academy of International Law.



safety of ever-increasing space traffic, additional information relevant to STM such as operator information and operator point of contact should be included with national registration as well as forwarded to the UN.

Third, to facilitate STM or space debris missions it may become necessary to intrude upon a State's jurisdiction over a certain space object in order to ensure the safety of space traffic. Consequently, authorisation from the registering State will be required. This will not require the State to grant authorisation, but such practices of acquiring or at least requesting jurisdiction should be encouraged to facilitate collision avoidance strategies as well as control space debris numbers. The Manual highlights the absence of a central registry for States of Registry and suggests methods to ascertain the information regarding a space object's State of Registry. Many States maintain national space object registries that are accessible online. In such instances, the State of Registry can be identified through governmental websites, which should provide information on the national space object register and a means of contact. Therefore, States are encouraged to make their national space object registries publicly available online, specifying a designated point of contact for registry related queries.

In situations where this information cannot be readily obtained from such sources, it is advisable to consult the publicly available resources on the website of the UNOOSA. This includes notifications to the United Nations concerning the acceptance of rights and responsibilities under Article VIII of the OST, as well as the Online Index of Objects Launched Into Outer Space. To ensure the utility of these sources, States are urged to provide timely and accurate information to the UN, particularly in accordance with the REG, to ensure the highest standards of safety in space traffic. (It may furthermore become helpful to consider the legal implications of the aforementioned State's declaration to the UN, particularly in relation to the attribution of responsibility.)

If these efforts yield no results within a reasonable timeframe, it would be prudent to reach out to the launching State.¹⁴⁵ This approach is based on the understanding that many space-faring nations have ratified both the OST and the REG, which stipulate that at least one of the launching States is responsible for registering the space object. Furthermore, in practice, the majority of space objects are either launched by or the launch is procured by the registering State, with the exception of cases involving in-orbit transfers of ownership.

¹⁴⁵ Treaty Articles should be read in context of one another, see e.g. Vienna Convention on the Law of Treaties 1969; *Schmidt-Tedd/Mick*, "Article VIII", 2009. For further reading see also *Nolte*, *Treaties and their Practice*, Hague Academy of International Law/Martinus Nijhoff, The Hague, 2019.



It is apt at this point to note that the concept of the launching State is not universally uniformly applied, primarily due to differences in the translations of the OST, especially the Spanish and the Chinese. In the original English version the OST, the LIAB and the REG define the launching State as the State that launches, procures or from whose territory or facility an object has been launched. In the Spanish version, for example, instead of the term procure the term “promueva” is used, which translates to “promote” rather than “procure” and is wider than the term “procure” under the ordinary meaning interpretation codified in Article 31 of the 1969 Vienna Convention on the Law of Treaties.¹⁴⁶ The Cambridge Dictionary on the English Language, for example, describes “promotes” as “to encourage or support something” while “procure” is explained as “to obtain something especially after an effort, and is often connected with finance. Even translation problematic aside, dispute regarding the term “procure” is discernible from practice as well as doctrine. Often the term is explained as paying for a launch or similar, however no universal agreement seems to exist.¹⁴⁷ For example, the Netherlands have asserted that in instances of on-orbit transfers of ownership, in particular purchase of a satellite in-orbit by a Dutch non-governmental actors, the Netherlands do not view themselves as a launching State.¹⁴⁸ The United Nations have attempted to address this issue with UNGA Resolution A/RES/59/115 to call for uniformity and practice-sharing. However, the issue remains. The Cologne Manual encourages States to discuss the issue and strive toward uniformity in the interest of legal certainty.

Should the launching State also prove difficult to identify, the next step would be to contact the national State of the space object operator. Pursuant to Article VI of the OST States bear international responsibility for all national space activities, whether carried on by governmental or non-governmental actors. The latter furthermore require authorisation and supervision of the appropriate State to ensure their compliance with the provisions of the OST. This creates yet another legal link between a State and a space activity, and through the latter to the space object.¹⁴⁹ Ultimately, therefore, if

¹⁴⁶ See also *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Moro-Aguilar/Popova* (assist. ed.), *Commentario de Colonia al Derecho del Espacio*, 2021.

¹⁴⁷ *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. II*, 2013; *Kerrest/Smith*, “Article VII”, 2009.

¹⁴⁸ Note verbale dated 29 July 2003 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General, A/AC.105/806; Note verbale dated 18 February 2004 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General, A/AC.105/824; Note verbale dated 29 July 2003 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General, A/AC.105/806; Note verbale dated 18 February 2004 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General, A/AC.105/824.

¹⁴⁹ *Gerhard*, “Article VI”, 2009.



neither the Registering State nor the launching State can be identified in a timely manner, communication should be directed to the national State of the space object operator.

The phrase "reasonable timeframe" or "timely manner" should be interpreted as practical and contingent upon the urgency of the situation. For instance, in cases of heightened urgency, less time and effort should be expended on identifying the State at each level before progressing to the next available option – such as moving from identifying the State of Registry to seeking the launching State.¹⁵⁰

Any changes in the status of space objects – such as de-orbiting, transfers of ownership, or changes in operators – should be communicated with the utmost urgency, as stipulated by Article IV of the REG and often mirrored in national space legislation. Timely notifications are essential for maintaining an accurate and functional registry. States are required to furnish this information to the United Nations, which serves as a centralised repository. Some national space laws therefore require operators to provide such information in a timeframe usually ranging between 7 to 14 days.¹⁵¹ The national space authority, in turn, must thereafter relay this information without unnecessary delay to the Secretary-General of the United Nations.

Especially, in the case of an on-orbit transfer of ownership, the national space authorities and the national registry must be notified immediately, and the implications for the legal relationship with the State should be clarified as soon as possible.¹⁵² To ensure a swift and smooth transfer, a formal transfer agreement should always be executed between the buyer and seller, which includes the obligation to inform the registry. In instances of dual registration, the most recent entry shall take precedence over the earlier one. Moreover, if governmental approval is required, appropriate contact protocols should be established.

Finally, this guidance is aimed at both operators and States, as operators often lack clarity regarding their responsibilities concerning registration or how to enact such registration. Consequently, States should develop clear "instructions" for operators, detailing which governmental entity is responsible for registration and serving as the primary contact point.¹⁵³ Additionally, the obligations of States

¹⁵⁰ For also Annex on Air Law and Air Traffic management.

¹⁵¹ For an analysis see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5.

¹⁵² For more on on-orbit transfers of ownership see *Chatzipanagiotis*, "Registration of Space objects and Transfer of ownership in Orbit", ZLW 2007; *Dasgupta*, "On-Orbit Transfer of Satellites between States", in: *Blount/Moro-Aguillar/Masson-Zwaan/Schrogl*, *Proceedings of the International Institute of Space Law 2016*, Eleven International Publishing, The Hague, 2017; *Hobe*, *Space Law*, 2023, pp. 91-93.

¹⁵³ As noted some States already employ information technologies to clarify procedures, see e.g. US FAA, accessible at: https://www.faa.gov/space/legislation_regulation_guidance; FCC, How to Prepare a USA ITU filing, accessible at: <https://www.fcc.gov/space/how-prepare-usa-itu-filing>.



should be elucidated, as emerging space nations frequently lack awareness of what is expected of them and how to fulfil these requirements. The registration procedures, including the timing and methodology, must be clarified at the national level, akin to the template provided by the UN outlining the requisite information to be submitted.¹⁵⁴

IV. Future developments

Efforts must be undertaken to educate emerging space-faring nations on the significance of adhering to registration as established by international space law.¹⁵⁵ Capacity-building initiatives can enhance understanding and facilitate the effective implementation of this Guideline and its underlying legal basis.¹⁵⁶

Several shortcomings have been uncovered on both the national and the international level. First, many satellites remain unregistered.¹⁵⁷ Second, information about which details should be registered and when remain unclear, and practice remains varied. Third, the registration system is only partially helpful in its current form to STC.

On an international level,

- 1) Future practices should prioritise timely and accurate notifications from States to the UNOOSA, particularly concerning changes in the status or ownership of registered space objects. This should be done UNOOSA without delay, thereby facilitating easy access to information for all actors in the space domain through a centralised point. This fosters a culture of compliance and responsibility within the international space community. Therefore, notifications to UNOOSA must be carried out by States in accordance with Article IV of the REG, primarily for safety purposes.¹⁵⁸

¹⁵⁴ See also Annex on National Space Acts.

¹⁵⁵ See inter alia *Masson-Zwaan et al.*, The need to improve registration practices in the context of space traffic management, *Acta Astronautica*, Vol. 223, 2024; *Hobe*, Perspectives for Space Law in the 21st Century, upcoming with the Hague Academy of International Law.

¹⁵⁶ See also LTS Guidelines 2019 and the efforts of the UNCOUOS, accessible at: <https://spacesustainability.unoosa.org>.

¹⁵⁷ See e.g. *Jakhu/Jasani/McDowell*, “critical Issues Related to registration of Space Objects and Transparency of Space Activities”, *Acta Astronautica*, Vol. 143, 2018.

¹⁵⁸ For an example of the submission process, please refer to the following link: <https://www.unoosa.org/oosa/en/spaceobjectregister/submissions/States-organisations.html>.



- 2) In instances of STM where jurisdiction over a space object may be in question, it is imperative to establish a legal link between the object and a relevant State, and to make contact with that State. This legal link must be ascertained even when an object is unregistered or when the registering State remains unidentified. Consequently, it is advisable to follow four recommended steps:

Firstly, efforts should be made to identify and contact the State of registry. According to existing space law, registration within a national registry serves as the primary link. Both national space object registers and the online database maintained by UNOOSA should be consulted to ascertain the registering State that holds jurisdiction and control over the relevant object.

Secondly, notifications submitted to UNOOSA concerning the acceptance of jurisdiction and control, in accordance with Article VIII of the OST, can be utilised. The notifying State should be approached for further clarification. For instances of identification, one may consult UNOOSA Online Index. This index encompasses registration information, including unverified details regarding unregistered objects – indicated in square brackets with the name of a State or organisation that UNOOSA believes, through unofficial sources, to be responsible. The use of brackets and green text signifies that the information in question has not been confirmed by the respective State or organisation. Nevertheless, this information serves as a valuable resource for identifying a potentially responsible State or organisation.

It is important to exercise caution regarding these notifications. For example, the United Kingdom and the Netherlands have reportedly employed Article XI of the OST notifications to provide information on space objects to the UN, despite not considering themselves the registering States (due to their non-launching State status). Consequently, they maintain secondary registers, as elucidated in the Netherlands' explanation (UN Doc. ST/SG/SER.E/INF.24).

Thirdly, in situations where the State of registry cannot be determined (for instance, if the national registry is inaccessible) or the object has not been registered at the national level, the legal link will be defined by the term 'launching State' as outlined in Article VII of the OST, alongside the provisions of the Liability Convention (LIAB) and the REG. The rationale for contacting the launching State in instances where the registering State cannot be identified is grounded in REG, which stipulates in Article II that "the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain." In cases where multiple States are involved in the launch, these States are obliged to "jointly determine which one of them shall register the object." This provision effectively links the act of registration to the launching State.



Moreover, even for those States that may not be parties to the REG, prevailing interpretations suggest that the provisions of the OST should be read in conjunction with one another. According to the general interpretative rules codified in Article 31 of the Vienna Convention on the Law of Treaties, a robust connection exists between the State of registry under Article VIII of the OST, the launching State under Article VII of the OST, and the responsible State under Article VI of the OST.¹⁵⁹ This interconnectedness validates the decision to engage with the launching State when the registering State is not identifiable.

Finally, in cases where neither the State of Registry nor the Launching State can be identified, it is advisable to contact the national State of the satellite owner. Typically, this State also qualifies as the appropriate State under Article VI of the OST. This approach is grounded in the stipulation that, pursuant to Article VI of the OST, the appropriate State is responsible for authorising and supervising non-governmental activities, and that States bear responsibility for all national space activities, irrespective of whether they are conducted by governmental or non-governmental entities.

On a national level,

- 1) The Guideline also addresses the legal ramifications of ownership transfers in outer space, underscoring the necessity for such changes to be promptly recorded in national registries and reported to the UN. This is vital for maintaining jurisdictional clarity and ensuring compliance with international obligations. It remains essential for States to comply with the provisions of the OST and REG.
- 2) Furthermore, the transparency of national registries is paramount; States must ensure that their registries are accessible to the public, regularly updated, and adhere to best practices established in the realm of space object registration. Current best practices include the availability of online electronic registries. Notably, the UK Registry, the Australian Registry, the Finnish Registry, and the Austrian Registry are all accessible online. If a registry cannot be made publicly available, States should at minimum designate a reliable point of contact for registry enquiries, ensuring that this contact is easily accessible and responsive. For example, Luxembourg has effectively provided a telephone number and email address for inquiries in its notifications to the UN, as detailed on the UNOOSA website and the publicly accessible Luxembourg government website.

¹⁵⁹ Inter alia see also *Schmidt-Tedd/Mick*, “Article VIII”, 2009; *Gerhard*, “Article VI”, 2009.



- 3) Moreover, States must clarify the information that they require from their operators on space objects for the national register and the procedure that should be followed. The actual registration in national registries must be conducted by governmental agencies, however, often emerging operators are unaware of their duties with regard to State authorities and in particular their role in national registration of a space object. Notifications regarding private space objects can be easily communicated between the authorising State and the non-governmental entity, for example on governmental websites dedicated to space activity in that States, and regulated under national space legislation, including instruments or other sources such as governmental websites defining procedures. An appropriate timeframe for such activities, including for notifications to the State about changes in space object status, should also be clarified and determined. In short, information about the registration process, the responsible agency (such as a point of contact), and the necessary details to be recorded in national registries as well as obligations of the operators such as providing timely information about changes in space object status that could endanger space traffic or humans on Earth, should be delineated in national space acts or made available on a publicly accessible platform for transparency purposes. This conclusion is supported by evidence indicating that instances of non-compliance often stem from a lack of understanding or knowledge. Consequently, national offices (licensing entities) should ensure that information regarding the actions required of private actors is readily accessible. For instance, in the United States, the National Environmental Satellite, Data, and Information Service (NESDIS) within NOAA clearly identifies a point of contact for inquiries related to remote sensing systems, facilitating a preliminary evaluation of whether activities fall under their jurisdiction¹⁶⁰. At a minimum, the information required from private entities should align with the data mandated by the REG for transmission by States to the United Nations Secretary-General.

Finally, on both levels,

- 1) The information provided for registration and via notifications to the UN, should in the future include information immediately relevant to STC such as information about operators, point of contact of operators. Ideally, it would furthermore include information on the space object (e.g. its materials, trackability for purposes of reliable SSA, information on its manoeuvrability to enlighten space actors as to the possible collision avoidance strategies).

¹⁶⁰ For more details, see: <https://www.nesdis.noaa.gov/about/regulatory-affairs/licensing>.



2) In the context of on-orbit transfers of ownership, it is imperative to establish a legal link, as current space treaties do not explicitly govern such transactions. Article VIII of the OST neither explicitly prohibits nor permits changes in registration or the transfer of ownership. The jurisdiction that a State acquires through the act of registering an object in its national registry, as per Article VIII of the OST, grants it legal authority to exercise control over the object and its associated personnel. This jurisdiction is akin to a quasi-territorial authority exercised over vessels or aircraft in international waters or airspace. Consequently, it is advisable for States to transfer jurisdiction through a change of registration to the buyer States, particularly in instances of inter-State sales or when the buyer is situated in a different country from the seller. Many national space laws stipulate that satellite owners and operators must notify their respective State when a satellite is sold to a new owner or operator.¹⁶¹

Several notable cases of on-orbit ownership transfers have been recorded, revealing a diversity of practices.¹⁶² For instance, in the case of SIRIUS 1 (formerly BSB-B1), both the transferring State, the United Kingdom, and the receiving State, Sweden, registered the satellite in their national registries, resulting in double registration. In the instances of AsiaSat 1 and AsiaSat 2, the satellites were transferred in conjunction with the transfer of sovereignty over Hong Kong, leading to the registration being transferred from the UK to the People's Republic of China. Conversely, in the case of Anik, a transfer of registration was never executed; registration remained with the transferring State, Canada, while factual control was handed over to the receiving State, Argentina. In the cases of NSS 6, NSS 7, and INTELSAT 513, the satellites were acquired in orbit by a private entity registered in the Netherlands. This entity subsequently issued a Note Verbale to UNOOSA, stating that it did not regard itself as the “launching State,” “State of registry,” or “launching authority” for purposes of the Liability Convention, the REG, or the ARRA but accepted international responsibility under Article VI of the OST, along with “jurisdiction and control” as per Article VIII of the OST, due to the fact that the buyer and new operator of the satellites was a non-State actor incorporated in the Netherlands.

In the event of an on-orbit transfer of ownership, it is essential to update the relevant national registries and to notify the Secretary-General of the United Nations. The transferring State's national registry should reflect that the satellite has undergone an ownership transfer in orbit, accompanied by

¹⁶¹ For existing State practices, see <https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/wg-tre/tre-topic4.html>.

¹⁶² For more information see *Sancin/Grünfeld/Ramuš Cvetkovič*, “Contemporary Challenges of International Law-Making for Outer Space”, *Pravnik* Vol. 36, No. 1, 2021; Dasgupta, “On-Orbit Transfer of Satellites between States”, in: *Blount/Moro-Aguillar/Masson-Zwaan/Schrogl*, *Proceedings of the International Institute of Space Law 2016*, Eleven International Publishing, The Hague, 2017.



pertinent information regarding the new registering State, such as the transferee State, for the purposes of “jurisdiction and control.” Subsequently, the object should be recorded in the national registry of the transferee State. Ideally, on-orbit ownership transfers should be supported by a bilateral agreement between the two States involved. Alternatively, a copy of the private sales contract could be attached to the national registries. For all on-orbit ownership transfers, it is vital that such transactions are recorded in the national registry of the transferring State, with the new State of registry or the State exercising jurisdiction over the object, along with the new owner and operator, duly noted in the national registry of the transferee State. Such notifications serve the interests of all parties involved. Furthermore, States should establish clear procedures within their national space legislation. Under customary international law, the principle of due diligence obliges States to ensure a robust legal framework and an effective transfer system for satellites, which ultimately benefits all parties involved.

The act of notifying the United Nations by States serves as an indication of their intention to amend registration and to accept the associated obligations outlined in Article VIII of the OST. This is substantiated by State practice, as exemplified by the cases involving NSS 6, NSS 7, and INTELSAT 513 satellites. In instances where no notification is submitted to the Secretary-General of the UN, reliance shall be placed on the most recently known registration. If no identifiable registration exists, the relevant launching State shall be contacted.

The underlying rationale is that States should be encouraged to implement changes in registration or to supplement their national registries with notifications concerning on-orbit transfers of ownership. In situations where ownership transfers occur between non-State actors, the State of nationality or incorporation should, in accordance with Article VI of the OST, be regarded as having the closest legal connection.

3) Finally, with regard to some objects unanswered questions as to applicability of air law or space law should be addressed. If an aerospace object is capable of taking off in a manner akin to that of an aircraft, it falls under the regulatory framework of air law. However, as it will also reach outer space, it will touch upon space law, too. This raises a potential dispute regarding whether such an aerospace object can be deemed ‘launched’ in the traditional sense and whether it is subject to REG or Article VIII of the OST. This circumstance introduces an additional consideration regarding the obligation of dual registration for aerospace objects that operate in both airspace and outer space.



States and operators should communicate, liaise, consult and coordinate with each other during all stages of space activity.

This includes coordination and communication with Air Traffic Management systems, the International Telecommunications Union and other relevant international organisations.

I. Introduction

Guideline 4 builds on the principle of (international) cooperation, which is one of the fundamental principles of space law.¹⁶³ The Guideline formulates a general rule underlying the Cologne Manual and STM: As ensuring the safe, secure and sustainable use of outer space is a common interest of States and non-state actors, space activities should always be conducted in a cooperative manner.

While other Guidelines address specific forms of cooperation, such as information exchange or collision avoidance, Guideline 4 expresses a general requirement for cooperation. Even if a particular aspect is not explicitly mentioned in the Cologne Manual, the underlying requirement remains that it should be addressed through cooperation. Accordingly, the Guideline is subsumed under the general part of the Cologne Manual as it, and its central ideas, underpin the other more specific Guidelines.

II. Structure of the Guideline

The Guideline is divided into two parts. The first sentence deals with the various forms of cooperation and its nature as an ongoing task. The second sentence addresses the specific issue of interaction with international organisations, with particular emphasis on Air Traffic Management (ATM) and the International Telecommunication Union (ITU) due to their central role in STM.

III. Rationale of the Guideline

Following the general idea of international cooperation (1.), the Guideline refers to its different forms (2.) and to the central role of international organisations (3.).

1. International Cooperation

Cooperation has always been an established principle in international space law. This is particularly evident in the OST, where the Preamble emphasises “the importance of international co-operation in the peaceful exploration and use of outer space”. The principle of cooperation, in the sense of peacefulness and mutual assistance, is also present in other articles of the OST. In particular, Articles I, III, IX, X and XI of the OST show that the OST as a whole is an expression of a cooperative approach.

¹⁶³ See The Imperative of Space Traffic Management: A Comprehensive Framework Rooted in the Principles of International Space Law.



The same applies to other international space law treaties. The latter can be seen in the Preamble and Article 2 Rescue Agreement or the Preamble of the Liability Convention.

Guideline 4 affirms that cooperation is not just an ideal and principle, but a necessary condition for STM.¹⁶⁴ As a global endeavour, space activities require effective cooperation between multiple actors, including States, private entities and international organisations. This is especially the case in the absence of a central authority that would assume responsibility for the regulation and coordination of space traffic. The current decentralised nature of the STM, on the one hand, and the common tasks and interests, on the other, make cooperation essential to avoid conflicts and to ensure the safe, secure and sustainable use of outer space. However, not only to avoid conflicts and enable other forms of cooperation necessary for STM, international cooperation, as mandated by the space treaties, should serve to promote capacity-building efforts. Particularly in context of STM, capacity-building for the further evolution of the necessary technologies to guarantee safe space operations should be undertaken.¹⁶⁵ This means that Guideline 4 provides interpretative guidance for all STM procedures and related decision-making processes. States and private actors should interpret all STM-related provisions in a manner that prioritises cooperation.

2. Communicate, liaise, consult and coordinate during all stages

The first sentence lists the various forms of cooperation and their application to all phases of space activities. This applicability does not mean that all cooperation mechanisms should be applied at the same time. Rather, the forms represent a graduated system in which the specific form of cooperation depends on the situation and the actors involved. The difference between the forms is mainly in the type of formality and commitment. While consultation and coordination are often based on treaty or customary obligations, communication and liaison are often – but not necessarily – less formal. As non-state actors (e.g. non-governmental organisations or corporations) are not subjects of international law, the forms of cooperation they engage in are more likely to be based on national (space) law, soft law instruments or informal practices.

Communication is the broadest and least binding concept in the context of the CMSTM and simply refers to the exchange of information. It does not necessarily involve an expectation of further engagement or action.¹⁶⁶ Nevertheless, communication serves to ensure transparency and is the basis

¹⁶⁴ See e.g. also *Flohrer*, Due regard and the need for space traffic coordination, 2025.

¹⁶⁵ See e.g. *ibid*; LTS Guidelines, 2019; ESA, ESA's Annual Space Environment Report, 2025.

¹⁶⁶ This is in analogy to decisions of the International Court of Justice in the *Pulp Mills on the River Uruguay* (Argentina v. Uruguay), Judgement, I.C.J. Reports 2010; *Obligation to Negotiate Access to the Pacific Ocean* (Bolivia v. Chile),



for any form of dialogue. Communication is therefore an essential starting point for STM and the safe, secure and sustainable use of outer space. This is reflected in the communication between operators and the national space agency, as well as in the communication of SSA or registration information at the international level. However, communication does not need to be linked to expectations or consequences of action.

Liaison, as used in Guideline 4, refers to a type of informal cooperation and implies a relationship or exchange of information without a binding commitment. It means that a relationship or contact is maintained, but not necessarily with a structured process or legal commitment. However, liaising means establishing (informal) contacts or relationships at the working level. It is therefore more than just communication. An example of such cooperation is the regularly exchange of information between a space agency and operators at national level, or the exchange of best practices between space agencies at international level. However, as the IADC shows, the transitions to more institutionalised cooperation are fluid.

Consultations involve a more structured exchange of views, often with a legal or procedural expectation, but not necessarily an obligation to act on the input received. Consultation is therefore generally understood as a procedural obligation. In this sense, consultations also appear in Articles IX and XII of the OST.¹⁶⁷ They refer to the possibility of requesting consultations with other parties in the case of “harmful activities” or facility visits. In both cases, the aim is to establish a formalised, diplomatic forum. By its very nature, this does not entail any specific expectations or consequences. In a broader sense, consultations can also describe procedural obligations that operators must comply with as part of the (national) authorisation and licensing process.

Coordination usually requires a higher level of cooperation and organisation. Coordination is not just about notifying others but about aligning and adapting plans to avoid conflicts. Coordination therefore involves active measures to take account of other activities. Coordination can be based on binding agreements (e.g. treaties) or non-binding agreements (e.g. memoranda of understanding). In both cases, however, coordination within the meaning of Guideline 4 is to be understood as a more intensive form of cooperation than mere liaison or communication. Coordination may refer to opera-

Judgment, I.C.J. Reports 2018. It is furthermore in accordance with the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, 51/122, 1996.

¹⁶⁷ For more on Article IX see *Marchisio*, “Article IX”, 2009. For more on Article XII see *Smith*, “Article XII”, in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009.



tors or private companies actively coordinating their activities in relation to satellites or mega-constellations with each other and with national authorities. In space law and STM, however, coordination – outside specific regulations such as collision avoidance – also concerns the cooperation of States through international organisations. This concerns the coordination and integration of ATM and STM, as well as the active coordination between States through the ITU when satellite networks or radio frequencies could interfere with each other.

3. International Organisations

The second sentence of the Guideline emphasises cooperation with and through international organisations. Because of their central role, ATM and the ITU are explicitly mentioned. However, the Guidelines remains open to the inclusion of other relevant organisations.

The experience gained from ATM and the need for coordination with STM was fundamental to the development of the Cologne Manual.¹⁶⁸ With the increasing number of space launches and the advent of sub-orbital flights, effective coordination between space and air traffic is essential. Without proper cooperation, there is a risk of conflicts between space operations and air safety. Coordination mechanisms such as joint airspace planning and real-time communication are essential to minimise risks. The standards of ICAO can play a central role. Nevertheless, a comprehensive approach involving all (national) stakeholders remains crucial, as ATM is not a unified but a decentralised system.

The ITU is also explicitly mentioned in the Guideline. The inclusion of the ITU reflects its crucial role in frequency allocation and management in the context of satellite navigation. The ITU regulatory framework provides an essential and effective mechanism for ensuring equitable and interference-free access to radio frequency resources. Effective STM depends on communication systems operating without harmful interference. Space traffic namely consists of a physical and a communications sphere. Space object communicate with ground stations via uplinks and downlinks, thereby any frequency interference (i.e. communications traffic in the primary domain of ITU) may have direct impacts on the physical safety of space traffic (primary domain of STM). By committing to cooperate with the ITU, Guideline seeks to ensure that space actors comply with international radio frequency regulations, while minimising the risk of signal congestion and interference.

¹⁶⁸ See Underlying Principles of the Cologne Manual – Working Group Air. See also Annex on Air Law and Air Traffic Management.



Finally, the Guideline extends beyond ATM and ITU to include cooperation with other relevant international organisations. These may include, in particular, UNOOSA, UNCOPUOS, the International Committee on Global Satellite Navigation Systems (ICG), and other multilateral bodies such as regional space agencies. Such cooperation is necessary to align national and private sector interests and policies with evolving international best practices and to ensure that STM remains a coordinated and inclusive endeavour. This is particularly true in the absence of a centralised global authority for STM.

IV. Future developments

In the future, the need for improved cooperation mechanisms will continue to grow as space operations become more complex. To keep pace, international cooperation tools will need to be expanded and developed. Given technical challenges such as artificial intelligence, this may also affect cooperation with regard to technology and its transfer.

In the long term, any fragmentation of STM must be counteracted.¹⁶⁹ On the contrary, the objective must be the comprehensive institutionalisation of STM in an international network. In this context, the establishment of an international authority responsible for STM should also be considered. Until then, however, the principle of cooperation as interpreted in Guideline 4 will guide the interpretation and execution of all STM activities.

Commentary to Guideline 5 – Space Traffic Coordination

Space traffic coordination on an international level is necessary to ensure the safety of space operations.

1. The operator of a space object

- a. should display the point of contact that must be publicly identifiable and available. The operator must be in a position to take responsibility for decisions regarding the space object.**
- b. should establish procedures and proper channels of communication to enable timely responses to a conjunction between two space objects and to consider the necessity of performing a collision avoidance manoeuvre.**

¹⁶⁹ For an analysis of the consequences and risks of legal fragmentation see UN/ILC, Fragmentation of International Law (report), UN Doc. A/CN.4/L.682 and Add.1*, 13 April 2006.



is the result of satellite replacement following impact with debris damaging solar panels.¹⁷⁰ It has been evaluated that overall costs would decrease at least 10% if collision avoidance measures were regularly implemented.¹⁷¹

Guideline 5 builds on the due regard and international cooperation principles contained in space law. It proposes a specific form of cooperation required for effective STC. While it relies heavily on the other Guidelines of the Cologne Manual to support its implementation and successful execution, it effectively forms the heart of the Cologne Manual, proposing a novel specific framework for STC and STM, supported not only by existing legal principles of international and national space law, but also by best practices.¹⁷²

While it is desired that States promote and encourage, possibly even regulate STC in the proposed manner in a top-down approach to establishing an international standardised STM, this Guideline is focused on operators as the immediate entities in control of the space object and able to perform collision avoidance measures.¹⁷³ Operators are therefore encouraged to present the driving force for compliance with and implementation of the Guideline as it is more cost-effective to perform active STC, taking evasive manoeuvres and adopting/negotiating pre-emptive coordination plans, than it is to repair or replace a space object, including accounting for loss of operations and services during the time it takes to repair a damaged space object or manufacture and launch a new space object.¹⁷⁴ In this manner, a bottom-up approach to establishing a systematic STM is also encouraged.

¹⁷⁰ IAA, Space Traffic Management: A Roadmap for Implementation, 2018; ESA, ESA's Annual Space Environment Report, 2025.

¹⁷¹ IAA, Space Traffic Management: A Roadmap for Implementation, 2018.

¹⁷² See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook; The Space Safety Coalition, Best Practices for the Sustainability of Space Operations" (undersigned by several NSAs), 2023; NASA, NID, accessible at: https://www.nasa.gov/wp-content/uploads/2015/04/faq-nid-and-hbk-collision-avoidance_0.pdf; ESPI, ESPI Report 71 - Towards a European Approach to Space Traffic Management, 2020; EU STM, EU STM Final Report: Space Traffic Management for XXI Century Space Operations, DO3_D13, 2022; Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022; IISL/IAF/IAA, Space Traffic Management Report, Acta Astronautica, Vol. 232, 2025; RAND, International Space Traffic Management (Research Report), 2023; Spaceways, D7.6 Three "STM briefs" papers published online, 2020 (research funded by EU Horizon 2020 Project); Aerospace, Space Agenda 2021: Space Traffic Management, 2021. For further analysis see also *Frandsen*, Space Traffic Regulation, University of Copenhagen, Copenhagen, 2023; International Academy of Astronautics (IAA), Cosmic Study on Space Traffic Management, 2006; IAA, Space Traffic Management: A Roadmap for Implementation, 2018; Merz et al., Current collision avoidance service by ESA's space debris office, 7th European Conference on Space Debris, Proceedings of the conference 2017.

¹⁷³ See e.g. *Flohrer*, Due regard and the need for space traffic coordination, 2025; Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022; NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook; *Frandsen*, Space Traffic Regulation, 2023.

¹⁷⁴ IAA, Space Traffic Management: A Roadmap for Implementation, 2018.



At presently *ad hoc* STC is undertaken following identification of a possible conjunction event between two or more objects. This determination of space object close approaches is based on miss-distances and conjunction probabilities assessed via available technologies. In practice, following the 2009 Iridium-Kosmos collision, the USSTRATCOM began sending Conjunction Summary Messages (CSM), similar to the Orbital Conjunction Message (OCM) of the ISS, to operators.¹⁷⁵ These are, however, not a suggestion to perform a particular orbital avoidance manoeuvre and do not take into account an object's characteristics or operational constraints. This task, and therefore the main task, remains on operators, i.e. to check this information for consistency, adapt them to their space object characteristics, evaluate it against its own operational and SSA data, and assess risk comparing it with its threshold criteria to finally decide on whether to take evasive action for orbital maintenance. This decision and analysis must then be communicated and coordinated with the operator of the other space object(s) and evasive manoeuvre computed. Those without personal capacity or know-how, have begun utilising a number of services provided by civil space agencies and industrial services providers emerging in the area of collision assessment.¹⁷⁶ Therefore, reliance on Guidelines on SSA and on Communications System and International Technical Advisory Body is required for seamless STC.

II. Structure of the Guideline

The Guideline begins with declaring and clarifying that STC on an international level is necessary to ensure safe space traffic. It continues to explain how this can be performed in practice based on experience gained from existing *ad hoc* STC already being performed.

First, space object operators should remain pro-active in identifying and preventing possible collisions. Once a potential threat has been identified, they should enter into communication with other space object operators. For this reason, all space object operators should designate a continually available point of contact empowered and made responsible for taking decision for STC measures, preferably capable of communication in English or with translational services on-hand. To assure effectiveness of the latter, a clear “command” structure should be specified within the operator's

¹⁷⁵ See e.g. *Rongier/Sgobba* (IAASS), Space Safety and Space Traffic Management, Presentation at the IISL-ECSL Symposium on Space Law 2015, Vienna 13 April 2015.

¹⁷⁶ Several governmental as well as non-governmental entities already exist that offer assistance to operators (ESA Space Debris Office; EU SST; US Space-Track; OKAPI Orbits (<https://www.okapiorbits.space>); Keyhan Space (<https://kayhan.space>) etc.



entity¹⁷⁷, e.g. clarifying who is responsible to take the decision on STC manoeuvre. Furthermore, communication and decision process in STC events should be determined in advance, including setting risk thresholds. In an effort to build STM from the bottom-up, it is moreover advisable that operators exchange practices and discuss the aforementioned points in an effort to standardize approaches to maximise space traffic safety through quick and predictable systematic approaches to STC.

Second, to aid the inter-operator communication, SST information providers, whether governmental or non-governmental,¹⁷⁸ should provide necessary information to operators such as collision avoidance, re-entry and fragmentation analyses. Collision avoidance analysis information should hereby be understood as including a risk assessment of collision between space objects or space object and debris pieces or fragments and the generation of collision avoidance alerts. This information should also be provided for Launch and Early Orbit (LEOP) as well as End of Life (EOL) phases. Re-entry analysis information is presently understood as including a risk assessment of uncontrolled re-entry of space objects into the atmosphere. Fragmentation analysis information includes information on in-orbit fragmentations, break-ups of space objects or collisions.

Third, operators should respond to critical conjunction warning by performing appropriate collision avoidance manoeuvres, for which baseline priorities are proposed, such as a logical necessity to avoid non-maneuvrable objects. In instances of manoeuvrable vs. manoeuvrable space object, first priority should be offered to malfunctioning objects (as their manoeuvrability may be impaired), second to objects on a rescue mission (whereby rescue missions should be distinguished from “normal” missions through the presence of an element of urgency), and third to human (crewed) missions (which already enjoy privileged status in practice). In all other instances collision avoidance plans or agreements between space object operators should be adopted in advance (advisable during the development and design phase or mission planning)¹⁷⁹, in a manner of a bottoms-up approach to STM.

¹⁷⁷ Operators are normally an entity with employees, e.g. SpaceX; OneWeb; Iridium; IsarAerospace etc.

¹⁷⁸ In some instances, this will be done by providers of SSA services, in other by associated entities such as commercial specialising in conjunction, re-entry and fragmentation analyses. In some jurisdictions, evolutions such as collision avoidance, re-entry and fragmentation analyses are provided by the SST service provider such as EU SST (or ESA Space Debris Office). In some others, these evaluation services are performed by commercial advisors or go-betweens (e.g. OKAPI Orbits; Keyhan Space, LeoLabs), on basis of SSA information provided by the initial SSA services provider, e.g. in the USA, evaluation services on behalf of the operator can be performed by private entities on basis of SSA information provided by US SSN and space object information provided by the operator of the space object. For the history and further explanation see e.g. *Rongier/Sgobba* (IAASS), Space Safety and Space Traffic Management, Presentation at the IISL-ECSL Symposium on Space Law 2015, vienna 13 April 2015.

¹⁷⁹ See Commentary on Pre-Launch Activities and Notification Guideline.



III. Rationale of the Guideline

The Guideline is grounded in space traffic mechanics and supported by existing State practice¹⁸⁰ as well as useful insights from ATM¹⁸¹. The challenges and rationale of the Guideline will be explained in 2 easy steps: 1. Space Traffic Mechanics and 2. Space Traffic Coordination Process.

1. Space Traffic Mechanics

The guiding rationale of this Guideline is to ensure quick and safe STC. Space traffic, however, presents several challenges to the establishment of standardised traffic rules and collision avoidance system required for quick and safe STC. In the following, the technicalities constraining STC will be shortly explained, by providing a short overview of orbital mechanics (1.1.), the existing process of conjunction assessment (1.2.) and identification of critical conjunction events (1.3.).

1.1. Orbital Mechanics

First, the mechanics of the orbital environment render terrestrial experience in road, air and maritime traffic of limited value. Terrestrial traffic rules often rely on the ability of operators to visually detect obstacles and analyse options in the moment, with available options/commands including evading to the left or right. In outer space such solutions are not viable. This is on the one hand because objects travel with significantly higher velocities (evaluated at approximately 7-8 km/sec in LEO and 3 km/sec in GEO, resulting in impact velocities of around 10-14 km/sec in LEO and 6 km/sec in GEO, which can render impact with a small 1 cm object, at worst a lethal occurrence and at best only severely impairing active object operations or disabling them) rendering comparable practices non-viable. The 2009 collision between the active Iridium 33 and the in-active Kosmos 2251, for example, occurred at evaluated 11 km/sec, annihilating both objects and adding over 2000 trackable debris pieces into orbit. In 2007 an estimated 0.2 to 0.3 cm debris collision with the ISS resulted in a substantial tear (6.7 cm long and 3.3 cm wide) in the thermal blanket of the Zarya module requiring refurbishment and endangering the lives of astronauts onboard. On the other hand, even setting aside the orbital velocity, space object operators cannot rely on sight, instead depending on available tech-

¹⁸⁰ For more information see Annex on State practice.

¹⁸¹ ATM has been identified as an efficient and proven concept, however, due to the significant differences in space to air mechanics as well as space to air law, ATM cannot be directly applied to outer space activities. Nonetheless, some useful concepts and practice has been identified that might in future aid space object operators or international and national legislators to develop a future oriented innovative STM. For more information see Annex on Air Law and Air Traffic Management.



nologies for tracking and monitoring space objects that currently permit them to approximately evaluate where an object is without knowing whether it is positioned right, left, above or below the second object.¹⁸² In-orbit collision avoidance (as well as conjunction analysis) therefore heavily relies on SSA and for this reason, this Guideline relies heavily on compliance with Guidelines for SSA, Cyber Security and Information Acquisition and Dissemination to assure reliable and secure tracking and monitoring capabilities as well as sharing of that (i.e. SSA) information.

Second, in the last two decades space technologies have evolved to enable reusable launch vehicles as well as small satellites (often referred to as smallsats), ranging from nanosats to cubesats, etc. These have in turn enabled the creation of large constellations of satellites consisting of several hundreds, sometimes thousands of satellites, with a few examples being SpaceX's Starlink, OneWeb, AmazonKuipers. Large satellite constellations primarily provide global broadband internet services to Earth and travel information, often mimicking one unit in analogy to a bee-hive in orbital regions between 300 and 1400 km altitude. The orbital regions show that these satellites populate the most popular orbits, including the orbit of the ISS at 370 to 460 km altitude.¹⁸³ This information is significant as smallsats, especially e.g. cubesats, often lack manoeuvrability capabilities and depending on selected orbit may not be compliant with the UNCOUOS Space Debris Mitigation Guidelines, in particular the 25-year de-orbiting rule, posing severe risks to orbital traffic.¹⁸⁴ (Some large satellite constellations like Iridium and Globalstar are composed of mass-produced larger satellites that pose fewer risks than the larger satellite constellations consisting of smaller (lower cost and short time production produced) satellites.) Therefore, this Guideline furthermore heavily depends on Guidelines on Pre-Launch Activities and Notifications as well as Sustainability to ensure appropriate active or passive collision risk mitigation efforts are implemented during the development and design phase particularly for large constellations and satellites without manoeuvrability capabilities, as well as to monitor and control the debris population.¹⁸⁵ This is furthermore supported in practice and doctrine as both the IADC and NASA recommend special considerations during development and design phase of large constellations due to the higher risk these pose to orbital traffic.¹⁸⁶

¹⁸² See e.g. *Frandsen*, Space Traffic Regulation, 2023.

¹⁸³ ESA, ESA's Annual Space Environment Report, 2025.

¹⁸⁴ *Nixon/Michaels*, Modern English for Aeronautics and Space Technology (2nd ed), Hanser, Munich, 2021; see also *Hobe*, Space Law, 2023.

¹⁸⁵ For rationale see IADC Statement on Large Constellations of Satellites in Low Earth Orbit (Rev. 3); NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

¹⁸⁶ *Ibid.*



The aforementioned information demonstrates the mechanics and restrictions of STC.

1.2. Conjunction Assessment and Identification of Critical Conjunction Events

Collision avoidance in space traffic begins with an evaluation of a possible conjunction event between two or more space objects.¹⁸⁷ This involves a level of pro-activity and vigilance from the operators (in their own self-interest) as well as SSA and SST providers (or their subcontractors). When the evaluation exceeds a certain acceptable risk threshold, one of the objects should take evasive action to change course and mitigate the risk of collision predicted by the conjunction assessment. At present this risk threshold is normally set at 1 in 10.000 chance of collision between two objects in orbit. Normally these encounters are notified with advance notice. In the event of ESA and SpaceX incident, the US network notified both stakeholders one week in advance. Following initial response, however, SpaceX ceased communication despite numerous ESA attempts to re-initiate contact, ultimately forcing ESA to conduct a unilateral manoeuvre of its Aeolus satellite without knowing whether SpaceX had enacted a manoeuvre or had on-board technology that would self-execute a manoeuvre. Following the event, SpaceX communication break-down was ascribed to an issue in SpaceX communication system and lack of knowledge¹⁸⁸, e.g. unclear communication and decision-making structure within SpaceX. Many nations and operators today do not have an entity or “point of contact” that would be clearly designated to manage conjunction situations and take the necessary decisions in such situations, for example in instances of manoeuvring or changing of orbits being required. This results in crucial time-loss (ESA-SpaceX example) or complete inaction (Iridium 33 – Cosmos2251 example).¹⁸⁹ In the mentioned case of ESA-SpaceX, unilateral action resolved the situation, however, unilateral action, cannot and should not become the norm as one satellite could malfunction, or not have manoeuvrability capabilities, in which case the unresponsiveness of the second operator could

¹⁸⁷ Technologies enabling conjunction analysis and collision avoidance may develop in future and with these the manner of their assessment, see e.g. *Dreyer et al.*, Future improvements in conjunction assessment and collision avoidance using a combined laser tracking/nudging network, 8th European Conference on Space Debris, 2021; *Scharring/Rodmann/Riede*, Network performance analysis of laser-optical tracking for space situational awareness in the Lower Earth Orbit, Advanced Maui Optical and Space Surveillance Technologies Conference, 2019.

¹⁸⁸ At the time of the incident, SpaceX was a relatively “young” operator of space objects in-orbit and therefore new to STC. SpaceX STC has since then greatly improved and SpaceX regularly manoeuvres its Starlink satellites out of way of other space objects, following a relatively low risk threshold. SpaceX therefore presently presents a rather good example of pro-active information-sharing (e.g. transparency of maneuver plans, rather clear avoidance practice and pro-avoidance attitude).

¹⁸⁹ For more information on the cases see ESA, https://www.esa.int/Space_Safety/ESA_spacecraft_dodges_large_constellation; Secure World Foundation, 2009 Iridium-Cosmos Collision, 2010; *Johnson*, Collision of Iridium 33 and Cosmos 2251, 2013; *Mejia-Kaiser*, “Collision Course”, in: Proceedings of the 52th IISL Colloquium on the Law of Outer Space, Daejeon, 2009.



lead to catastrophic consequences that could perhaps have been avoided. With increasing orbital traffic such events cannot be repeated, especially with emergence of large constellations of satellites.¹⁹⁰

Once a critical conjunction has been identified, the operator of one object must contact the operator(s) of the other object(s) and evasive actions coordinated. In other words, it is imperative that space object operators remain vigilant and pro-active and communicate with one another. Communication is key in STC and STM, whereby emphasis is placed on operators who have the actual ability to influence the space object in question and perform collision avoidance. This is applicable to both space operations in-orbit as well as launch operations that transcend airspace and only temporarily utilise outer space for purposes of orbital insertion and/or re-entry¹⁹¹.

2. Space Traffic Coordination Process

The Guideline begins with outlining and emphasising that STC on an international level is required to ensure safety of space operations. The Guideline is then divided into three similar blocks: 2.1.) operator coordination, 2.2.) information sharing and 2.3.) collision avoidance measures including priorities.

2.1. Operator coordination

The first block addresses the necessity of inter-operator coordination. Any collision avoidance measures must first and foremost be effective. This can only be achieved when real and actual communication and coordination between operators, i.e. persons and entities with the actual ability to affect a space object, is actively taking place. For this it is not only necessary to keep updated on the status of one's own space object, its operational status, telemetry, ephemeris and orbital position, but to keep informed about possible conjunction events with other objects. Once a possible conjunction event has thus been identified, operators must enter into contact with one another and coordinate possible action. Coordination is crucial as unilateral action of one or both operators of the respective space objects may in effect heighten the collision probability.

The ensuing communication process is divided into three further points illustrated by the three subparagraphs of the Guideline's first point. To ensure effective operator coordination, all operators should designate a point of contact responsible for taking decisions regarding the space object (2.1.1.),

¹⁹⁰ The Starlink constellations is already straining the current capacities of space object operators and ad hoc STC. In many instances, STC involving Starlink is succeeding due to pro-activeness of SpaceX. However, with announcements of further large constellations, e.g. by China, such *ad hoc* STC and reliability on the willingness and ability of operator of the large constellations does not present a reliable and sustainable option.

¹⁹¹ This includes non-orbital (also known as sub-orbital) spaceflight activities.



should in advance establish procedures and channels for timely responses (2.1.2.) and should share and discuss collision minimisation measures, including determination of a risk threshold (2.1.3.).

2.1.1. Point of Contact

Space objects operators must be able to identify one another. Identification requires *firstly*, a level of transparency with regard to which operator operators a certain space object and *secondly*, that operators have a point of contact in place so that they can easily be contacted once they have been identified.¹⁹² Space object operators should therefore appoint and publicly display (a.) a 24/7 available point of contact (b.), aware of proper terminology in and good knowledge of English or with translational services on-hand (c.). The point of contact must furthermore have the authority to perform STC (d.).

a.) Displaying the Point of Contact

The point of contact information should be displayed in a manner that enables public identification, so that the operator can be contacted once their object has been identified as being on a possible collision course. Several options remain open to operators and should be considered, such as displaying the contact point on a public electronic site or sharing the information with the UNOOSA. Information about the point of contact must be kept up-to-date. The aforementioned is in the interest of all, including the operator, and is supported in existing space law, especially Articles I, VIII, IX and XI of the OST, and Article IV of the REG, as well as State practice. For example, within the framework of the implementation of LTS Guidelines, nations were requested by UNOOSA to inform about a national entity, available and operating 24/7, in order to interoperate and exchange information on anomalies in space. Therefore, a procedure exists, in a short- or medium-term view, where and how nations can exchange basic information on hazardous situation in outer space. It is a first step regarding interoperability of nations and their respective entities regarding space safety.

Ideally in future, information on the points of contact could be routinely shared. For example, embassies around the world keep a list of active ambassadors that is routinely updated, doublechecked and shared with other embassies.¹⁹³ In analogy, a national, regional or (ideally) global list could be maintained by States, associations of operators or association of States, or by the UNOOSA, and routinely updated, e.g. on a half-year or one-year basis. On a national level, a national list could be maintained by a national point of contact for space activities (e.g. the space authority in the respective

¹⁹² See e.g. also Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022.

¹⁹³ See e.g. <https://afsa.org/list-ambassadorial-appointments>; <https://2009-2017.state.gov/s/cpr/rls/c23721.htm>.



State)¹⁹⁴. Considering that State authorities responsible for outer space affairs may nonetheless not possess the necessary processing and responsiveness speed, it should be considered entrusting or sharing such national lists with SSA providers, e.g. EU SST or US SSN, since these entities are already involved in the STC process.¹⁹⁵ National lists could furthermore be shared with the UNOOSA, to store and provide information when valid legal interest is presented.¹⁹⁶ Operators should then contact the holder of the national lists and receive the necessary information. Since it is the responsibility of the State (Article VI of the OST) to translate international obligations into domestic, binding on non-governmental actors, it is recommended that the State should in any case include the requirements to designate the operator's point of contact within national licencing systems and procedures.¹⁹⁷ On a global level, the list could resemble the UN Index of Objects Launched into Outer Space maintained by UNOOSA. A similar list on space objects is already being maintained by the UNOOSA, however, updates are in the discretion of States, with UNOOSA occasionally issuing a circular asking that the information be updated. This present UNOOSA Database is, however, not meant to include operator details, only national focal points, while operator details could be included in Registration Submissions.¹⁹⁸ In future, it could even be imagined that in addition to the existing UN database, information on operators, their points of contact as well as SSA information, could be maintained and kept within a STM dedicated body.¹⁹⁹ Initially, the UNOOSA database could be utilised with the ultimate goal being that a dedicated body is developed and the relevant information regularly updated in it by personnel and relevant stakeholders.

b.) Around the Clock Availability

¹⁹⁴ In practice, different entities are responsible for administration of space activity in different States. In some, a department of a Ministry is made responsible, in others the national space agency administers such tasks as authorization and supervision of space activity of non-governmental entities. For an analysis see Lex Ad Astra; Wheeler (ed.); von der Dunk (ed.).

¹⁹⁵ See also Commentary on Communication System and International Technical Advisory Body Guideline.

¹⁹⁶ As noted, contacting State authorities or UNOOSA for purposes of STC may nonetheless not be ideal. At present, many State authorities and UNOOSA do not have capacities in place to respond with the speedy responsiveness desired for STM. Therefore, at the moment these options should be viewed as a secondary or supplementary option because it would be an indirect method of identification and would prolong the process, e.g. operators would need to identify and contact first the national point of contact and then the operator's point of contact. However, especially in instances of national State authorities responsible for outer space affairs, it may be possible to develop the requisite response times. For example, if these lists were shared or entrusted with SST providers, e.g. EU SST or US SSN, the timeliness would be improved and is expected to suffice STM requirements.

¹⁹⁷ For more see Guideline on Non-Governmental Space Activities and Associated Commentary.

¹⁹⁸ States are encouraged to report regularly and in a timely manner to aid in STC (for more see Guidelines on Information Acquisition and Dissemination as well as on Registration).

¹⁹⁹ Explained in further detail in the Guideline on Communication System and International Technical Advisory Body and its associated Commentary.



Logically, to ensure responsive, the point of contact must be available 24/7. The foregoing means that the operator point of contact must be willing and able to respond immediately and fully. Operators are often legal persons, whereby the point of contact will need to be a natural persons or multiple natural persons who work in shifts in analogy to air traffic controllers in ATM. These natural persons may be on-site of the control and command facility or elsewhere as long as they remain available and ensure same level of responsiveness, including the ability to reach the control and command facility in due time to perform the manoeuvre, should it be deemed by the two or more involved operators that action is necessary, in analogy to medical personnel on-call. Especially for smaller operators, the latter option might present a more viable alternative.

In future STC might be undertaken by ways of automatisisation, dispensing with the human factor, however, before this becomes a viable option, systematic procedures, risk thresholds and priorities will need to be determined to a sufficient degree of reliability. However, even in such cases, the human factor should not entirely be dispensed with, especially not in the early stages of automatisisation, and should retain a level of human oversight to assure proper functioning, therefore even in instances of automatization an “on-call” point of contact is advised for instances of malfunction or other difficulties.

The aforementioned is primary aimed at operators of space objects with active manoeuvrability capabilities. Operators of space objects with only passive manoeuvrability capabilities should nonetheless also remain reachable at any point in order to clarify their object’s capabilities, options and built-in collision avoidance measures included and considered during the development and design phase and/or mission planning phase. Alternatively, these operators must assure the aforementioned by other appropriate means capable of achieving the same result, e.g. ensure that the capabilities and characteristics of their space objects are known for purposes of STC.

c.) Terminology

Operators point of contact should be aware of proper terminology. This includes remaining abreast of the proper terminology as terminology evolves. Use of the English language is advised in analogy to lessons learned from ATM. Alternatively, translational services should be assured, whether on-call or otherwise available on-site around the clock with the point of contact.



In instances of automatisisation or relying on translation technology,²⁰⁰ reliability of utilised information technology should be assured, including potential use of artificial intelligence and its source material. Presently many of the aforementioned systems are still fraught with issues and difficulties, therefore complete reliance on these is inadvisable, or at least should be compensated through announcement of which systems are being utilised and/or agreement regarding acceptable and reliable systems.²⁰¹

d.) Authority to Perform STC

The operator point of contact should be empowered and obligated (e.g. clearly designated as responsible) to take the decision on whether a space object should take evasive manoeuvres or keep on course.²⁰² This moreover includes the authority and ability to share any necessary information that will help avoid a collision event.

This indicates the necessity for clear “command” structures within the operator’s entity. Clarity with regard to who is responsible for making STC decisions and who is responsible to provide necessary information input so that an informed decision can be taken.²⁰³ To help with these decisions, internal procedures, especially risk thresholds should be determined. The aforementioned will greatly help improve responsiveness and reliability of inter-operator communication and coordination. Internal procedures should furthermore include contingency possibilities and plans, including emergency contacts and scenarios, so that operator personnel can react and respond immediately without the need to seek approval or otherwise consult, calculate or perform other action costing time. This is supported by experience from ATM.²⁰⁴

Ideally the point of contact who contacts another operator or the point of contact who is contacted by another operator should have the decision-taking power. If the point of contact does not have this authority, then the point of contact must be in a position to promptly and without delay, contact the person who has the decision-taking authority, who must then logically likewise be reachable at all

²⁰⁰ Today numerous websites and apps offer translational services, e.g. Lingua, DeepL, Google Translate as well as some AI supported systems. However, their reliability and quality differ and is not without flaw.

²⁰¹ For example discussed and shared as proposed in the last paragraph of the first block of STC Guideline.

²⁰² See e.g. *Flohrer*, Due regard and the need for space traffic coordination, 2025.

²⁰³ In practice, operators of two manoeuvrable objects, who should perform an avoidance manoeuvre, often do not take action due to neither knowing which one is required to take action or whether they are permitted to take action. This inclination toward inactiveness is strengthened by the fact that every additional manoeuvre in outer space is costly and takes a toll on the space object (e.g. fuel) therefore fear of consequences (economic as well as legal, in terms of liability and responsibility) in the event that an action would go awry often leads operators to inaction and an inclination to pass the responsibility to someone else in absence of clear instructions.

²⁰⁴ See Annex on Air Law for more information.



times to assure effective STC. (In instances of automatization these eventualities must be foreseen and planned for, e.g. programmed in.) The timeliness of these actions is crucial in space traffic as events can occur quickly due to high orbital velocity.

In conclusion, a simple and clear structure within the operator's infrastructure, easily available information about the point of contact and responsiveness should be the guiding forces for every space object operator as this is in their self-interest as well as the interest of other stakeholders, including investors and overseeing States.

2.1.2. Coordination procedures and communication channels

Coordination can only be achieved through swift and effective communication. Building on this, the block continued to elaborate that operators should establish procedures (a.) and proper channels of communication (b.) to enable timely STC.²⁰⁵ In practice, due to the different evaluation methods and technologies, operators may disagree on the probability of collision.²⁰⁶

a.) Procedures

Procedures should include as already specified, a clear responsibilities structure, determination of internal risk thresholds and contingency planning (including chain of command as well as emergency scenarios). As noted, unilateral action should be avoided as it may in fact increase risk of collision. However, in instances, where one operator nonetheless does not react or cannot be reached, unilateral action will still be necessary. In those instances, operators of objects in an evaluated higher orbital plane should manoeuvre up (into higher orbital position) and operators of objects in lower orbital plane should manoeuvre down (into lower orbital position).

b.) Communication channels

Communication channels must be reliable.²⁰⁷ Once a point of contact has been identified, efficient communication channels should be utilised for seamless coordination. Presently no such procedures

²⁰⁵ In analogy see also *Blount/Hofmann* (eds.), *Space Law in A Networked World*, 2023.

²⁰⁶ See inter alia *Merz/Bastida Virgili/Braun*, Risk reduction and collision risk thresholds for missions operated at ESA, 18th Australian Aerospace Congress, 24-28 February 2019, Melbourne; *Sweetser et al.*, "Quantitative assessment of a threshold for risk mitigation actions", *Journal of Space Safety Engineering*, Vol. 7, No. 3, 2020; *Lacomba et al.*, Collision risk handling at regulatory level, the example of the French space operations act, *Journal of Space Safety Engineering*, 2025.

²⁰⁷ See also *Guideline on Cyber Security and associated Commentary*.



or internationally agreed methods of communication exist. Therefore, the Guideline proposes establishments of such, beginning at operator²⁰⁸ level and (ideally) eventually discussed and determined at international²⁰⁹ level. The necessity for such is highlighted by the mentioned ESA/SpaceX close encounter, where breakdown in SpaceX communication link and lack of clear structure and knowledge on responsibilities of SpaceX, forced ESA to perform unilateral manoeuvre without information from SpaceX.

The reaction/response from the point of contact must be immediate. An approximation of the “red telephone” is required for this type of alerts/communication. In further analogy to ATM radio frequencies could be used or an electronic platform like the one used by ICAO for NOTAMs developed at operator, national, regional or international level.²¹⁰ Emails are unreliable (e.g. can be slow, can land in spam, go unseen/unnoticed or simply unanswered for longer periods of time), as confirmed by the mentioned ESA/SpaceX close encounter, and should not be solely relied upon.²¹¹ A different type of electronic communication would nonetheless be feasible as long as it would ensure efficiency to quickly and reliably transmit the relevant detailed information, alerting the receiver. These options could be software solutions whereby software makes certain that immediate alerts are distributed and reacted on. This would require that all operators agree to one software or at least that multiple software are able to interact. It should furthermore not be discounted that a specific technological solution not yet viable might present itself in future.²¹² A combination of aforementioned methods is also feasible and recommendable. Nonetheless, the human factor should not be forgotten or disregarded, and the phone option should take priority with software presently presenting excellent supplementary means.²¹³

The importance of efficient communication and coordination should not be underestimated. For instance, in fairly straight simple coordination of maritime traffic where the ships’ Captains are able to see the incoming ship and coordinate by sight, contact, communication and active coordination with

²⁰⁸ See above point on Point of Contact, subtitle Authority to Decide.

²⁰⁹ See Commentary on Communication System and International Technical Advisory Body Guideline.

²¹⁰ For more information see Annex on Air Law and Air Traffic Management.

²¹¹ Emails still present a viable supplementary tool.

²¹² For one option see also the Guideline on Communication System and International Technical Advisory Body and associated Commentary.

²¹³ For the importance of sharing information and the insight into which information might present as most relevant e.g. information on your object, orbital parameters, see also the Guideline on Information Acquisition and Dissemination and its associated Commentary.



the other ship is still required even in events of simple collision avoidance manoeuvres.²¹⁴ The same is true of ATM.²¹⁵ Even in instances of automatised collision avoidance or avoidance by sight by the aircraft's pilot, constant communication with the air traffic controllers is standard practice.²¹⁶

2.1.3. Collision minimisation measures

The third paragraph of the first part aims at encouraging innovation and cooperation in developing and systematising operator-level approaches into national, regional and eventually international standards. This has been identified as especially important in three aspects: a.) Risk thresholds that trigger a collision avoidance manoeuvre, b.) terminology and space traffic priorities (which will be discussed in more detail below). The aim of the last subparagraph is to encourage systematisation of STC and a build-up of an international STM in a bottom-up approach to maximise response times of operators and counteract any fragmentation processes taking place as STC and STM approaches are developed at national and regional level.²¹⁷ Such practices serve to identify and upgrade best practices, counteracting competing approaches that could result in higher collision risk.

a.) Risk thresholds that trigger a collision avoidance manoeuvre

In practice, due to the different evaluation methods and technologies, operators often disagree on the probability of collision, therefore, operators should share and discuss their approaches to determining the likelihood of a collision between their space object and an approaching object, including risk determination and threshold to trigger a collision avoidance manoeuvre.²¹⁸ As noted, operators should internally determine risk thresholds to streamline decisions on STC. As technology evolves these are likely to change.

²¹⁴ See e.g. the International Regulations for the Prevention of Collisions at Sea (COLREGs), published by the International Maritime Organization. See inter alia also *Frandsen*, *Space Traffic Regulation*, 2023; Pejović, *International Maritime Law and Practice*, Routledge, Oxon, 2025.

²¹⁵ See Annex on Air Law and Air Traffic Management.

²¹⁶ For more information see Annex on Air Law and Air Traffic Management.

²¹⁷ For challenges of fragmentation see UN/ILC, *Fragmentation of International Law* (report), UN Doc. A/CN.4/L.682 and Add.1*, 13 April 2006. Fragmentation may also occur in financial frameworks and may impact the space sector (World Economic Forum, *Navigating Global Financial System Fragmentation*, 2025.) Presently, the space industry is valued at around 384B\$ (BryceTech, *2022 Global Space Economy at a Glance*, 2022); with projections estimating growth (StanleyMorgan, accessible at: <https://www.morganstanley.com/Themes/global-space-economy>) and increasing private investment (ESPI, *ESPI Report 91 – Space Venture Europe 2023, 2024*).

²¹⁸ See e.g. NASA *Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook*; The Space Safety Coalition, *Best Practices for the Sustainability of Space Operations* (undersigned by several NSAs), 2023; ESPI, *ESPI Report 71 - Towards a European Approach to Space Traffic Management*, 2020; EU STM, *EU STM Final Report: Space Traffic Management for XXI Century Space Operations*, DO3_D13, 2022; Iridium/OneWeb/SpaceX facilitated by AIAA, *Satellite Orbital Safety Best Practices*, 2022.



b.) Terminology

Common and standard terminology should be developed through practice or governance instruments at national, regional or international level.²¹⁹ Practice in the space sector has so far noted difficulties with terminology and language, leading to uncertainties whether the two operators truly understand each other. Development of an international standardisation at a technical level is advised.²²⁰

2.2. Information sharing

The second block aids the first by clarifying that SST information providers, whether governmental or non-governmental, should provide information to operators covering collision avoidance, re-entry and fragmentation analyses.

In some jurisdictions these analyses will be offered by initial SST provider (e.g. EU SST), while in others, the initial SST provider will only provide information with which the analyses can be performed and a secondary entity or the operator itself, will perform the actual analysis.²²¹ This is why the Guideline text utilises the term “SST information provider” to encompass both the initial SST services as well as other service providers that perform analyses or other services useful to STM.

Which information should be provided in the scope of the collision avoidance, re-entry and fragmentation analyses, is likely to change or be complemented in future depending on available technology and should therefore be in line with best practices at the time of application, with periodic reviews

²¹⁹ As noted, use of English is desired as exemplified and supported in experience from communication in ATM. Alternatively, translation services should be part of the point of contact.

²²⁰ Some of the most elemental considerations are indicated in the definitions section of the Cologne Manual. Further terminology should be developed at an operational level as such may be subject to quick and unforeseen change as technology develops.

²²¹ In the USA these tasks are frequently performed by commercial entities (e.g. LeoLabs; Keyhan Space) relying on raw information provided by USSTRATCOM, while in EU the EU SST (or ESA Space Debris Office) often performs these tasks, itself or via use of subcontractors. This may furthermore vary across jurisdictions depending on SSA capabilities as well as international cooperative structures in place. According to the ESA, ESA’s Annual Space Environment Report, 2025, the information relied upon have been provided by USSTRATCOM, JSC Vimpel Interstate Corporation and Keldysh Institute of Applied Mathematics (KIAM), and the Royal Aircraft Establishment (RAE) Tables of artificial satellites, while orbital information was gleaned from DISCOS Database (Database and Information System Characterising Objects in Space) with classification of active inactive status of payloads relying on T.S: Kelso, Celes Track and Union of Concerned Scientists (UCS) database. This illustrates the complex and often varied sources utilised by space actors to ascertain the necessary information and expertise.



performed to ascertain whether these are still appropriate.²²² The latter is in line with practice in quickly evolving fields such as outer space, cyber and artificial intelligence.²²³

Lastly, noting that commercial entities cannot be required to provide these services free-of-charge, a duty of non-discrimination normally already binds commercial entities via national legal frameworks, meaning they must provide services on a fair market price to any interested parties. It should be noted that majority services providers would prefer to work together therefore a permissive framework should be enabled as long as a monopoly that would negatively impact STC is not created.

2.3. Collision avoidance measures including priorities

The third block builds on the first, recognising that it is often unclarity or confusion on part of operators, especially emerging or first-time operators, that prevent swift and seamless action. It begins by emphasising that operators of space objects should respond to critical conjunction warnings with appropriate collision avoidance measures. This means that having considered the first and second block i.e. having identified a close conjunction event and taken decision to take evasive action, operators should take appropriate collision avoidance manoeuvres. In order to ensure such and their effectiveness, States should consider establishing an internationally agreed standard of priorities.²²⁴ The Guideline thereby recognises that for efficient management of any traffic, including space traffic, it is necessary to adopt right of way rules or priorities.

Priorities are hereby to be understood as the right to decide which object should remain on-course and which should take evasive action. To illustrate on an example, in the event of a non-crewed space object on a collision course with the crewed International Space Station (ISS), it may be deemed safer and more efficient that the ISS take evasive measures as it can be better controlled by on-board astronauts.²²⁵

²²² As noted, presently, collision avoidance information is understood as including a risk assessment of collision between space objects or space object and debris pieces or fragments and the generation of collision avoidance alerts. This information should also be provided for Launch and Early Orbit (LEOP) as well as End of Life (EOL) phases. Re-entry analysis information is presently understood as including a risk assessment of uncontrolled re-entry of space objects into the atmosphere, while fragmentation analysis information includes information on in-orbit fragmentations, break-ups of space objects or collisions. In future, these analyses may change as technology evolves.

²²³ See e.g. *Blount/Hofmann* (eds.), *Space Law in a Networked World*, Brill/Nijhoff Publishers, Leiden, 2023; Tallinn Manual.

²²⁴ See e.g. *Frandsen*, *Space Traffic Regulation*, 2023.

²²⁵ State practice illustrates that the ISS regularly adjusts course to manoeuvre out of the way of incoming debris or other objects. See e.g. Liu et al., “Maneuver strategies of Starlink satellite based on SpaceX-released ephemeris”, *Advances in Space Research*, Vol. 74, No. 7, 2024; AIAA, *Collision Avoidance Maneuvers by Starlink Satellites Increases Exponentially*, 2023, accessible at <https://aiaa.org/2023/07/07/collision-avoidance-maneuvers-by-starlink-satellites-increasing-exponentially/>.



Technical and practical categorisation is generally permitted via Article I of the OST.²²⁶ Partly this is due to its permissive nature, seeking rather to enable space activities rather than restrict them, and partly due to the correlation freedom of exploration and use and the required orbital maintenance to enable the technical possibility of the legal freedom of usability.²²⁷ Prioritising space traffic will be necessary to streamline and systematise STC. Thereby, it should be kept in mind that in the future many of these decisions may be in whole or in part taken by automated collision avoidance, however, this does not mean that developing priorities is not necessary. To the contrary, as exemplified by experiences in ATM, the human factor should not be disregarded. Priorities need to be agreed upon by humans and input into the automated system (e.g. programme, software, application, artificial intelligence).²²⁸

As mentioned, right of way is fairly straight-forward and simple in maritime traffic, where the ships' Captains are able to see the incoming ship and execute a manoeuvre by sight. Equally, air traffic management is relatively easy. Air traffic rules are detailed in Annex 2 to the Chicago Convention and air law determines that each of the incoming aircraft shall adjust course to the right. Equally, road traffic normally abides by priority to the right (with exception of countries who have right of way to the left). None of the aforementioned options are possible in space traffic due to the different orbital mechanics that disable sight and identification of right, left, up and down.

To assist States and operators in this task and considering the constraints of orbital mechanics mentioned in the introduction, the Guideline proposes minimal priorities that should be followed and that arise logically and are supported by existing space law as well as State and industry practice. (Several factors have considered for determination of priorities, however, all faced significant challenges either due to geopolitical considerations or due to orbital mechanics.²²⁹) The Guideline divides the priorities into two categories. The first is conjunction between a manoeuvrable object and one or more

²²⁶ For analysis see *Hobe*, "Article I", 29; *Hobe*, *Space Law*, 2023.

²²⁷ See e.g. *Hobe*, Article I, in *COCOSL Vol. I*.

²²⁸ In ATM, for example, collision avoidance is the combination of Right-of-Way-Rules as contained in Annex 2 of the Chicago Convention and the Airborne collision avoidance system (ACAS) that executes these.

²²⁹ Several factors have been considered, such as identity of the operator, space object characteristics, mission objective or a calculation of different indicators, including use of artificial intelligence by space object, orbital parameters, whether one operators is more experience or in a position that makes a manoeuvre easier to undertake, reliability of safety procedures, "costs" for propellant and loss of operational time, risks to third objects, economic factors (e.g. for which object the manoeuvre is less costly or whether the operator is commercial or non-profit), etc. However, all of the aforementioned would require international agreement, which either for purposes of geo-politics or difficulties in performing these evaluations or determining the characteristics of object, mission or operator have proven difficult, impractical and unlikely to succeed. Majority traffic regulations rely on simple instructions that can be taken quickly, if not instantly. For such calculations to be a viable basis, the conjunction alerts would need to be sufficiently advance (as in the case of ESA/SpaceX where the alert was issued ten days in advance of projected encounter) or would need to be able to be carried out quickly. For more information see *Space traffic coordination challenges*.



non-maneuvrable objects (including space debris) (2.3.1.). The second is conjunction between two or more manoeuvrable objects (2.3.2.).

All remaining priorities should be agreed to by States and operators, in a type of bottom-up approach to STM (complemented by simultaneous attempts at top-down approach) by entering into agreements regarding priorities and collision avoidance measures (2.3.3.).

In spite of the aforementioned, situations may still arise where no priority has been pre-agreed and contact with the other operator(s) cannot be established, and unilateral action will be required. As noted, unilateral action should be avoided as it may in fact increase risk of collision, however, where one operator nonetheless does not react or cannot be reached, unilateral action will still be necessary. In those instances, operators of objects in an evaluated higher orbital plane should manoeuvre up (into an even higher orbital position) and operators of objects in an evaluated lower orbital plane should manoeuvre down (into an even lower orbital position).

2.3.1. Conjunctions with non-maneuvrable space objects

The Guideline clarifies that all non-maneuvrable objects, including e.g. non-maneuvrable space objects, space debris, fragments, parts thereof, dispensed launch vehicles or even natural objects, should in all instances be evaded via implementation of evasive manoeuvre if such is possible. While this may seem redundant, historical examples, such as that of the 2009 Iridium-33 collision with the in-active and un-controllable Kosmos-2251, exemplify that this simple dogma should and must be explicitly mentioned to clarify to operators that they are under an obligation to take evasive action.²³⁰ Taking evasive action is in the interest of the operator, owner and the international community at large as it is more cost effective than repairing or replacing active space objects and sanitizing the orbits of space debris.

2.3.2. Conjunctions with manoeuvrable space objects

The second category are conjunction events between two or more manoeuvrable objects. This is most closely associated to right of way rules or “rules of the road” as understood in terrestrial traffic. Therefore, these can be understood as *real* or *true* priorities.

²³⁰ See e.g. Secure World Foundation, 2009 Iridium-Cosmos Collision, 2010; *Johnson*, Collision of Iridium 33 and Cosmos 2251, 2013; *Mejia-Kaiser*, “Collision Course”, in: Proceedings of the 52th IISL Colloquium on the Law of Outer Space, Daejeon, 2009.



First priority should always be given to any malfunctioning objects (crewed or uncrewed) as their control and manoeuvrability may be impaired or at least compromised. Therefore, due to their unreliable control and evasive manoeuvre capability, these objects are effectively equalised with non-maneuvrable objects and should in analogy with non-maneuvrable objects (including space debris), be evaded.

Second priority should be granted to rescue missions (crewed or uncrewed) in analogy to terrestrial traffic, since these are on a mission to assist an object in distress and/or situation of necessity (crewed or non-crewed). Historical examples of space objects in distress include Apollo 13 and Salyut 7. In the case of the latter, a specifically designed/prepared mission to save Salyut 7 was sent to the rescue. The temporal and urgency elements are the crucial differentiating factor that set normal missions apart from rescue missions. Rescue mission should therefore not be understood as any normal in-orbit servicing mission or regular active debris removal mission, which do not work on basis of a heightened urgency and have had normal mission preparation time. This is again supported with analogy to terrestrial traffic, where ambulances can function either as a rescue vehicle that requires priority or as normal traffic participants, when enacting normal planned transport services. This prioritisation is furthermore supported by experience in ATM and air law.²³¹ In terms of distinguishing between these missions and normal in-orbit servicing missions, the temporal need element effectively determines when an “ambulance” is to be given priority and when not. Again, prompt and clear communication and coordination ultimately clarify and enable to carrying out of this priority.

Third priority should always be offered human spaceflight (crewed missions). The third priority therefore mandates that human (crewed) objects should be given priority over all non-human (non-crewed) normal (normally-functioning) missions and objects. Priority and special care for human (crewed) missions is evident in State practice as well as space law. For instance, it can be extrapolated from the customary right to life binding on all States and via national legal framework on all non-State actors, as well as other legal instruments emphasising the importance and sanctity of human life such as Article V of the OST, the provisions of the Rescue Agreement and Article 10 of the Moon Agreement. Furthermore, NASA Best Practices Handbook advises special attention must be paid to the ISS and other human (crewed) missions. Equally, China’s protests to the SpaceX Starlink manoeuvrability system posing risk to their space station have been issued to the UN. Both of these instances can be supported with references to space law, e.g. Article V which demands all assistance be provided

²³¹ For more information see Annex on Air Law and Air Traffic Management.



to astronauts and all instances that could pose a danger to them reported.²³² As of May 2025, the prime examples of such objects are the International Space Station as well as the Chinese Space Station Tiangong.

2.3.3. Agreements on priorities and collision avoidance measures

The Guideline concludes with encouraging States and operators, alike, to enter into agreements regarding space traffic priorities and other collision avoidance measures that help systematise the former and heighten the response time to conjunction events. This is already advised and performed in practice, for example in the USA by the NASA²³³ and exemplified by the Space Safety Agreements in place between NASA and SpaceX and NASA and AST Space Mobile, whereby the non-State actors agree to give priority to NASA assets, in particular the ISS.

In event of same-tier objects (e.g. manoeuvrable crewed object vs. manoeuvrable crewed object(s) or manoeuvrable non-crewed object vs. manoeuvrable non-crewed object(s)), it is advisable, evaluated as most viable and supported by State practice that operators communicate and establish collision avoidance plans as early as development and design phase or mission planning.²³⁴ With these agreements operators could determine concrete collision avoidance plans, including who has priority, could even alternate priority, agree on associated economic aspects, e.g. possibility of taking over part of manoeuvre costs, sharing costs, compensations schemes – whether financial or non-financial (e.g. manoeuvre for manoeuvre) – including liability questions for the eventuality of damage being caused by the manoeuvre.

Aware of the inherent danger of operators utilising non-manoevrable space objects as these must be evaded by the operator of the manoeuvrable space object, incentives for operators to design manoeuvrable objects and undertake evasive manoeuvres in events of possible conjunction events should be built into the agreements. The Guideline does not restrict the manufacture of space objects to only manoeuvrable, leaving space actors to freedom of whether to manufacture a manoeuvrable or non-manoevrable object, while at the same time incentivising the production of manoeuvrable objects,

²³² Precedent from practice is for example the China submission to the UN under Article V of the OST, indicating that the Starlink constellation as a "phenomenon (...) constituted dangers to the life or health of astronauts aboard the China Space Station" and reported two collision avoidance manoeuvres, see https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105/aac_1051262_0_html/AAC105_1262E.pdf. For an analysis of OST, Art. V see *von der Dunk/Goh*, "Article V", in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) Goh (assist.ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009. For notifications to the UN see also UNOOSA, accessible at <https://www.unoosa.org/oosa/en/treatyimplementation/ost-art-v/index.html>.

²³³ NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²³⁴ See also Guideline on Pre-launch Activities and Notifications and associated Commentary for more information.



which are in the interest of all. This decision was adopted to at the same time enable access to outer space for all while still focusing on and promoting best future technologies. The latter will become increasingly important as the numbers of active as well as inactive objects in-orbit continue to rise. In a scenario of only non-maneuvrable objects in a densely populated orbit, collision would become inescapable as illustrated by collisions between space debris, which is non-maneuvrable by default. Pre-launch mission planning and object design should mitigate collision risk for non-maneuvrable objects – for example avoiding placing such objects in orbits where systematic collision risk arises or agreeing to an orbital collision avoidance plan with other users of the selected orbit.²³⁵

IV. Future developments

In future, standardisation of collision avoidance measures is desired and indeed necessary. With rapidly increasing number of objects in orbit as well as the continued operation of large satellite constellations, ad hoc STC will become unreliable and insufficient.

At several instances the possibility of automatisation of the process of collision avoidance was discussed. While this is a very probable scenario, it serves primarily to remove the necessity for constant human vigilance over the STC and STM infrastructures²³⁶. It does, however, not remove the necessity to develop collision avoidance guidelines or plans, including priorities. Any automated system, even one employing artificial intelligence, needs to be programmed with the required priorities, collision avoidance plans and measures, and other relevant factors (e.g. SSA information).

STC is one of the most difficult and most complex topics of STM. Considering the geo-political as well as technical challenges (e.g. availability of reliable, secure and precise SSA) to STC a combination of a top-down and bottom-up approach is suggested to run simultaneously. STC standardisation should begin by evolving STC plans on a national operator-to-operator level, progressing to regional plans and finally to international plans. These plans can in the beginning remain restricted to a specific orbit with the goal of evolving plans for every orbit guiding the efforts. This process should simultaneously be supported by attempts to regulate STM in a top-down approach via adoption of governance instruments that establish clear instructions for operators and minimise obstacles in com-

²³⁵ For more information see the Guideline on Pre-Launch Activities and Notifications and associated Commentary.

²³⁶ On the concept of infrastructures within STM see also Guideline on Cyber Security and associated Commentary and Guideline on Communications System and International Technical Advisory Body and associated Commentary.



munication, information-sharing, cooperation and coordination. The final stage of the bottom-up approach to adoption of standardised international STC plans is evaluated as the most difficult and most likely to encounter geo-political push-back.²³⁷

Understanding, the current international affairs, national and regional bottom-up approach is evaluated as the most likely to succeed, with proposals for geo-political blocs building the first STM building blocks. For example, the previously mentioned Space Safety Agreements in place between NASA and SpaceX and NASA and AST Space Mobile by which NASA assets are given priority and other similar agreements could help build STM from the bottom up. However, this approach poses significant fragmentation dangers. As analysed by the International Law Commission, the coexistence of competing national or regional legal instruments and systems creates a danger of fragmenting international law and creating uncertainty. This should be avoided and uniformity is advised. This does not mean that national and regional initiatives should not be proposed and developed, but it is advised to account for similar initiatives and approaches taken and encourage standardisation and uniformity via negotiation, coordination and compromise. The latter has already been possible when the space law treaties were being drafted and it is the submission of the Cologne Manual that the same urgency exists on the international community now with regard to space traffic. Dangers of fragmentation should therefore be counteracted by e.g. accounting for other agreements of this kind, by following a similar or same international strategy or by other appropriate measures. The aforementioned is in the interest of all States and operators as well as humanity in general as the failure to regulate space traffic will eventually render certain orbital regions inaccessible, cutting humanity's access to space services in those orbital regions.

At this point it should be clarified that while geo-politics are able to promote national interests in a terrestrial setting without clear immediate danger, this will not be the case for outer space as orbital traffic increases. Up until now an *ad hoc* national approach was able to sustain orbital operations, however, in future with increasing numbers of objects in-orbit this will no longer be sufficient. Already at present the number of possible conjunction events has increased 40% in 2022 alone from an evaluated 1000 events in September 2017 to between 4000 and 5000 in September 2023.²³⁸ Even

²³⁷ See e.g. ESPI, ESPI Report 71 - Towards a European Approach to Space Traffic Management, 2020; EU STM, EU STM Final Report: Space Traffic Management for XXI Century Space Operations, DO3_D13, 2022.

²³⁸ ESA, ESA's Annual Space Environment Report, 2025; NASA, Conjunction Assessment Risk Analysis (CARA), accessible at: https://www.nsf.gov/attachments/308703/public/8_CARA_Overview_Alinda_Mashiku.pdf; IAA, Space Traffic Management: A Roadmap for Implementation, 2018. See also Campiti et al., Orbital kinematics of conjunction objects in Low-Earth Orbit and opportunities for autonomous observations, *Acta Astronautica*, Vol. 208, 2023;



so, launches are constantly increasing, delivering even more objects into orbit, exemplified by an increase from 18,000 catalogued objects in September 2017 to 28,000 catalogued objects in November 2023, from this an evaluated 2000 active satellites in 2018 to estimated 9000 in 2023.²³⁹ Experts evaluate space activity will continue to increase, reaching one trillion US Dollars by 2040. While this does not indicate a number of space objects, SpaceX alone predicts 52,000 Starlink satellites in orbit.²⁴⁰ STM is crucial to the safety of these objects and continuation of this and all other space activity.

In conclusions, however, at presents the STM needs establish the following recommendation that should gradually be implemented to form a comprehensive international STM system. Safety of space traffic has been closely linked to collision avoidance measures (e.g. identification of close encounters, conjunction analysis, efficient communication and coordination between operators). For these reasons pre-launch obligations of operators should be accepted, including an obligation to attain SSA data for pre-launch conjunction analysis and to issue a pre-launch notification. This recommendation is confirmed by State practice. For example, a duty to acquire SSA data, a duty to inform about scheduled launches and planned orbital manoeuvres and a duty to know or stay informed as to the status of space objects have been found to exist on States and operators as part of customary due diligence obligations. However, the established duties require unified recommendations on how these are to be done. Furthermore, operators should designate a point of contact, available 24/7 per telephone, and preferably capable of basic communication in English (alternatively translational services should be on-hand). Moreover, for collision avoidance measures the Manual should recommend adoption of international standards, and categories e.g. priorities between space objects akin to rules of the road, discussed below. Finally, for purposes of STM a separate (complimentary to the registration system established by the space law treaties) dynamic system e.g. “space object database” supported by SSA information, and contact information on operators, should be established. This system should further be augmented by the existence of a complimentary technical body tasked with gathering STM relevant information, as well as analysing and processing these, finally being able to

Moomey et al., *Trending and Analysis of Payload vs. All Low Earth Conjunction Data Messages below 1,000 km, from 2016 through 2021*, AMOS, 2022.

²³⁹ NASA, *Conjunction Assessment Risk Analysis (CARA)*, accessible at: https://www.nsf.gov/attachments/308703/public/8_CARA_Overview_Alinda_Mashiku.pdf; Statista, *Number of Satellites by Year*, accessible at: <https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/>.

²⁴⁰ Space Future, accessible at: <https://x.com/SpacesFuture/status/1893792011024576654>; Erwin, *Industry report demand for satellites is rising but not skyrocketing, 2023*, accessible at: <https://spacenews.com/industry-report-demand-for-satellites-is-rising-but-not-skyrocketing/>.



advise space object operators, owners, space activity licence holders, States and other relevant stakeholders upon request.

Commentary to Guideline 6 – Space Situational Awareness

States and non-state actors should cooperate at all times to acquire, collect, improve, validate and share SSA information to the extent necessary to ensure safe space operations. They are encouraged to cooperate, develop and further improve SSA capabilities and capacities, including monitoring and tracking capabilities. It is in the interest of the international community to make SSA information available and accessible to the maximum extent possible and practicable.

Space actors should aim towards the establishment of a worldwide SSA information base including information about critical conjunctions, orbital traffic, space weather, and the risk of an operation. Until a global information base is established, space actors – including governmental and non-governmental – owners and operators should cooperate and share SSA information, building an international SSA network chain for the quick and efficient exchange of all necessary and vital information, including critical conjunctions alerts and analysis, orbital traffic, space weather, and the risk of an operation.

I. Introduction

Space Situational Awareness (SSA) is a critical component of all Space Programs.²⁴¹ It provides comprehensive knowledge and understanding of space hazards, thereby playing a vital role in maintaining the safety and security of economies, societies, and citizens who depend on space-based services for communication, navigation, and observational applications.²⁴² SSA is broadly defined as the understanding of the space environment, including the positions of space objects and relevant space weather information, primarily gathered through space surveillance and tracking of these objects.

SSA should not be confused with Space Surveillance and Tracking (SST) which consists of a network of sensors designed to monitor and track space objects, alongside processing capabilities that yield

²⁴¹ See e.g. EU STM, accessible at: https://defence--industry--space-ec-europa-eu.translate.goog/eu-space/space-traffic-management_en?_x_tr_sl=en&_x_tr_tl=sl&_x_tr_hl=sl&_x_tr_pto=sc; *Merz et al.*, Current collision avoidance service by ESA's space debris office. 7th European Conference on Space Debris, Proceedings of the conference, 2017; NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²⁴² EUSPA, SSA, accessible at: <https://www.euspa.europa.eu/eu-space-programme/ssa>.



data, information, and services concerning objects in Earth's orbit.²⁴³ It is essential to distinguish between SST and STC. SST focuses on detecting space debris, cataloguing debris objects, and predicting their orbits. Conversely, STC encompasses the technical means and operational procedures required to ensure safe operations within the space environment, particularly through the utilisation and sharing of SSA data as well as collision avoidance protocols.²⁴⁴ The monitoring of Near-Earth Objects (NEOs) is another critical function within SSA, enabling the assessment of the risk posed by natural space objects such as asteroids and comets.

SSA comprises both a physical dimension and a communications dimension. Notably, telecommunication traffic – such as spectrum deconfliction – must be addressed in relevant manuals since interference can lead to delays or unresponsiveness of physical objects in orbit. Thus, for SSA the ITU plays a vital role, too.

Any information regarding imminent collisions or close conjunctions, whether it relates to objects owned or directed by specific actors, should be promptly shared with all affected or relevant parties. Furthermore, the establishment of rules and standards for cyber systems that support SSA is imperative (see also the guideline concerning Cyber Security). SSA information bases are considered vital assets of the international community and should be legally protected under national legislation in all countries, and ideally at the international level. States should also agree to provide the necessary technical and other means of protection for SSA information bases located within their territories.

According to Article V of the OST, astronauts are regarded as envoys of humankind and should be afforded all possible assistance, including an obligation to share information regarding any circumstances that could affect their safety.²⁴⁵ This principle is further developed in the Rescue and Return Agreement. SSA should be seen as an important part in this process.²⁴⁶

Safety of space traffic has been closely linked to collision avoidance measures (e.g. identification of inappropriate (e.g. close) encounters, conjunction analysis, efficient communication and coordination

²⁴³ See e.g. EU Space Surveillance and Tracking, accessible at: https://defence-industry-space.ec.europa.eu/eu-space/ssa-europes-eyes-space/eu-space-surveillance-and-tracking_en. See also Andrisan et al., SST Analysis tool (SSTAN) supporting Space Surveillance and Tracking (SST) services assessment, 7th European Conference on Space Debris, 2017. Relatively recently a third term was introduced by the USA: Space Domain Awareness, focusing on identification, characterisation and understanding of any relevant passive or active factors that could affect space operation, in particular safety and security of national space assets, see jenaoptronik, Terminology: SST, SSA and SDA; *Erwin*, Air Force: SSA is no more; it's 'Space Domain Awareness', Spacenews.com, 2019.

²⁴⁴ For more see ESA, Space Safety, accessible at: https://www.esa.int/Space_Safety/Space_Surveillance_and_Tracking_-_SST_Segment.

²⁴⁵ For an analysis see *von der Dunk/Goh*, "Article V", 2009.

²⁴⁶ For more see *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist.ed.), *Cologne Commentary on Space Law: Vol. II*, Carl.Heymanns Verlag, Cologne, 2013.



between operators). For these reasons pre-launch obligations of operators should be accepted, including an obligation to attain SSA data for pre-launch conjunction analysis and to issue a pre-launch notification. This recommendation is confirmed by State practice and more elaborated in the Guidelines on Pre-launch Activities and Notification, Space Traffic Coordination and Information Acquisition and Dissemination.

(Annexed: Synopsis LTS implementation reports on guidelines B.1-B.5)

II. Structure of the Guideline

The Guideline emphasises two key aspects: the necessity for immediate cooperation in SSA and the long-term objective of establishing a global SSA information base.

In the first instance, it is essential to recognise that outer space represents a domain of collective interest; therefore, collaboration in the realm of SSA is fundamental to ensuring safe and efficient operations in this environment. As new space assets are developed, it is imperative to leverage contemporary research to enhance SSA capabilities.²⁴⁷ The data gathered through SSA initiatives should be shared widely, incorporating a transboundary technical system to bolster the validation of such information.

The second aspect of the Guideline envisions the construction of a worldwide SSA information base. A pertinent example of current cooperation can be drawn from the European Union Agency for the Space Programme (EUSPA). At present, over 200 organisations benefit from Space Surveillance and Tracking (SST) services—such as collision avoidance, re-entry analysis, and fragmentation analysis—facilitated by the EU SST Front Desk at EUSPA. This initiative has successfully safeguarded more than 500 satellites from potential collision risks.²⁴⁸ By promoting collaboration among the facilities and research centres of Member States, this subcomponent contributes to the development of a rapid response service capable of characterising newly detected NEOs.²⁴⁹ Additionally, Space Weather Events (SWE) necessitate the creation of models that assess the implications of various scenarios, thereby enhancing predictive capabilities. This leads to the establishment of a dedicated space weather service tailored to identify and address user needs.²⁵⁰

²⁴⁷ For a quick overview of present capabilities see Secure World Foundation, Space Situational Awareness Fact Sheet, 2024.

²⁴⁸ EUSPA, SSA, accessible at: <https://www.euspa.europa.eu/eu-space-programme/ssa>.

²⁴⁹ Ibid.

²⁵⁰ Ibid.



The term “space actors” encompasses both governmental and non-governmental entities engaged in space activities. The “necessary and vital information” refers not only to the examples provided in the Guideline but also to any data essential for ensuring the safe utilisation of outer space. Furthermore, for an effective SSA system, efficiency is paramount, and timely information exchange is crucial to allow for prompt reactions to emerging threats.

III. Rationale of the Guideline

The acquisition of information regarding close conjunctions, orbital traffic, space weather, and the risks associated with operations is essential for any orbital manoeuvre, orbital insertion, or transit through various orbital regimes. The significance of such information is underscored by the 2019 LTS Guidelines, which emphasise the necessity of being informed pre-launch, during pre-launch activities, and about the in-orbit situation to accurately predict possible outcomes. This can be achieved through the collection of Space Situational Awareness SSA information.

The serious repercussions of lacking SSA information prior to launch were exemplified by the 2013 incident involving Ecuador, which launched its first Pegasus satellite into a densely populated orbital region without any SSA data. This oversight resulted in the satellite's (assumed) destruction within minutes of attempting orbital insertion. SSA functions as a cognitive framework that supports both the short-term tactical and long-term strategic objectives of STM.

An increasing number of entities are collaborating to aggregate information from satellite owners and operators regarding the status of their assets. Additionally, there is a growing presence of private companies that supply SSA information and report on conjunction events. States with space assets lacking their own SSA capabilities should be mandated to procure such services to facilitate planned orbital corrections, maintain ongoing awareness of collision risks for their space objects, and obtain expert assessments for executing evasive manoeuvres. The credibility of the data used is of paramount importance, making the enhancement of SSA capabilities crucial to ensuring the reliability of SSA information. The risk of collisions in outer space due to faulty SSA data can only be mitigated through the establishment of a robust, internationally coordinated SSA system, achieved through cooperation among States and individual contracts.

The Guideline clarifies together with the Principle section of this Manual that States have an obligation to provide SSA systems and data, both pre-launch and pre-manoeuve in orbit, and to inform operators of available capabilities, such as a comprehensive list of SSA resources or informational



points where they can obtain relevant data. SSA systems can through conjunction assessments²⁵¹ identify potential collision threats and can therefore mitigate risks of collision.

Currently, a standard civilian ATM regime has been successfully developed with the support of ICAO and various regional organisations (e.g. the European Union Aviation Safety Agency (EASA) in the EU and the Federal Aviation Administration (FAA) in the USA). However, this system cannot be directly transposed to outer space due to significant differences in air and space law, as well as technical variances (for example, orbital mechanics differ markedly from aerodynamics; aircraft are piloted by individuals who can easily discern directional cues, whereas space objects are controlled remotely in an environment where directional orientation is less intuitive). Consequently, a new framework for space must be developed over the long term, tailored to the distinct needs and characteristics of outer space, its differing notions of sovereignty, and its potential to inform new national legislations that support cooperation in sharing SSA data.

At present, no singular international entity exists to provide SSA data or conduct evaluations of the hazards associated with activities or objects in space. While several institutions at the national level track and report on space objects and their real-time locations, as well as routinely assess hazardous activities (such as re-entries and endangered zones on Earth), no comprehensive international system is in place. Some of these national institutions offer information on publicly accessible websites regarding internationally relevant hazardous anomalies arising from space debris or man-made objects that pose risks to populations and the Earth's environment on various scales.

Examples of existing institutions include: European Space Surveillance and Tracking (EUSST), ESA Re-entry List, DISCOS Database, the Aerospace Corporation, LeoLabs, CelesTrak (TS Kelso), German SSA Centre, and United States Space Surveillance Network (US SSN).

To date, approximately 70 States have developed SSA capabilities or have at least initiated discussions or implemented regulations regarding SSA. (See Annex 2) However, a significant barrier to effective STM is the absence of a universally agreed data set available to all stakeholders, as well as a lack of verification mechanisms for the data.

It is evident from the information gathered that not all space actors possess SSA capabilities or have easy access to SSA information. Emerging space-faring nations, particularly developing countries,

²⁵¹ *Oltrogge/Cooper*, "Space Situational Awareness & Space Traffic Management", in *Madi/Sokolova* (eds.), *Space Debris Peril- Pathways to Opportunities*, 2021, pp. 20-21.



often experience detrimental consequences due to inadequate SSA data, leading to damage or destruction of satellites during orbital insertion in congested regions such as Low Earth Orbit (LEO). The availability of reliable and responsive SSA services is therefore critical for the success of STM. States and other actors lacking SSA capabilities should be mandated to procure SSA data from external providers, potentially through contractual arrangements, such as those available from EUSST, which are offered at no charge.

Given the significant value of SSA systems in ensuring STM and space traffic safety, it is recommended that these systems be recognised as a matter of international interest and afforded appropriate legal and technical protections. While international legislation would provide the most comprehensive safeguard, trends in space law suggest that enacting national legislation may be the most pragmatic avenue for achieving this goal. In drafting such legislation, it is advisable to employ open-ended language that allows for adaptability to rapid technological advancements. For instance, States could mandate that "SSA operators implement measures to prevent unauthorised access and to promptly notify relevant authorities of any unauthorised access to SSA systems." Additionally, a recommendation to "establish a safety plan to prevent unauthorised access and ensure timely notification of such events, in accordance with current industry best practices, with particular attention to the threat of cyberattacks," would help maintain the technical robustness of SSA systems.

States should be encouraged to collaborate in SSA efforts, share information, and establish a comprehensive information base to facilitate international cooperation. On a national level, States ought to clarify obligations for operators concerning information sharing, reporting, and quality control to ensure effective national cooperation. However, it should be taken into consideration, that definition of SSA information can vary as e.g. European countries like to include the environment as one variable while JAXA does not.

IV. Future developments

The development of technical capabilities in SSA is essential, particularly given the current over-reliance on radar systems in the Northern Hemisphere. To enhance this process, it is crucial to collect and disseminate data from diverse global sources. This approach aims to eliminate data 'dark spots,' thereby reducing the risk of collisions and mitigating the proliferation of space debris.

At present, conjunction analysis data are typically provided only a few days in advance, often within a timeframe of three to seven days. However, advancements in technology could expedite this process significantly, allowing for more timely and efficient data delivery.



In terms of capabilities, the establishment of an international SSA service is a desirable objective. For instance, the creation of a new entity dedicated to the collection, analysis, provision, and verification of SSA data could be proposed. Nevertheless, the realisation of such an initiative in the short term appears improbable. An alternative approach would be to foster a collaborative network of existing SSA providers. This would be facilitated by promoting cooperation and information sharing, ideally through the identification or establishment of a common platform. At a minimum, the existence of various SSA sources should be documented and communicated among both governmental and non-governmental entities.

An example of this could be the United Nations Office for Outer Space Affairs (UNOOSA) operating a comprehensive information base that catalogues available SSA capabilities and disseminates this information to States as part of its capacity-building initiatives. The Manual should advocate for capacity-building and educational efforts to be prioritised. On a national level, information could be shared through online governmental platforms detailing licensing processes. It is essential that commercial providers transparently communicate fair market prices, while organisations such as the European Space Surveillance and Tracking (EU SST) offer their information free of charge.

Moreover, developed countries should extend their support to developing nations in terms of capacity building. In this context, the expertise of the industry could be harnessed to establish standards for quality assurance in space situational data. Such initiatives would contribute to a more robust and cooperative global framework for space safety and sustainability.

Many of the aforementioned information bases are likely to be compiled in parallel with nearly the same data. This seems to be an unnecessary duplication of efforts and spending of resources, and could thus be presented as an argument for cooperation (at least on the level of States, if not also on the level of private SSA providers) – e.g. add the data together in one more complete set and avoid duplication of resources. This, however, raises the very basic question if the provision of SSA data should be a public service or a service to be offered on a profitable basis.

Finally, a question has been posed whether reliability of SSA providers is to be assessed. Ideally a central STM agency would set minimal international standards and assess the reliability of SSA providers. The Commentary section of the Guideline on Communication System and International Technical Body should be consulted for more information. At present, however, the Cologne Manual advises all stakeholders to focus on further development, improvement and coordination of SSA providers. At present, SSA systems lack both coverage (monitoring capabilities are presently limited to cc. objects larger than 5-10 cm in LEO and 0.3-1 m in GEO) and precision (when a conjunction is



reported the location of the object is speculative; in reality objects could be within an oblong “bubble” surrounding the reported location).²⁵² ESPI therefore concluded on whole that main issues for STM are 1) Technical Challenges (tracking and accuracy), 2) difficulties processing data into actionable information and 3) coordination between operators (e.g. no shared protocols for collision avoidance procedures – currently only ad hoc action which will not suffice in future as space traffic grows).²⁵³ The Cologne Manual therefore encourages further development including capacity-building and any necessary cooperation projects, especially to cover also the southern hemisphere, which is presently less covered than the northern hemisphere. This is in the interest of the entire international community to allow for a higher coverage and subsequently degree of safety. The latter presents an ideal catalyser for international cooperation and should be actively encouraged.

Commentary to Guideline 7 – Information Acquisition and Dissemination

Throughout all phases of space activity, operators:

- 1. should exchange and contribute information.**
- 2. should acquire space situational awareness information before becoming active and should share space situational awareness information.**
- 3. should stay informed of the status of their space objects and should inform the appropriate authority about any relevant changes regarding the space object, its operator or owner, and its status.**

All unforeseen events such as catastrophic events, large disposals, satellite transmission issues, and other special events that affect other space flight participants should be reported in a timely manner.

I. Introduction

In order for STC and STM to function, it is incumbent on space actors and all relevant stakeholders to acquire certain information, to gather certain information and to exchange this information with other space actors. While States have obligations under international law to acquire, gather and share some information as for example detailed in the OST or the REG, this Guideline focuses on operators,

²⁵² See ESPI, Towards a European Approach to Space Traffic Management (report).

²⁵³ See ESPI, Towards a European Approach to Space Traffic Management (report).



both governmental and non-governmental operators of space objects in-orbit and launch vehicles, in an effort to support and operationalise the remaining Guidelines of the Cologne Manual.

In this manner, it supports the Guideline on SSA and Pre-Launch Activities and Notifications. While the Guideline on SSA seeks to emphasise the importance of SSA and encourage its further evolution as well as capacity building measures to advance this objective, and the Guideline on Pre-Launch Activities and Notifications confirms the necessity of SSA information for STC, this Guideline declares that space object operators should acquire and disseminate information, in particular that they should acquire SSA information, gather operational information about their own space objects and share the aforementioned information as far as practicable and in a timely manner. The Guideline therefore focuses on SSA information as well as space object and operator information that is required for effective STM.

II. Structure of the Guideline

The Guideline is divided into five easy sentences. It begins with a simple clarification that information acquisition and dissemination should be observed throughout all phases of space activity. This is also clear from the Guideline on Pre-Launch Activities and Notifications and is a logical conclusion considering risks from and to space objects that continue through the entirety of a space activity's duration. The Guideline then stresses the importance of operators exchanging as well as contributing information. The rationale of these first two sentences is then clarified in the remaining three sentences, which explain in more detail which information should be acquired and disseminated throughout all phases of space activity: 1.) SSA information, 2.) Status of space object(s) and 3.) Information on unforeseen events.

1) Space situational awareness information

It has been ascertained that SSA²⁵⁴ is fundamental to the ability of space object operators to perform STC and thereby cooperate in STM. Operators must therefore acquire SSA information before beginning a space activity as well as disseminate that information in a timely manner.²⁵⁵

2) Status of space objects

²⁵⁴ For possible definitions see Commentary to the SSA Guideline.

²⁵⁵ Several governmental (e.g. EU SST, SpaceTrack) as well as non-governmental (Lockheed Martin, Atamax Space etc. – see Coherent Market Insights, Global Space Situational Awareness (SSA) Market Regional Insights, accessible at: <https://www.coherentmarketinsights.com/industry-reports/global-space-situational-awareness-market>) sources exist.



In order to facilitate STC and STM, as well as aid SSA, operators should keep track of the status of their space object(s).²⁵⁶ This includes orbital parameters, control ability, functionality as well as other relevant factors about the space object in-orbit.²⁵⁷ This includes reporting these to the relevant State authorities along with the identity of the operator and owner, and any subsequent changes to these.

In relation to orbital parameters and functionality of the space object: any relevant changes should be regularly shared with the chosen SSA provider, unless the operator possesses its own SSA capabilities.²⁵⁸ The Guideline on Pre-Launch Activities and Notifications and its associated commentary should be consulted for more information.

The aforementioned information includes but is not limited to: regularly updated ephemeris (e.g. Three times daily for heights less than 500 km, once daily for LEO, twice weekly for other orbits), basic construction and mission information (e.g. Deployable structures, satellite materials, rough dimensions, expected altitude, registered radio frequencies), overview of its orbital maintenance capabilities and strategy (e.g. manoeuvrability, technology used, burn duration (if applicable)), understanding of flight control and navigation paradigm (especially whether ground-based control in part or fully is an option, or does the object use autonomous controls, etc.) orbital parameters of the selected (parking) orbit, launch trajectory, potential launch or in-orbit control anomaly, trackability, laser use (if applicable), injection vector, spacecraft identification for cataloguing by established catalogues. The basis for required information is State practice e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

In relation to changes in identity of owner or operator of the space object: The relevant authorities should be identified on a case-to-case basis, but are discernible from existing State practice and national space laws as national space authorities, which should then inform the UN Secretary General via a diplomatic note (e.g. Note Verbale) in accordance with the Article IV of the REG. The latter is particularly important in instances of in-orbit transfers of ownerships.²⁵⁹ For the latter the Guideline on Registration and its associated commentary provide more information and should be consulted.

²⁵⁶ Several national space acts require operators to keep track of and periodically share with national space authorities the status of their in-orbit space object, see Annex on National Space Acts. See also *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5. See also NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²⁵⁷ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023; Iridium/OneWeb/SpaceX facilitated by AIAA, *Satellite Orbital Safety Best Practices*, 2022.

²⁵⁸ *Ibid.*

²⁵⁹ On-orbit transfers of ownership are a particular issue that touches on numerous legal and practical questions. For purposes of the Cologne Manual it suffices to say that numerous national space acts require private operators to inform



3) Unforeseen events

It has been evaluated that some events pose higher risk to space traffic than others and therefore fall in the special events category. These include controlled as well as uncontrolled events. Among the controlled events larger disposals or disposal of a large number of satellites at once, e.g. large satellite constellations, have been evaluated as likely and posing higher and varied risks to space traffic due to the larger number of satellites travelling normally in a single formation and may therefore require special planning and timely reporting. Among the uncontrolled events are such events as catastrophic events, loss of control events or transmission issues. These cannot be controlled or planned but should therefore be promptly reported in as much detail as possible. The language of the Guideline was left deliberately open to include any other events that may fall within this category.

III. Rationale of the Guideline

The rationale of the Guideline focuses on information. In order to perform STC and STM, space traffic participants, governmental as well as non-governmental, require certain information in order to decide whether certain action is required or not. Even in instances of automation, the necessity for information remains the same. Without information about space object operator, space object and surrounding space traffic, neither human nor machine can perform responsible STC to ensure safe conduct of space traffic.

Reviewing space law and general international law, duties of due regard to the corresponding interests of others were identified.²⁶⁰ Due regard is customarily (*inter alia*) satisfied through observance of a proper standard of care to minimise possibility of damage occurring.²⁶¹ The proper standard of care is ensured through adoption of due diligence measures, such as observance of appropriate technical guidelines or standards.²⁶² The Cologne Manual proposes several such measures to assure safe space

about any such events and in instances of transfers to a new State even require prior consent of the national space authority, see e.g. rzow

how Space Activities Act of 2022 or the French Space Operations Act, No. 2008-518. For a full analysis of national space acts see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5. For more information on on-orbit transfers of ownership see e.g. *Dasgupta*, “On-Orbit Transfer of Satellites between States”, in: *Blount/Moro-Aguillar/Masson-Zwaan/Schrogl*, *Proceedings of the International Institute of Space Law 2016*, Eleven International Publishing, The Hague, 2017. On the inter-connection of due regard and due diligence see *Foster*, *Global Regulatory Standards in Environmental and Health Disputes*, Oxford University Press, Oxford, 2021.

²⁶⁰ Art. IX of the OST.

²⁶¹ *Corfu Channel case*, Judgement of April 9th 1949, I.C.J. Reports 1949; *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, I.C.J. Reports 1996.

²⁶² *Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Reports 2010; *Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)* and *Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica)*, Judgement, I.C.J. Reports 2015.



operations. Majority of these either directly or indirectly depend on availability of reliable information. This Guideline therefore *firstly* confirms that space object operators, whether operators of objects in-orbit or launch operators, need to exchange and contribute information, especially SSA information, which they should acquire in a timely manner prior to begin of their space activity, as well as information on their own space object, e.g. its operational status, malfunctions etc. Such changes be detected, these must be reported to the appropriate authorities, which according to practice informed by Article VI of the OST and majority of existing national space acts, are national State space authorities. Finally, recognising that a major danger to space operations are unforeseen events, this Guideline iterates that information on any more impactful events such as malfunctions or (near-)simultaneous disposal of larger numbers of space objects (e.g. large constellation deorbiting or malfunctioning) should be disseminated.

In this manner, the Guideline actually identifies three distinct duties arising out of existing space law: Duty to Acquire (1.), Duty to Know (2.) and Duty to Inform (3.), which logically need to be observed throughout all phases of space activity by all actors. Detailed instructions on the three duties are not required and will not be specified herein as details might change with available technology.²⁶³ Therefore, the Cologne Manual restricts itself to describing information relevant to STC and STM should be acquired (e.g. SSA information), known (e.g. gathered by the operator or an entity or person entrusted by the operator to perform this task) and should be disseminated among the relevant stakeholders (e.g. those that could be impacted by the space object in question) for purposes of space safety and in line with the Rescue Agreement.) Alongside the preceding, discussions raised the question of who must be informed and when has been raised and answered. It will depend on the circumstances. In events transitioning airspace, ATM should be notified at minimum. For events on-orbit other space object operators are the logical conclusion. In the latter case either full transparency should be followed and a public notice issued, or in instances when this is not desired or realistic, SSA should be consulted to determine which objects are expected to be in the vicinity of the object planning a manoeuvre and its operators are to be notified in private. For more information on the proposal see Commentary to the Guideline on Space Traffic Coordination.

This should be observed by all space actors, building on the premise that if a State has the possibility to launch a space object into outer space (for example, by procuring the launch), it should also have

²⁶³ Space technology is quickly evolving, see e.g. the rise of laser application in space sector (*Scharring/Kästel*, “Can the orbital Debris Disease Be Cured Using Lasers?”, *Aerospace* 2023).



the obligation to avoid collisions and to mitigate the production of space debris to maintain orbits for future use.²⁶⁴ This is in the interest of all and therefore the obligation to acquire and evaluate SSA information prior to launch, during operations in orbit and prior re-entry to Earth should be recognised as obliging all States, developed and developing, as well as all non-state actors, regardless of capabilities (e.g. large commercial actors such as SpaceX as well as start-ups and universities), through means of national space acts and authorisation processes/licencing as well as supervision and control.

1. Duty to Acquire

Due to the importance of SSA information to space activity and safety of space traffic, operators must acquire SSA information before every launch, during operations in-orbit (including during removal into a graveyard orbit) and prior to re-entry. Operators without SSA capabilities must acquire SSA information from other providers, for example by contracting those services. This duty can be seen as part of wider due diligence obligations and due regard obligation from Article IX of the OST, as well as the LTS Guidelines (the B guidelines). Following analysis of State practice, this duty is presently focused on SSA as the pre-condition to responsible STC, especially since many actors do not themselves possess (sufficient) tracking and monitoring capabilities. Additionally, analysis revealed that some actors may not possess capacities (e.g. educated personnel) to perform STC. In those instances, STC services should likewise be acquired.²⁶⁵

States with the financial and technological and technical capabilities (e.g. qualified human capital, information technology systems, computing systems, artificial intelligence and know-how) should establish SSA capabilities/assets, and require its national actors, governmental and non-governmental, to use these. This is for example the practice of the USA.²⁶⁶ Non-governmental operators should be required to procure SSA data as part of the national authorisation process. This is in the interest of States, especially for their military and defence sector.

In absence of aforementioned capabilities, a duty to acquire such information and/or services from reliable sources prior to each launch as well as during the entire operation of an object, including end-of-life measures, exists on all space object operators (governmental and non-governmental). Several

²⁶⁴ See Uderlying Principles of the Cologne Manual - Working Group Sustainability. See also *Mejia-Kaiser*, *The Geo-Stationary Ring*, 2020; *Viikari*, *Environmental Element in Space Law*, Martinus Nijhoff, Leiden, 2008; *Foster*, *Due Regard for Future Generations?*, Cambridge University Press Online, 2024.

²⁶⁵ A further solution for this type of actor could be employment of educational measures to develop the necessary capabilities or development of an International Technical Advisory Body as specified in Guideline on Communication System and International Technical Advisory Body.

²⁶⁶ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.



SSA and STC services already exist.²⁶⁷ Various avenues are therefore open to operators without own SSA capabilities to acquire SSA information. The first model can be illustrated by an initiative of the US Department of Commerce and Department of Defense, where the SSA responsibility of the US military will be partially transferred to the Department of Commerce, releasing SSA services to the non-military space users. Support on USSPACECOM is already advised for all US operators.²⁶⁸ Furthermore, many international operators rely on the US tracking and monitoring network, e.g. Brazil. The second model could be illustrated as the so-called EU Space Situational Awareness Support Framework, an initiative where more than 180 organisations are gaining services regarding collision avoidance, fragmentation and re-entry from the EU-SST partnership.²⁶⁹ Those services are free of charge and globally accessible to operators worldwide.²⁷⁰ This could present an opportunity for countries and operators who do not have SSA capabilities.²⁷¹ The third model could be contracting private SSA services. For example, Mexico and some other countries have contracted with a Canadian company performing satellite manoeuvring.²⁷² In instances where these services are contracted from SSA information providers from another States, bilateral agreements, detailing *inter alia* provisions on State security and confidentiality if necessitated by vital State security concerns, should be concluded to this effect.

2. Duty to know

Under the duty to know, space object operators should actively gather information on the operational status of their space objects, in other words are required to stay informed on the qualities and operational status of their space objects. This includes, e.g. having information on their space object manoeuvrability capabilities and their operational functionality, on malfunctions in command and control, etc.

²⁶⁷ See the Commentary to the SSA Guideline and Guideline on STC.

²⁶⁸ As discernible from the NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²⁶⁹ For more see Guideline on SSA and associated Commentary. For an overview of SSA services see Secure World Foundation, Space Situational Awareness (Fact Sheet), 2024. For more on European capabilities see ESPI, ESPI Report 10, 2008.

²⁷⁰ EU SST, Services, accessible at: <https://www.eusst.eu/services/>.

²⁷¹ See e.g. FlyPix AI, Leading Space Domain Awareness Companies, 2024, accessible at: <https://flypix.ai/blog/space-domain-awareness-companies/>; ArianeGroup, accessible at: <https://ariane.group/en/news/boosting-space-surveillance-capabilities/>.

²⁷² Mexico initially carried out telecommunications but left the manoeuvring of the satellites in this position to a Canadian company. Presently, this is no longer carried out. The Mexican government made a large investment to build stations and train space object controllers.



This duty developed from various legal foundations, including Article IX of the OST, which confers on States a duty of due regard and cooperation, which is elaborated to include a duty of due diligence and thereby, it can be argued, of communicating known dangers.²⁷³ Supported by the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries²⁷⁴, this obligation of sharing is predicated on being aware, knowing of a certain danger. Furthermore, the duty of “continuing supervision” from Article VI of the OST, implies the same obligation. Article VI of the OST States that obligates States to continually supervise non-governmental space activity.²⁷⁵ In practice this has resulted in adoption of national space legislation, which often requires non-governmental operators to report to national space authorities any issues in control of space objects, any changes in space object status or mission status that could pose a danger, especially to human populations, or could impact State security or determination of the responsible States, such as for example changes in space object owner and/or operator, especially when such sales are transnational resulting in the new owner and/or operator being situated in another State.²⁷⁶ A further foundation is provided by Article IV of the REG, which requests provision of certain space object information to the Secretary General of the UN. Moreover, foundation can be extrapolated from customary due diligence obligations as well as general principles of law, known to all national legal systems and applicable to outer space through Article III of the OST, e.g. due care/due diligence/good administration/etc. that are normally imposed and enforced by States in an effort to satisfy their own aforementioned international obligation. Therefore, it can be confirmed that both under space law as well as general international law, a duty to actively stay informed – a duty to know – exists.

3. Duty to Inform

Once information has been acquired, it becomes imperative that such information is disseminated/shared. Duty to inform operationalises and logically follows the two aforementioned duties,

²⁷³ See above; see also Marchisio, “Article IX”, 2009; UN Doc. A/AC.294/2022/WP, 2022; Harrington, Due Regard as the Primer Directive for Responsible Behaviour in Space, *Loyola University Chicago International Law Review*, Vol. 20, No. 1, 2023. On due regard in other contexts see also *Fisheries Jurisdiction (United Kingdom, v. Iceland)*, Merits, Judgement, I.C.J. Reports 1974. On due regard in aviation see e.g. ICAO Doc. MIDANPIRG/18 & RASG-MID/8-WP/46 9/2/2021. For due regard in maritime law see Gaunce, *On the Interpretation of the General Duty of „Due Regard“*, University of Calgary, Brill, 2018.

²⁷⁴ For more on the Space Benefits Declaration see *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Stubbe* (assist. ed.), *Cologne Commentary on Space Law: Vol. III*, Carl-Heymanns Verlag, Cologne, 2015.

²⁷⁵ *Gerhard*, “Article VI”, 2009; von der Dunk, “The Origins of Authorisation”, in: von der Dunk (ed.), *National Space Legislation in Europe*, Martinus Nijhoff, Leiden, 2011.

²⁷⁶ For an analysis of national space laws see *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025, Chapter 5.



and is therefore based in the same legal basis (e.g. due diligence), with additional legal foundation identifiable in Articles I (the benefits requirement), III, V and IX (duty to cooperate), as well as XI (agreement to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of space activities) of the OST, as well as Articles III and IV of the REG, pursuant to which States should furnish information to the Secretary General of the UN regarding each space object on their national register as soon as practicable.²⁷⁷ Article IV of the REG, also requests provision “from time to time” of “additional information concerning a space object carried on its registry” and “to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in Earth orbit.” In practice, select national space acts thus require national operators to provide to State space authority information on transfers of ownership in-orbit, especially if it involves the transfer of the operation of the flight system from one State to another; if the space object is no longer functional and has been de-orbited or re-orbited; if it decayed and is no longer in outer space; if the space object was passivated and there is no risk of explosion in case of collision; if the space object has lost control or is displaying difficulties in control and/or operation, especially if it may present a danger etc.²⁷⁸ Many States inform UNOOSA on the status of missions and space objects (e.g. when a satellite has

²⁷⁷ Article IV REG decrees:

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry:
 - (a) Name of launching State or States;
 - (b) An appropriate designator of the space object or its registration number;
 - (c) Date and territory or location of launch;
 - (d) Basic orbital parameters, including:
 - (i) Nodal period;
 - (ii) Inclination;
 - (iii) Apogee;
 - (iv) Perigee;
 - (e) General function of the space object.
2. Each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.
3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in Earth orbit.

While the information from Article IV of the REG is of limited assistance to STM (see also *Hobe*, *Space Traffic Management: Some Conceptual Ideas* (2016), ZLW, 65 (1). pp. 3-21). *Hobe* and *Kaiser* suggest addition of such orbital parameters as epoch, inclination, right ascension of ascending node, argument of perigee, eccentricity, mean motion and mean anomaly (see *ibid*, p. 13, *Kaiser*, *Legal and Policy Aspects of Space Situational Awareness*, *Space Policy* 31 (2015), p. 5). *Hobe* furthermore analyses SSA, traffic rules, space debris provisions and evaluations of space object space worthiness are required for STM (See *Hobe* (2016)).

²⁷⁸ For an analysis of national space acts see *Lex Ad Astra*, Chapter 5.



decayed, was de-orbited or re-orbited).²⁷⁹ This is, however, not done by all, and the practice with respect to timing varies considerably owing to the fact that the REG does not set a deadline.²⁸⁰ International cooperation should furthermore be encouraged to improve these practices.²⁸¹ Transparency and information-sharing are after all the cornerstone of space traffic safety as illustrated by the example of Iridium 33.²⁸² States and operators must inform about planned manoeuvres and other changes in space object status (for example, if a space object is malfunctioning or decays). For effective space traffic and SSA, it would be helpful for a duty to inform to exist so that operators would know they need to inform about e.g. a planned manoeuvre in one week or in two weeks' time and the other operators or the company that is doing the SSA for that satellite know where it is going to be, and consequently do not provide false information to other space actors.²⁸³

The duty to inform can finally be supported with examples from practice. Several ISO standards address information sharing: ISO 26900:2012, ISO 19389:2014, ISO 13526:2010, ISO 13541:2021. Furthermore, space object operators willingly share information, especially between allied blocks, in the interest of safety and security of space traffic.²⁸⁴ Nonetheless, information sharing practice is unfortunately not universal. Recognition of a duty to inform, e.g. share or disseminate information relevant for the safe conduct of space traffic, such as SSA information, would be extremely useful and could help solve the issues of non-sharing SSA information, despite substantial SSA capabilities, recorded in some instances.²⁸⁵ It should at this point be noted that the duty to inform would not compromise privacy or security, as it should be understood as restricted to information that is strictly necessary for ensuring safety of space traffic. It therefore does not impact mission data.

Several information sources already exist, e.g. information bases from which information could be gleaned and shared:

²⁷⁹ See for example: ESA's European Student Earth Orbiter, launched in 2018, end-of-life in 2020, <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V22/021/59/PDF/V2202159.pdf?OpenElement>.

²⁸⁰ To address the issue, the UNGA adopted resolution 62/101 (2007). It is the recommendation of the Cologne Manual that the aforementioned instruments should be considered and States are appealed to comply with the obligation to inform from the REG as soon as practicable after the successful launch of the space object.

²⁸¹ In regard to this the LTS Guidelines are proving helpful (see also Annex Synopsis LTS implementation reports on guidelines B.1-B.5.) and United Nations General Assembly Resolutions can help improve it further as they have done in the past, e.g. 51/122 (1996), 1962 (XVIII), 41/65 (1986) (Venezuela/China; ESA/Russian Federation); 37/92 (1982) (the SPIDER program; Surrey/Nigeria cooperation for RS).

²⁸² As noted Iridium 33 changed orbit without proper notification. It has been reported that Iridium 33 did not clearly inform about a change of orbit in the days before collision with the dysfunctional Cosmos 2251 satellite

²⁸³ See Commentary on Pre-launch Activities and Notification Guideline.

²⁸⁴ See noted examples, e.g. Space Data Association; ESA, ESA's Annual Space Environment Report, 2025; *Flohner*, Due regard and the need for space traffic coordination, 2025.

²⁸⁵ See e.g. *Hobe*, Space Law, 2023.



- Pursuant to Article VIII of the OST, national space object registers record varying information on space objects registered by the State. These could be used to ascertain the registering (jurisdictional) State and in some instances space object operator and/or owner, and possible transfer of ownership in-orbit.
- UN Register of Objects Launched into Outer Space as well as UN Index of Objects Launched into Outer Space can provide some basic information (e.g. registering State, responsible State).
- ESA Database and Information System Characterising Objects in Space are more precise than the UN databases and useful, but limited in scope (regional and civil).
- SSA information and systems are useful for real time traffic concerns (examples US SSN, EU SST).

To clarify, a duty to inform exists on two levels. Firstly, a duty exists on space object operator(s), whether governmental or non-governmental, to inform, at minimum, on scheduled launches, planned on-orbit manoeuvres that change space object trajectory or could otherwise impact other space objects, and any changes in space object status (e.g. on-orbit transfers of ownership, operational difficulties, de-orbiting, etc.). It would furthermore be valuable if operators would periodically provide ephemeris and telemetry information to SSA information providers (at least their chosen SSA information provider),²⁸⁶ thus also under normal operations, i.e. even if no manoeuvre is planned etc. The aforementioned is supported in practice.²⁸⁷ In instances of imminent collision, any entity possessing relevant information should immediately notify the operator(s) of the affected space object(s), or if these are unknown, SSA information provider, the registering States (if known; alternatively, the launching State could be contacted)²⁸⁸ and the Secretary General of the United Nations. In cases of non-imminent danger, the operator and the registering State should nonetheless be notified in interests of space traffic safety and cooperation.

Secondly, a duty exists on any entity receiving or possessing information on an expected collision to inform all impacted and concerned parties. A duty to inform would not necessarily preclude commercial provision of information or equal free-of-charge information sharing. In instances of commercial

²⁸⁶ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²⁸⁷ See e.g. NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

²⁸⁸ See Commentary on Registration Guideline.



providers, details can be determined by parties in a contract. Examples to support both free-of-charge²⁸⁹ and contractual information sharing exist in practice.

Methods of information-sharing should be reliable and quickly reactive.²⁹⁰ Present trends indicate use of information technologies, optionally supported by artificial intelligence, or depending on the addressee appropriate information channels, e.g. televised publication, telephone.²⁹¹ Where use of information technologies is involved, their protection should be assured for secure and reliable communication.²⁹² Establishment of standardised communication channels alongside a directory or catalogue (constantly updated) is advised, as well as that of a new international technical advisory body.²⁹³

IV. Future developments

It is hoped that in future standardisation of STM related content will take place. A process of standardisation could further elaborate on the aforementioned duties, identify risks and helping orient the evolving duties to minimise the identified risks. This would be in line with the evolutionary interpretation of legal norms, indicated in the customary interpretational norms codified in the 1969 Vienna Convention on the Law of Treaties, Article 31 and furthermore elaborated on by the International Court of Justice in the Navigational and Related Rights case.²⁹⁴

The presently identified duties form the basis that is required for functionality of STM. These will therefore require periodical review as space traffic and with it STM evolves to accommodate a growing number of actors and newer technology. In essence, however, these duties are not expected to alter much as the duty to acquire, duty to know (or stay informed), and duty to inform about real life situation surrounding one's space activity in order to safeguard space operations (whether in orbit or launch activities), exist in law and can furthermore be based in international space law.

²⁸⁹ E.g. EU SST; US SSN. For more information see Commentary on SSA Guideline.

²⁹⁰ See also Guideline on STC and Communication System and International Technical Advisory Body.

²⁹¹ See also Commentary on Pre-launch Activities and Notification.

²⁹² See also Commentary on Cybersecurity Guideline and Commentary on Communication System and International Technical Advisory Body Guideline.

²⁹³ For more information see Commentary on Communication System and International Technical Advisory Body Guideline.

²⁹⁴ Dispute regarding Navigational and Related Rights (*Cost Rica v. Nicaragua*), Judgement, I.C.J. Reports 2009. For a commentary of Article 31 of the 1969 Vienna Convention on the Law of Treaties see *Dör*, "Article 31", in: *Dör/Schmalenbach*, Vienna Convention on the Law of Treaties (2nd ed), Springer, Heidelberg, 2018.



Commentary to Guideline 8 – Cyber Security

States should ensure the cyber security of infrastructures including ground-based networks and space links and digital data that support Space Traffic Management or the guidance and control of space objects in accordance with current best practices and state of the art.

- 1. These infrastructures should be considered of high criticality and of international interest and subject to protection, either by international or national legislation.**
 - a. Organisational procedures and technical measures should be implemented against cyber security threats for the protection of infrastructures and digital data.**
 - b. States should obligate the operators of space objects or infrastructures of their responsibility for the implementation of appropriate organisational and technical measures for cyber security.**
 - c. Relevant personnel should be trained to ensure their awareness about potential cyber threats and their knowledge about avoidance and appropriate response.**
 - d. Operators of space objects or infrastructures should respond to incidents promptly and report these without unnecessary delay to established centralised bodies or relevant authorities.**
- 2. International efforts should be undertaken to develop standards for minimum organisational and technical cyber security requirements specific to infrastructures and digital data.**
- 3. Operators of space objects or infrastructure should develop cyber security strategies, perform cyber vulnerability evaluations, and implement best practices for the protection of infrastructures and digital data.**

I. Introduction

Cyber security is an essential component of the Cologne Manual on Space Traffic Management. In an era where digital infrastructures and digital data are indispensable for space activities,²⁹⁵ ensuring

²⁹⁵ Space object operators rely on technology composing their space objects, technology for tracking and monitoring as well as analysing space traffic and particularly on catalogues sources including maintenance, verification and adequate update frequency of these catalogues. See *Flohner*, Due regard and the need for space traffic coordination, Presentation at the 2025 IISL/ECSL Symposium at the 2025 UNCOPUOS Legal Subcommittee, ESA Unclassified, 14 May 2025.



the security of these infrastructures, especially focusing on information technology (IT) systems, artificial intelligence (AI) and digital data, is paramount. The integration of cyber security within STM is not merely a technical necessity but a fundamental prerequisite for the safe, secure and sustainable management of space traffic. Given the increasing reliance on digital communication, automated control systems, and partly AI within the space domain, safeguarding these systems against cyber threats is imperative.²⁹⁶

Guideline 8 has been deliberately positioned towards the end of the regulatory framework. The rationale behind this placement is that some of the earlier Guidelines establish foundational principles that apply broadly to STM, while the Guideline on cyber security represents one of the more specific and technical rules that build upon those principles.

II. Structure of the Guideline

1. General Structure and Purpose

The Guideline follows a structured approach that strives for clarity and coherence. The overall structure reflects a logical progression from broad principles to specific obligations. The Guideline determines the need for cyber security protection within STM and space traffic, followed by the assignment of responsibilities to States and operators in the establishment of security measures (paras. 1 a. to d.), and finally, the creation of an international framework for cyber security collaboration (paras 2., 3.). The arrangement of these provisions ensures that the obligations placed on different space actors are well-defined and proportionate to their roles within STM. The approach therefore ensures a clear allocation of responsibilities, also in the context of Art. VI of the OST. Moreover, this structure ensures a balanced distribution of regulatory burdens, providing clear guidance without unduly constraining technological progress or private sector participation.

2. Explanation of Individual Provisions

The following explains the choice of certain terms and distinguishes them from related terms where relevant. Where appropriate, parallels are drawn to existing national or international regulations that govern similar subject matters. The list of existing regulations does not claim to be exhaustive but is intended to provide a cross-section of existing regulations from selected legal systems.

²⁹⁶ For more see *Blount/Hofmann* (eds.), *Space Law in a Networked World*, Martinus Nijhoff, Leiden, 2023.



a) *Ensuring the Security of Infrastructures and Digital Data*

The first sentence of the Guideline references infrastructures and digital data to which its essential regulatory scope applies. With the term “infrastructures,” especially all information technology (IT) systems and digital data that support STM or the guidance and control of space objects are included. Infrastructures therefore currently mainly comprise IT systems, while remaining open to new technologies, so that future technical developments (for example, the increased use of AI) are also covered by the term.²⁹⁷ Hence, whenever the term “infrastructures” is used, it shall refer to this definitional scope. Infrastructures are included because their protection ensures the safety of space traffic during all phases of operation. The protection of related digital data aims to ensure their confidentiality, integrity, and availability.

The term *security* refers to protection against external threats and unauthorized access to the systems by third parties. This is to be distinguished from the term *safety*, which refers to the technical functioning of a system itself. While security contributes to the safety of a system alongside other factors, it remains conceptually distinct from it. The aim of the Guideline is to offer regulatory protection of infrastructures and digital data from unauthorized and malicious cyber activities and thus terminologically refers to security.

Infrastructures in the context of STM mainly consist of ground-based networks. The explicit inclusion of space links further acknowledges the need to protect ground-space and space-space communication links against unauthorised activities which are not routed through a ground-based network.

The primary aim of this Guideline is to align the protection of these infrastructures and digital data with established best practices and technological advancements, ensuring resilience against cyber threats. The reference to current best practices and state of the art finally reflects the technological openness of the Guideline. Since cyber activities and protective measures against them are constantly evolving, the intended regulatory protection should also be aligned with ongoing technological progress and opportunities.

²⁹⁷ Analysis revealed that cyber activities mainly target satellite data or component parts of satellites infrastructure, including ground and space-based technology. See e.g. *Hobe*, *Space Law* (2nd ed.), Nomos, Baden-Baden, 2023, p. 231. For most severe cyber operations and analysis of the cyber domain see *Tallinn Manual 2.0*, Cambridge University Press, Cambridge, 2017.



b) Recognition as Critical Infrastructure (para. 1)

By designating the infrastructures as of high criticality, this provision underscores the need for enhanced protection at both national and international levels. The (legal) classification as critical infrastructure ensures that they receive special regulatory and operational attention, similar to other sectors essential for national security and public safety. This corresponds to national legislative developments such as Germany's IT Security Act 2.0 (IT-Sicherheitsgesetz 2.0)²⁹⁸, which imposes stringent cyber security obligations on operators of critical infrastructure, and the United States' CISA Act²⁹⁹, which formalises federal cyber security responsibilities for infrastructure protection. In the European Union the NIS2 Directive, which is to be implemented by the Member States into national law, recognizes already the space sector as a sector of high criticality. The obligations under this Directive apply to operators of ground-based infrastructure, owned, managed and operated by Member States or by private parties, that support the provision of space-based services, excluding providers of public electronic communications networks.³⁰⁰ Infrastructures within the meaning of this Guideline providing space-based services fall under this definition. This qualification of the Directive can serve as a model, although it has gaps regarding space objects that do not (any longer) provide space-based services and space links.

c) Organisational and Technical Measures (para. 1 a.)

aa) Security Measures

Para. 1 a. emphasises the need for a combination of both organisational and technical measures to mitigate cyber risks. Therefore, each section in the following will indicate whether the measures discussed are of an organisational or technical nature. In general, organisational measures can include governance frameworks, risk assessment protocols, and contingency planning, training and awareness (para. 1 c.) and incident response and reporting (para. 1 d.), while technical measures can encompass firewalls, intrusion detection systems, encryption, and access controls. Several (national and regional) regulatory frameworks, such as the NIS2 Directive, establish similar security obligations

²⁹⁸ The law designates certain sectors, such as information technology or telecommunications, as critical infrastructure at national level; *see* Zweites Gesetz zur Erhöhung der Sicherheit informationstechnischer Systeme of 18 May 2021, BGBl. I 2021, no. 25 of 27 May 2021, p. 1122.

²⁹⁹ Cybersecurity Information Sharing Act, 6 U.S.C. §§ 1501–1510 (2015).

³⁰⁰ NIS2 Directive; Annex I (Sectors of High Criticality), section 11. These obligations apply independent of the size of the (operator) entity, when the disruption of the service could induce a significant systemic risk, in particular where such disruption could have a cross-border impact, Art. 2, 2.d. A similar qualification of the space sector as critical infrastructure can be found in the EU Directive 2022/2557 on the resilience of critical entities, Annex, section 10.



for operators of essential and important entities, including those in the space sector. NIS2 introduces strict cybersecurity requirements, expands reporting obligations, and fosters sector-wide harmonisation to enhance resilience across critical infrastructures. It should be noted, however, that most regulations like NIS2 focus primarily on the organisational dimension, with technical specifications emerging to a much lesser extent due to their technology-neutral approach.

In the context of space objects, the terminology “guidance and control” was deliberately chosen. This terminology is more appropriate for space-traffic-related contexts, as it specifically refers to the directional control of a space object. The broader term “command” can also encompass the control of a payload (e.g. telecommunication transponders, remote sensing cameras) in space objects. However, this has no direct relation to directional control in the narrower sense of space *traffic* and is beyond the scope of this Manual.

bb) Obligations for Operators (para. 1 b.)

In the context of this Guideline, the term “operator” relates to operators of space objects *and* operators of infrastructures, considering that operators of space objects may not operate the underlying infrastructures. Operators of infrastructures play a crucial role in maintaining cyber security. Para. 1 b. establishes appropriate organisational and technical safeguards. States should impose this obligation on operators, either by licensing conditions as part of the authorization of space activities (under Article VI of the OST) or by specific cyber security requirements for operators of infrastructures. Para. 1 b. reinforces the idea that cyber security is not solely the responsibility of States but requires active participation from private sector entities. Many jurisdictions, including the European Union through the NIS2 Directive³⁰¹, impose similar obligations on critical service providers, ensuring that cyber security standards apply universally across both public and private entities. Para. 1 b. ensures that the legal responsibility of operators is explicitly defined, thereby preventing regulatory gaps that could be exploited to the detriment of overall security.

cc) Training and Awareness (para. 1 c.)

Awareness and preparedness are specific organisational cyber security measures. Para 1 c. requires regular training for personnel to ensure they remain vigilant against emerging threats. By fostering a

³⁰¹ Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union and repealing Directive (EU) 2016/1148 (NIS2 Directive), OJ L 333, 27.12.2022, p. 80.



culture of security awareness, operators of space objects and operators of infrastructures can reduce the likelihood of cyber breaches and improve response times when incidents occur. Various jurisdictions impose sector-specific training obligations which requires companies to ensure employee competence in cyber risk management. The European NIS2 Directive recognizes ground-based infrastructure of the space sector as critical infrastructure. According to the Directive, Member States shall ensure that members of the management bodies of essential and important entities are required to participate in training programs. Additionally, they shall urge essential and important entities to regularly offer appropriate training to all employees, enabling them to acquire sufficient knowledge and skills to identify and assess risks, as well as to understand cybersecurity management practices and their impact on the services provided by the entity.³⁰² Similarly, the U.S. Cybersecurity Maturity Model Certification (CMMC)³⁰³ introduces structured security training for operators of critical infrastructure. Cyber security training and awareness should apply to personnel of operators of space objects and operators of infrastructures.

dd) Incident Response and Reporting (para. 1 d.)

Incident response and reporting are specific organisational cyber security measures. Effective cyber security requires swift responses to incidents. Para. 1 d. requires prompt reporting of cyber incidents to centralised bodies or relevant authorities. In the EU, the NIS2 Directive obliges critical infrastructure operators to report significant cyber security incidents without undue delay and, in any event, within 72 hours,³⁰⁴ ensuring coordinated responses and mitigation strategies. Establishing such reporting mechanisms within STM ensures that cyber incidents do not escalate into systemic failures that could compromise space operations and international cooperation. For this reason, and given the continuous monitoring needs in the space sector, a reporting obligation within less than 72 hours should be considered to minimise potential damage. Incident response and reporting should apply to all operators of space objects and operators of infrastructures.

ee) Development of International Standards (para. 2)

This provision highlights the necessity for globally accepted minimum organisational and technical cyber security standards for STM. Establishing common benchmarks fosters a uniform approach to

³⁰² Art. 20 para. 2, Art. 21 para. 2 g) NIS2 Directive.

³⁰³ For an overview see *Gamble*, *The Cybersecurity Maturity Model Certification (CMMC) – a Pocket Guide*, Cambridge-shire: IT Governance Publishing 2020.

³⁰⁴ Art. 23 para. 4 b) NIS2 Directive.



addressing cyber threats. Organisational cyber security measures for the space sector can follow the organisational procedures already established for other sectors, but space sector specific responsibilities of authorities, points of contact and formats of international coordination may need to be established. International standardisation of technical measures like firewalls, intrusion detection systems and encryption should however not impose a particular type of technology.³⁰⁵

Given the transboundary nature of cyber threats in space operations, the development of international norms is imperative to ensure uniformity and reduce regulatory fragmentation.

ff) Cyber Security Strategies for Operators (para. 3)

Operators of space objects and operators of infrastructures should be required to develop and maintain comprehensive cyber security strategies. These strategies should include regular vulnerability assessments and adherence to best practices.³⁰⁶ By institutionalising proactive security management, this provision ensures that infrastructures remain resilient to evolving threats. Operators may establish cyber security strategies independent of obligations imposed by States. Additionally, such strategies can be shaped by industry best practices, international standards, and voluntary frameworks, ensuring adaptability to evolving threats and technological advancements.

III. Rationale of the Guideline

The Cyber Security Guideline represents a significant step towards establishing a coherent regulatory framework for infrastructures and digital data that support STM or the guidance and control of space objects. While the presented existing national and international cyber security regulations provide essential guidance on general cyber security principles, they do not comprehensively address the unique challenges of space traffic. The coexistence of multiple frameworks across different jurisdictions and sectors has resulted in regulatory variations, which may pose challenges for legal clarity and operational efficiency in STM. However, initiatives such as NIS2 on the European level contribute to greater harmonisation, fostering a more coordinated approach across different sectors.

³⁰⁵ As recognized in Art. 25 NIS2 Directive.

³⁰⁶ For an analysis of present trends and challenges see e.g. also *Blount/Hofmann* (eds.), *Space Law in a Networked World*, Martinus Nijhoff, Leiden, 2023; ESPI, *Space, Cyber and Defence Report*, 2023; IDA, *National Security Issues in Cyberspace and Space*, 2024; *Froehlich* (ed.), *Cyber Space and Outer Space*, ESPI/Springer, Vienna, 2021; *Periyasani/Katina/Ramasamy*, *Cyber Space and Outer Space Security*, Routledge, London, 2024.



This Guideline fills that regulatory gap by providing a structured and dedicated approach to cyber security within STM. It is not merely an adaptation of pre-existing cyber security norms but an independent regulatory effort that builds upon recognised best practices while tailoring them specifically to the needs of space traffic management. By defining cyber security obligations in an STM-specific context, the Guideline ensures that especially ground-based IT infrastructures and control systems, space links and digital data streams are protected in a manner that is aligned with the unique operational realities of space activities. The aim is therefore to protect space activities during all phases of operations.

At the same time, the implementation of this Guideline by States and operators can be facilitated by drawing upon established cyber security frameworks. The NIS2 Directive, for example, provides a robust structure for risk management and incident reporting, which applies to IT infrastructures for the space sector as critical infrastructure. Other national cyber security legislation like the German IT-Security Act (IT-Sicherheitsgesetz) and the US CISA Act do – at least until now – not explicitly apply to the space sector but offer regulatory templates that can help guide national implementation. The Cyber Security Guideline, therefore, functions as a central reference point, offering an integrated approach that bridges regulatory cyber security gaps in STM between different national jurisdictions.

By positioning this Guideline as both an independent regulatory achievement and a framework that aligns with existing laws and regulations, it aims to provide States with a structured yet adaptable tool to enhance cyber security in STM. This dual approach ensures that national authorities retain the flexibility to incorporate established best practices while simultaneously contributing to a globally harmonised STM security architecture. The Guideline thus not only complements but also significantly advances existing regulatory efforts by introducing a dedicated, sector-specific cyber security framework tailored to the evolving landscape of space traffic management.

IV. Future Developments

As space traffic increases and technological advancements accelerate, cyber security challenges will evolve. The growing reliance on artificial intelligence and machine learning introduces new cyber risks, including algorithmic manipulation and adversarial attacks. Future legal frameworks must adapt to these emerging threats. Similarly, with the proliferation of private actors in the space sector, ensuring compliance with uniform cyber security measures will require strengthened regulatory mechanisms and space sector-specific guidelines, possibly as licensing requirements of authorizations by the appropriate State under Article VI of the OST.



Diplomatic efforts can play a crucial role in shaping future cyber security norms in space. The development of UN-sponsored cyber security frameworks and bilateral agreements among space-faring nations will likely influence the evolution of STM-related cyber security regulations.

Independent thereof, operators of space objects and operators of infrastructures may engage in informal coordination and cooperation and implement best practices driven by self-interest to protect their assets and missions, similar to the activities of the IADC for space debris.

Commentary to Guideline 9 – Military Activities

- 1. In all their space activities military operators should follow the space traffic management Guidelines as contained in the Cologne Manual as far as practicable.**
- 2. If, for national security reasons, the desired level of transparency required for the active management of space traffic cannot be ensured, operators**
 - a. may deviate from these requirements as long as they guarantee the same level of space traffic safety and,**
 - b. must take the necessary manoeuvres at their own expense and bear full liability and responsibility in the event of collision.**

I. Introduction

Military activity in outer space is one of the most complex and sensitive aspects of STM, given its inherent link to national security. Unlike civilian and commercial space operations, military activities often require operational discretion, making full transparency and international oversight challenging.³⁰⁷ Recognising this, the Guideline on military activity balances adherence to the STM principles with the constraints imposed by security concerns.

Positioned towards the end of the STM framework, this Guideline underscores its role as a distinct regulatory measure that builds on established principles. It acknowledges that while military actors operate under unique conditions, they still bear responsibility for minimising risks to other space users and contributing to space safety and sustainability.

³⁰⁷ For further reading on challenges of and trends in space security see e.g. *Pekkanen/Blount* (eds.), *The Oxford Handbook of Space Security*, Oxford University Press, Oxford, 2024.



Rather than imposing rigid limitations, the Guideline fosters responsible military engagement by integrating security considerations into STM without compromising essential traffic management measures. By ensuring flexibility where necessary while reinforcing accountability, it strengthens the overall STM framework and promotes constructive military participation in space governance.

Additionally, the Guideline directly follows the Guideline on cyber security, reflecting the increasing intersection between cyber operations and military space activities. Given military reliance on digital infrastructures and communication networks, this placement highlights the interconnected nature of security-related space operations.

II. Structure of the Guideline

1. General Structure and Purpose

The Guideline follows a two-tiered structure: first, it sets the expectation that military actors should adhere to the STM Guidelines as contained in the Cologne Manual whenever feasible. Second, it introduces exceptions allowing deviations when national security concerns make full compliance impracticable, provided that these deviations do not compromise the safety of space operations or the overall STM framework.

2. Explanation of Terms and Individual Provisions

a. Military Space Activities

Military space activities encompass all actions carried out for military or defence purposes, including those undertaken by the armed forces in relation to outer space. This includes activities directly affecting space traffic, such as the launching, orbiting, and manoeuvring of space objects, irrespective of the type of entity executing these operations. The increasing reliance on outer space for national security, surveillance, and defence purposes³⁰⁸ underscores the need for integrating such activities into the broader STM framework.

b. Adherence to STM Guidelines Where Practicable (para. 1)

The Guideline states that military operators should follow the STM Guidelines "as far as practicable." The direct addressees of the Guideline are therefore the operators. This wording is intentional, acknowledging that full compliance may not always be feasible due to classified missions, operational secrecy, or strategic imperatives. However, it establishes a baseline expectation that military activities

³⁰⁸ See e.g. NATO, *Overarching Space Policy*, 2019, accessible at: https://www.nato.int/cps/en/natohq/official_texts_190862.htm; ESPI, Brief No. 73, 2025; ESPI, Brief No. 57, 2022; Pike, "The military uses of outer space", in SIPRI Yearbook 2002; IDA, *National Defense Space Architecture Commercial Integration*.



should align with the broader STM framework whenever possible. This provision seeks to encourage voluntary coordination and engagement with STM processes while leaving room for necessary exceptions. It further highlights the overall need to manage space traffic in a sustainable and safe manner.

c. Justified Deviation Based on National Security (para. 2 a)

Recognising the reality that military operations often require discretion, the Guideline allows operators to deviate from the STM requirements if national security concerns prevent the desired level of transparency. However, this deviation is not without conditions: in these cases, military operators should ensure that their activities maintain an equivalent level of space traffic safety. This ensures that military exceptions do not result in heightened risks for other space actors. Implicitly, this provision also encourages States to develop internal risk mitigation strategies that align with the STM objectives.

d. Liability and Responsibility for Manoeuvres (para. 2 b)

To prevent military operators from shifting risks onto civilian or commercial actors, the Guideline also establishes a liability principle. If operators deviate from the STM requirements, the Guideline imposes an obligation to take the necessary manoeuvres at their own expense and bear full liability in the event of a collision. This refers to all costs that are incurred or arise during space manoeuvres. The provision therefore serves two critical purposes: first, it discourages reckless deviations from the STM Guidelines by attaching financial consequences, and second, it reinforces the foundational principle that space actors must bear responsibility for the consequences of their activities. By codifying this expectation, the Guideline ensures that military exceptions do not undermine the archived stability with the STM Guidelines even if they are motivated by understandable national security interests.

III. Rationale of the Guideline

The foundation of the Guideline aligns with established principles of international law while reflecting the political realities of military space operations. Under the OST, military activities in outer space are not prohibited *per se*.³⁰⁹ Article IV of the OST restricts military activity only in as far as it prohibits the placement of nuclear weapons and weapons of mass destruction in outer space, including

³⁰⁹ For an analysis see *Schrogl/Neumann*, “Article IV”, in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl-Heymanns Verlag, Cologne, 2009; Hobe, *Space Law* (2nd ed.), Nomos, Baden-Baden, 2023, pp. 123-131.



on the Moon and other celestial bodies, and restricts military activity on celestial bodies.³¹⁰ Further explicit restrictions are not named in the OST, aside from a general repeated principle of peaceful purposes.³¹¹ This Guideline operationalises those fundamental principles by embedding military activities within the STM framework while allowing flexibility for national security considerations.

Moreover, the Guideline subtly engages with principles of International Humanitarian Law (IHL) in the context of armed conflict in space.³¹² Given the increasing discourse on the applicability of IHL to outer space,³¹³ this provision offers a preliminary framework for risk mitigation without encroaching upon States' sovereign decision-making. The Guideline does not explicitly regulate military conflicts. However, it provides a structure for ensuring that peacetime military operations adhere to traffic management principles to prevent unintended escalations or hazardous incidents.

By requiring military operators to assume full liability when deviating from STM norms, the Guideline finally reinforces a key aspect of space law while maintaining operational flexibility.

IV. Future Developments

The evolving landscape of military space activities will continue to challenge the implementation of STM principles. The increasing use of dual-use technologies, autonomous space systems, and space-based surveillance assets will require ongoing dialogue between military and civilian stakeholders. Future regulatory developments may explore mechanisms for enhancing transparency in military operations without compromising national security imperatives.

Another significant area for future consideration is the development of confidence-building measures (CBMs) related to military STM compliance. Diplomatic initiatives may seek to establish voluntary reporting mechanisms, notification procedures, or pre-defined risk reduction measures that could facilitate greater military adherence to STM Guidelines.

Finally, as the integration of cyber operations into military space activities continues to expand, the intersection of cyber security and STM will require further regulatory adaptation. Ensuring that cyber

³¹⁰ For an overview see *Hobe*, *Space Law*, 2nd edn, Nomos, Baden-Baden 2023, p.123 ff.

³¹¹ The terminology of peaceful purposes remains contested though State practice has indicated that it amounts to respecting the UN Charter and its prohibition of the use of force, but not all military activity in outer space (see e.g. *Schrogl/Neumann*, "Article IV", 2009; *Lachs*, *The Law of Outer Space*, 2010; *Hobe*, *Space Law*, 2023; *Grünfeld*, "NewSpace: The Star Wars Soldier of the Future?", in: *Blount/Moro-Aguilar/Masson-Zwaan/Schrogl* (eds.), *Proceedings of the International Institute of Space Law 2022*, The Hague, Eleven International Publishing, 2024, pp. 599-611.

³¹² See e.g. ICRC, *Weapons in Outer space*, accessible at: <https://www.icrc.org/en/law-and-policy/weapons-outer-space>; ICRC, *IHL contributes to the prevention of an arms race in outer space*, <https://www.icrc.org/en/un-outer-space-ihl-statement>.

³¹³ See e.g. *von der Dunk*, *Armed Conflicts in Outer Space*, 97 *Int'l L. Stud.* 188, 2021.



vulnerabilities do not lead to unintended disruptions in space traffic management will be an ongoing challenge, necessitating greater cooperation between cyber security frameworks and STM policies.

Commentary to Guideline 10 – Communication Systems and International Technical Advisory Body

Operators of space objects should connect and communicate through designated reliable communications systems and interoperable information exchange systems in support of effective space traffic coordination. It should be encouraged to do so by using a single universal and dedicated Communication System and an international technical advisory body to ensure standardised and frictionless operations.

1. Communication System

The Communication System should accommodate information on the operator, its point of contact, and necessary SSA information. Additionally, it should provide information on the following components associated with SSA capabilities engaged with the Communication System: (1) surveillance and tracking capabilities, (2) entities gathering STM relevant information, (3) data centres receiving and analysing information, and (4) third actor using the information for conjunction analysis and collision warnings. Ideally, it should be the aim to centralise this information in a dynamic system.

SSA service providers should be engaged with the Communication System in order to establish the dependable backbone of the Space Traffic Management system including a harmonised space object catalogue, standardised message format, and information sharing parameters. The operators should utilise and collaborate with any of the SSA service providers supporting the Communication System.

Information technology systems in support of Space Traffic Management should be interoperable with machine-to-machine interfaces and be designed and operated to warrant their continuity, availability and integrity.

2. International technical advisory body

Space actors should be encouraged to establish an international technical advisory body to advise operators of space objects, space activities and recommend collision avoidance



measures. The objective of the international technical advisory body should be to develop common protocols and standards for effective space traffic coordination.

I. Introduction

Communication and firm understanding of technical options are essential to safe and efficient coordination of space traffic. The Guideline focuses on presenting a proposal for the establishment of 1) a Communication system whether through a specialised platform or through existing communication channels (e.g. a chain) connecting operators and other relevant stakeholders with the aim of enabling quick and reliable communications for coordination purposes, proposing also which information should be exchanged between operators, as well as an 2) International Technical Advisory Body, which could be organised as one entity with appropriate expertise or a chain of existing entities pertaining primarily to SSA providers and analysts that have expertise in conjunction analysis and will be capable of recommending manoeuvre for collision avoidance purposes or advising against such action.

These proposals have been driven by challenges experienced by space object operators during the last decade.³¹⁴ Firstly, it has been noted that the absence of global coordination means resulting in ad hoc case-by-case negotiation subject to mutual trust, access to information and readiness to take action, is severally straining present best practices. This is especially strained in instances of “rush hour” traffic.³¹⁵ This resulted in the proposal for a communication system connecting primarily operators. Secondly, it has been analysed that space object operators rely heavily on catalogue sources such as space object or debris catalogues for operational safety. The elevated frequency of launches is, however, resulting in delays in updating existing catalogues. Furthermore, the validity of the information recorded, accessibility of certain information (through e.g. restricted information sharing, lack of knowledge, expertise or technology on part of an operator – especially new operator) etc. is compromising the ability of operators to rely on these catalogues, resulting in uncertainty on e.g. object status, manoeuvrability capabilities, operator knowledge etc.³¹⁶ This has resulted in the second proposal, that for the establishment of an international technical advisory body. Both components proposed could be consulted by space actors on a purely voluntary basis.

³¹⁴ Flohrer, Due regard and the need for space traffic coordination, 2025.

³¹⁵ “Rush hour” traffic hereby refers to instances of high space traffic, e.g. when an object crosses the “parking altitude” or “parking orbit” of a large constellations. See Flohrer, Due regard and the need for space traffic coordination, 2025; NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, 2023.

³¹⁶ See e.g. Flohrer, Due regard and the need for space traffic coordination, 2025.



The Guideline discussion began by examining possible organisational structures for STM. As numerous studies and experts have already analysed ideally all STM relevant information and required actions would be centralised and in the hands of one agency, whether ICAO, ITU, UNOOSA or a new STM agency.³¹⁷ However, experts furthermore agree that the geo-political landscape at the moment does not enable the centralisation of such strategic assets and often strategically sensitive data and information. Therefore, in the short term, such a centralised organisation of STM is unlikely. However, as space traffic drastically increases with unprecedented speed and numbers, STM is needed immediately to prevent collisions in-orbit which could render the orbital environment hazardous, in worst case scenarios unusable for hundreds of years. The work of the Cologne Manual therefore focused instead on the achievable first steps toward a workable STM that will be geo-politically acceptable, technically viable and able to form the building blocks for future evolution of STM and STC. The discussion therefore focused on existing national and regional structures, examining how these could be linked to create an effective chain of communication capable of quickly connecting the relevant stakeholders with one another and with all relevant services.

For this, the preceding Guidelines establishing building blocks of a functional STM form the baseline, determining which stakeholders and which services are crucial for STM. First, as illustrated by the Guideline on SSA, SSA is the precondition for any form of STM. Second, as exemplified by Guidelines on Pre-Launch Activities and Notifications as well as Space Traffic Coordination, quick, reliable and effective communication between operators is a key aspect for an efficient STC at the heart of any STM system. Third, for the two points outlined, the Guideline on Cyber Security clarifies that in an age of digitalisation, reliability of both SSA and communication depends *inter alia* on the cyber security of systems enabling both, and, as noted by the Guideline on International Cooperation, Coordination and Consultation, it should be the aim of cooperation to further enable not only the sharing of information and international coordination, but also development of new technologies and capacities.³¹⁸ Fourth, inclusion of military as well as non-governmental actors in STM is crucial to its long-term success, with the military requiring exemptions to transparency standard desirable for STM as analysed in the Guidelines on Military Space Activities and Non-Governmental Space Activities.

³¹⁷ See e.g. Hobe, “Space Traffic Management: Some Conceptual Ideas”, *ZLW*, Vol. 65, No. 1, 2016, pp. 3-21; IAA, *Space Traffic Management*, 2018; Frandsen, *The Regulation of Space Traffic*, University of Copenhagen, Copenhagen, 2023.

³¹⁸ See e.g. Flohrer, *Due regard and the need for space traffic coordination*, 2025.



Having analysed the preceding, the Cologne Manual proposed that communication systems and technical advisory institutions are the two key organisational aspects required for a functional and efficient STM.

II. Structure of the Guideline

The Guideline is divided into three parts. The first paragraph serves as the introductory note reaffirming that efficient communication and reliable SSA and other information relevant to STM are crucial for STC. For this purpose, the Guideline proposes the establishment of a reliable communication system and an international technical advisory body, stressing that the establishment of a single dedicated communication system would be optimal and preferable.

The second part subdivided into three paragraphs details the aforementioned Communication system, reiterating information required to assure effective STC thus identifying the necessary elements in a communication system; information about the space object operator (e.g. point of contact), information about the space object (e.g. SSA information), information about SSA information providers and information about conjunction analysts. In some instances, the latter might be the same as SSA information provider (e.g. European actors rely primarily on EU SST, which already provides a collision, fragmentation and debris analysis required by Guideline on Space Traffic Coordination). In other instances, the SSA information provide might be a private entity specialising in evaluation and analysis. Crucial is that emerging as well as established actors have information at their disposal as to where they can acquire the necessary information for safe integration into existing space traffic. To ensure a functional system, the Guideline emphasises that to ensure safety of space operations SSA service providers and space object operators should engage with the communication system and other actors engaging with the communication system in their respective capacities, which includes developing harmonised space object catalogue, standardised message format and information sharing parameters to streamline STC. Considering that these systems will likely require use of technology, the second part concludes with affirming that any information technology systems as well as artificial intelligence in support of STM should be interoperable with machine-to-machine interfaces and be designed and operated to warrant their continuity, availability and integrity.

The last paragraph informs on the international technical advisory body to advise operators of space objects on collision avoidance and risk minimisation by *inter alia* developing common protocols and



standards for STC. This aims to assist space object operators, especially new actors or those from States without their own SSA capabilities, in the technical evaluation of when and which evasive action to take.

III. Rationale of the Guideline

The rationale of the Guideline seeks to aid STC by proposing establishment of future-oriented capacities to aid space object operators. In this manner, the Guideline builds on the preceding Guidelines, which identify the necessary elements for ensuring safety of space traffic, proposing the creation of a communication system to facilitate reliable communication between relevant stakeholders and an international technical advisory body to help space object operators identify critical events and act appropriately.

In short, it has been determined as necessary to create a dynamic STM space object communication system, using SSA information, with real-time information on position and location of space objects, and contact information of space object operators. This could be formed as a form of catalogue or an informal connected chain i.e. network of existing national and regional structures. The international technical advisory body could perform technical assessments, e.g. evaluation of a hazard factor of a proposed space activity and provide advisory services, e.g. via standardisation provide advice on whether a collision avoidance manoeuvre should be performed. It would be the task of such a body to gather information, process/analyse/verify the information and finally advise end users, e.g. space object operators, space activity licence holders, on planned space activities. To establish these capabilities, other tasks including, but not limited to, the creation of tracking stations of the common good as well as possible other ground stations monitoring space weather and conjunctions would be advisable, with legal basis for this provided in Articles I and IX of the OST,³¹⁹ as well as encouraged by the LTS Guidelines. This is especially important considering a lack of radar capacities in the Southern Hemisphere.³²⁰

This will aid all stakeholders, especially emerging space object operators and space-faring nations, who may not possess their own SSA or launch capabilities, and are in the process of developing space

³¹⁹ For an analysis of the legal basis see *Hobe*, “Article I”, in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl Heymanns Verlag, Cologne, 2009; *Marchisio*, “Article IX”, in: *Hobe/Schmidt-Tedd/Schrogl* (eds.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl Heymanns Verlag, Cologne, 2009.

³²⁰ See e.g. *Commentary on Space Situational Awareness Guideline*; Secure World Foundation, *Space Situational Awareness Fact Sheet*, 2024.



technologies and know-how. The establishment of such capacities could furthermore help gradually bridge the lack of capacities and lack of SSA radars in e.g. the Southern hemisphere as well as foster cooperation between stakeholders. Existing legal provisions as well as historical examples provide support for the establishment of both a communication system and an international technical advisory body.

Inspiration was drawn from existing discussions on the organisational structure of STM. In the past two decades, the idea of creating a new centralised entity in charge of STM, analogous to ICAO or ITU, has been discussed.³²¹ This has been evaluated as unlikely in the short term due to lack of unified strategy, geo-political considerations as well as lack of financial and human capacity. Therefore, the Guideline as a first step proposes linkage of existing national (e.g. US SSN or EU SST)³²², regional and international capacities into an efficient and quickly reactive chain. *Firstly*, space law, through Articles IX and I of the OST indirectly requires the adoption of appropriate measures to ensure the accessibility of outer space and due regard for the interests of other States, as well as ensuring the same is adopted by non-governmental actors as specified in Article VI of the OST. Furthermore, duty of cooperation, enshrined in Articles I, III, IX, X and XII of the OST, as well as UN General Assembly Resolutions 1721 (1961) and 55/122 (2000) can help support the Guideline proposal. *Secondly*, the examples of Intelsat, EUTELSAT and INTERSPUTNIK support the creation of such capacities and structures and safety of space operations should act as an incentive with confidence building measures employed to help establish as well as sustain them.³²³

The Guideline is set up of three parts detailing two key elements analysed as required in an organisational structure capable of supporting an innovative and efficient STM system; a general introductory part (1.), communication system (2.) and international technical advisory body (3.).

1. Introductory Part

The introductory first paragraph reiterates that space object operators should connect and communicate. To optimise these processes the Guideline proposes operators connect and communicate through designates reliable communications systems and interoperable information exchange systems in support of effective STC. It should be encouraged to do so by using a single universal and dedicated

³²¹ See e.g. *Hobe*, “Space Traffic Management: Some Conceptual Ideas”, *ZLW*, Vol. 65, No. 1, 2016, pp. 3-21; IAA, *Space Traffic Management*, 2018; *Frandsen*, *The Regulation of Space Traffic*, University of Copenhagen, Copenhagen, 2023.

³²² See e.g. Secure World Foundation, *Space Situational Awareness Fact Sheet*, 2024.

³²³ See e.g. *Lyall/Larsen*, *Space Law: A Treatise* (3rd ed.), Routledge, London, 2024.



Communication System and an international technical advisory body to ensure standardised and frictionless operations. This paragraph emphasizes the standardization of the key elements of the organizational structure required for STM to assure reliability of the system.

The Guideline utilised the term “system” and “body” in order to avoid confusion and conflation with the static framework of space object registration as well as UNOOSA “Online Index of Objects Launched into Outer Space”. It is advised not to use the term database in any future systems as this implies a centralistic static collection of data, which imbues too many uncertainties for space object operators and States. Instead, the Guideline makes use of the word “system” and “body”, which could in future be supported by a dynamic catalogue of space objects detailing information relevant to STM.³²⁴

The two elements, communication system and international technical advisory body, could act as streamlining or quasi-centralising organs that collect information on national and regional structures and capacities, gathering strictly necessary information including SSA information, and facilitating STC processes or directing end-users, e.g. space object operators, especially new operators, to appropriate entities, such as SSA information providers. In this manner, an international chain with 24h quick information exchange could be fashioned.

The aforementioned could naturally prove geo-politically sensitive, especially between political or ideological blocks. Geo-political considerations and sensitivities should be afforded appropriate and careful attention to ensure viability of the proposal. Therefore, it should be stressed that the Guideline restricts itself to information and measures strictly necessary for safe conduct of space operations, in the interest of all and supported by outer space legislation. Furthermore, confidence-building measures, e.g. legal framework, educational tools etc., could be employed to facilitate acceptance of a single dedicated communication system and international technical advisory body. Historical examples confirm feasibility of the proposed concepts,³²⁵ especially the examples of Intelsat and Eutelsat systems, which could be consulted as possible guiding initiatives. In practice, non-state operators and SSA information providers are generally predisposed to cooperation and communication. Some

³²⁴ Linguistically Generally “database“ or “catalogue“ refer to something dynamic, flexible, a living/interactive/responsive system. A “register“ in contrast, is rather something of a one-time entry, which is of course sometimes updated, but which gives you legally relevant information and not something very relevant for operational purposes.

³²⁵ Historical examples include inter alia the United Nations Organisation, the ICAO, the ITU, the IMO, the ILO, EUTELSAT, INTERSPUTNIK, etc. For more information on the creation of international organisations and cooperation and coordination structures, see for example *Rittberger et co.*, International Organization (3rd ed.), Red Globe Press, London, 2019.



entities are already pooling information, disclosing space object location, etc.³²⁶ An example is Space Data Association. The Association is, however, composed of exclusively private entities and considering that many global space actors are still primarily governmental or with high governmental oversight, the specific composition and structure of the Association will not be appropriate. However, States have in practice already demonstrated willingness to develop and invest in e.g. SSA infrastructure and conclude cooperation agreements and frameworks to secure the safety of their space assets. Therefore, the establishment of such capacities is nonetheless evaluated as possible and acceptable.

2. Communication System

The second paragraph addresses the first element introduced by the first paragraph as required in an STM system, namely the communication system. Communication system in support of STM and STC efforts is composed of reliable communications systems connecting the operators with one another and interoperable information exchange systems in support of effective STC. In some instances, these two might be one and the same. In this scenario, the operators would communicate with one another via an online platform, email, telephone or other communication means and will themselves possess all the required information and provide it to each other. In other instances, operators might communicate via the same communication means as above, but with aid of automatised information exchange systems providing the operators with the necessary information to coordinate their actions among each other via communication channels.

Ideally, both of these elements would be joined in a single dedicated Communication System, which joins the means of communication (i.e. capability to directly connect operators) with the reliable information exchange system (i.e. dynamic database capable of storing or directly referring stakeholders to the relevant information and/or information providers). It was analysed that for an efficient STC an information exchange system should gather information on the operator, its point of contact and SSA information (alternatively direct access to a reliable SSA provider or SSA information provider could suffice). SSA information should at minimum include (1) surveillance and tracking capabilities, (2) entities gathering STM relevant information, (3) data centres receiving and analysing information, and (4) third actor(s) using the information for conjunction analysis and collision warnings (these third actors could be SSA providers themselves, space object operators themselves or

³²⁶ E.g. Space Data Association, accessible at: <https://www.space-data.org/sda/>



another party, which analyses SSA information and space object information to evaluate whether and which manoeuvre is necessary to avoid collision)³²⁷.

Primarily two types of information are required or desirable in an STM Communication System for effective STC: (1) real-time tracking of objects (SSA data), and (2) contact data of operators.

Ideally, it should be the aim to centralise this information in a dynamic system. SSA service providers should be engaged with the Communication System in order to establish the dependable backbone of STM including a harmonized space object catalogue, standardized message format, and information sharing parameters. The operators should utilize and collaborate with any of the SSA service providers supporting the Communication System.

Information technology systems in support of STM should be interoperable with machine-to-machine interfaces and be designed and operated to warrant their continuity, availability and integrity. Hereby, artificial intelligence is considered included and should be given the same consideration as the information technology infrastructure.

The aforementioned Communication system with access to dynamic operational information has been evaluated as crucial as existing structures are inappropriate for daily STC efforts. Diplomatic channels are too slow, while existing global agencies like ICAO, ITU, UNOOSA, UNCOPUOS are not designed for this purpose, e.g. with other priority tasks, and/or presently ill-equipped to take over STC. UNOOSA and UNCOPUOS as UN agencies are as of now unsuited to daily tasks and quick reactions required in STM.³²⁸ UNCOUPUS should nonetheless be considered as an appropriate forum for capacity- and confidence-building measures as well as discussion and negotiation of STM related questions, such as determining information required for STC or measures to be implemented at national, regional and international level. For this purpose, the Cologne Manual presents analysed options to formulate the first steps toward a comprehensive international STM.

³²⁷ In the USA, so-called in-between actors emerged, primarily commercial in nature, that analyse SSA information provided by US SSN and space object information provided by the space object operator and/or owner, to evaluate whether action in the form of a manoeuvre is necessary (see e.g. *Rongier/Sgobba* (IAASS), Space Safety and Space Traffic Management, Presentation at the IISL-ECSL Symposium on Space Law 2015, Vienna 13 April 2015). European actors mainly rely on EU SST that provides SSA information as well as performs analyses (see e.g. EU SST, Services, accessible at: <https://www.eusst.eu/services/>).

³²⁸ It should be differentiated between the UNCOPUOS and UNOOSA, for example, in future the UNCOPUOS could be the forum to agree on the setting up of STM, including negotiating its rules and principles, as well as mandating UNOOSA or a new agency to implement such a system. UNOOSA could therefore be the entity, which receives additional mandates and tasks under STM, which of course would require additional resources and possibly the setting-up of a sub-entity (following the example of UNSPIDER, IAWN etc.). Something like a STM task force set up within UNOOSA, operating somehow different from the typical UN bureaucracy could (potentially) be imagined as functional and plausible in future.



3. International Technical Advisory Body

The third and last paragraph addresses an international technical advisory body. This body has been envisioned following the realisation that many entities not only do not possess SSA capabilities, but furthermore do not possess the expertise or human capital needed to interpret and analysis the received conjunction messages, SSA or other relevant information and factors. This is especially true for emerging and smaller actors. To assist in this endeavour the establishment of an apolitical technical body is desired that will be able to perform these services as well as connect the end-user (e.g. operator) with the necessary other entities or services if needed. It is recommended that this body be international to ensure standardisation and a level of uniformity that will make STC more streamlined and easier to perform, without needing to factor in different approaches and to lend an impression of reliability to the end-user (e.g. operator). It has been analysed that often the problem are different reports and users are left to decide which is more reliable without any tangible guiding hand. The hope is therefore that the international technical advisory body could take over this task and gather experts to decide this and then advise the end user, who may have other tasks occupying his capacities. While this may not be absolutely necessary for the experienced user, research shows that majority are not as experienced and especially in an age of commercialisation, where many more actors are joining the sector and launching space objects, this is often not the case with the new and especially smaller stakeholder/operator. There are many actors already on the market offering such or similar services. The international technical advisory body could gather their information and share it with users or it could work together with these entities and provide end advice to the stakeholder/operator that approached the body directly.

In this manner the body would gather and analyse STM relevant technical information (such as SSA information, space debris models, etc. pre-launch or pre-manoeuvre) and advise space object operators, owners, space activity licence holders, States regarding risks, hazardousness of their activity, etc. Numerous institutions at national level already track and monitor among others the more hazardous objects.

Components currently identified:

1. surveillance and tracking capabilities (radars and telescopes)
2. gathering information (with aid of potential ground stations)



3. information centres receiving and analysing information, performing rudimentary verification³²⁹
4. third actor using the information for conjunction analysis and collision warnings (e.g. users)

It does not present as viable to divide the three functions between different bodies. Viable and advisable would be pooling of information, however, in the event of pooling at least a certain degree of central processing would need to be established. Otherwise, in event of decentralized processing by numerous actors working with different software, different models, different assumptions, it would be unlikely that the same result would be arrived at, leading to discrepancies and uncertainties. In circumstances where 100% certainty is not achievable, a unified approach is preferable to numerous differentiating approaches. Currently, many regional approaches to STM act as competing or in best cases complimentary to one another. Current regional STM approaches identified: US approach (Space Track - transitioning towards the system that will be led by the Department of Commerce),³³⁰ European approach (EU-SST),³³¹ possible other regional initiatives.

IV. Future developments

In future, States and other stakeholders should be encouraged to connect to create an organisational structure for STM. In the short term the aim should, as mentioned, be linking existing national, regional and international infrastructure and actors, which support and enable STC and STM, such as SSA information providers and conjunction analysts. These entities should endeavour to create a quickly reactive and efficient chain at national, regional and ideally international level. In the long-term, however, the final ideal goal should be the creation of an international centralised new entity for STM with global reach and international mandate.

Stressing the importance of an international STM system is logical, in support of safety and grounded in international space law. STM requires international regulation due to its nature, e.g. launched objects cross airspace or even multiple airspaces under jurisdiction of different States pursuant to Article 1 of the Chicago Convention, into outer space, which is designated by Articles I and II of the OST as an area beyond national jurisdiction akin to the high seas, and space activities are often multi-State

³²⁹ From space security related discussions, we know that verification is a key issue for many States and may become of interest in future.

³³⁰ Space Policy Directive 3 (US); SpaceTrack, accessible at: <https://www.space-track.org/auth/login>; Space Traffic Management (STM) Architecture, accessible at: <https://technology.nasa.gov/patent/TOP2-294>.

³³¹ EU STM, accessible at: https://defence-industry-space.ec.europa.eu/eu-space/space-traffic-management_en; EU SST, accessible at: <https://www.eusst.eu>.



endeavours or endeavours of non-state actors from various States.³³² Furthermore, as elucidated by previous Guidelines, STC therefore requires communication and coordination of space object operators from various States with one another as well as, in some instances, with launch providers or SSA information providers from other States. Currently STM initiatives are national with jurisdiction only over that State's space objects, e.g. USA. Some further initiatives are regional, e.g. EU. The emergence of such competing systems is an appropriate first step, but in the long-term threatens to create fragmentation processes that could negatively impact safety of space operations.³³³ Therefore, as STM frameworks develop nationally and regionally, their negative impacts should be counteracted with coordinating efforts that strive toward harmonisation of STM approaches at an international level enacted.³³⁴ Therefore, at minimum as States devise and enact their own STM frameworks, coordination rules should be agreed. These could theoretically lead to the creation of a central international organisation for STM, akin to the ICAO for ATM.

Analysis therefore confirmed that a bottom-up approach to establishing STM should be complemented by (near-)simultaneous top-down approach efforts. While analysis confirmed that the establishment of a single central international agency or organisation for STM, akin to ICAO for ATM, is not viable in the short-term primarily due to, e.g. questions of State sovereignty, geo-politics and fears over data-polling, it should nonetheless be regarded as the ultimate and ideal goal in the long-term.

Following the establishment of an initial STM at national and regional levels with coordinating efforts at international level, global agency overseeing STM is the logical final step in STM development. This is confirmed by experiences in ATM, where one entity regulates one airspace sector and ICAO oversees the international harmonisation processes and aids in coordination. This should be transposed to outer space in order to avoid confusion and overlapping jurisdictions of several authorities managing a future STM regime. As its starting point to creating a harmonised STM regime in

³³² For an analysis of Articles I and II of the OST see e.g. *Hobe*, *Space Law*, 2023; *Hobe*, "Article I", 2009; *Freeland /Jakhu*, "Article II", in: *Hobe/Schmidt-Tedd/Schrogl* (ed.) *Goh* (assist. ed.), *Cologne Commentary on Space Law: Vol. I*, Carl Herymanns Verlag, Cologne, 2009; *Lachs*, *The Law of Outer Space*, 2010.

³³³ For an analysis of the consequences and risks of legal fragmentation see UN/ILC, *Fragmentation of International Law* (report), UN Doc. A/CN.4/L.682 and Add.1*, 13 April 2006. Fragmentation may also occur in financial frameworks and may impact the space sector (World Economic Forum, *Navigating Global Financial System Fragmentation*, 2025).

³³⁴ Various approaches can be adopted such as international discourse among stakeholders (e.g. Space Data Association) at industry level as well as State level (e.g. legislative, UNCOPUOS). At space object operator level simple actions such as keeping informed of other operator's approaches or other State approaches can aid in heightening safety. A helpful historical example of an international organisation developing from regional actions is provided by ICAO, for more see Annex on Air Law and Air Traffic Management.



future, the proposed communication system and international technical advisory body, e.g. SSA coordination, communication and necessary information-sharing should be addressed first and only later on oversight and potential control capacities. Following acceptance of such a step, the STM agency or entity could begin overseeing space traffic and STC, endeavour to harmonise national and regional approaches, develop verifying procedures for SSA information providers and even adopt or develop an international STM regulatory framework (see Annex on Space Traffic Management Agency). It should be noted that any STM agency will need to be composed of primarily governmental actors, i.e. States, due to the specifics of the space sector and the State-oriented nature of space law, while permitting for the possibility of non-governmental actor inclusion and participation, including possible voting rights, etc.

At the moment, however, the creation of the necessary infrastructure, the mentioned chain of existing capacities, including the creation of a dedicated communication system and international technical advisory body, but particular a single entity overseeing STM still faces significant geo-political obstacles (1.), financing (2.) and human capital challenges (3.) as well as lack of unified strategy (4.). Herein a short overview is granted to help further discourse on future organisational structure of STM.

1. Geo-political obstacles

Geo-political decisions are not only guided by national interests and national economies, but are also imbued with concerns about the misuse or over-arching requests for data. It should be stressed that any STM system or body would not require the gathering or centralisation of space object mission data, objective or results of space activity, but would only require information necessary for safe conduct of space traffic, such as the announcement of difficulties in operation, control of space objects or malfunctions, planned orbital manoeuvres that change trajectory of a space object or may otherwise impact space traffic and orbital parameters that can be ascertained via SSA capacities. Therefore, the objective of STM is not the pooling of data, but the swift and efficient communication and coordination of strictly necessary information for safe conduct of space operations.

A further geo-political hurdle may be the different developmental level as well as cultural, social and economic factors associated therewith. For many States, outer space activities are not of primary concern

Confidence building measures with proper legal safeguards can aid in alleviating geo-political concerns. Studies can be made of existing international organisations and their beginnings, such as the ITU, the ICAO or even the UN. International forums should be utilised for inter-state discourse, such as the UNCOPUOS to discuss concerns and agree to solutions. Other stakeholders can engage in



other confidence building measures to propagate the concept of STM, especially an STM agency in the long run. At its starting point concentrating on existing cooperation regimes as well as focusing on SSA coordination, inter-actor communication and information-sharing with oversight following last should help facilitate geo-political acceptance.

It is worth mentioning that the present blank slate is an opportunity that should be used by States and other stakeholders to create an innovative STM system freed from the constraints and issues imposed by sovereignty. ATM is a sovereignty-centred system, which is not and should not be the case for outer space. As a good example, the ITU regime has been examined and the importance of international cooperation stressed.

2. Financing

Being aware of the significant financial burdens involved with either the creation of a singular global entity or the linkage of existing entities into a functioning and effective net of stations, a further proposal has highlighted the necessity for a concept similar to “aviation carbon emissions”³³⁵ for the build-up of infrastructure required for STM. Specifically, States that are authorising the launch of vast numbers of space objects (for example, USA with Starlink and AmazonKuiper, UK with One Web, etc.), especially into LEO and GEO, should contribute financially for the creation and operation of tracking and ground monitoring stations in both northern and southern hemisphere to help with the supervision aspect of the constellations they are authorising.³³⁶

Legal support for such financing endeavours can be found in the customary principle of polluter pays, while support for higher participation of those States authorizing larger numbers of space objects can be gleaned from the customary principles on common but differentiated responsibilities.³³⁷ Furthermore, State practice supports such financing endeavours. In the 1980s, the US Government invested (with public money) in the establishment of reception stations for its remote sensing LANDSAT

³³⁵ For more on the concept see Annex on Air Law and Air Traffic Management.

³³⁶ For financing models see e.g. *Hobe*, Perspectives for Space Law in the 21st Century, (upcoming with Hague Academy of International Law).

³³⁷ The application of the principle of Common but differentiated responsibilities is not advisable to STM measures such as Guidelines described in the Cologne Manual. Due to outer space activities being ultra-hazardous and conducted in an area beyond national jurisdiction, where actors must show due regard to the activities of others pursuant to outer space legislation (e.g. Articles I, III and IX of the OST), practice does not support application the principle of common but differentiated responsibilities. On the other hand, application of the same principle to financial aspects of STM, is supported in practice and should therefore be considered. For further analysis see *Viikari*, Environmental Element in Space Law, 2008; *Hobe*, Space Law, 2023; *Hobe*, Perspectives for Space Law in the 21st Century, (upcoming with Hague Academy of International Law).



system in many countries.³³⁸ This was achieved through bilateral agreements. Many of these stations were later modified to receive signals from the French SPOT system, sparing the French Government great investment. States have historically demonstrated an interest in keeping their space assets safe through construction of SSA necessary infrastructure in their territories and abroad, linking these via cooperation agreements, including paying for the construction of required infrastructure in foreign territory. Examples include the described US establishment of reception stations as well as such organisations as EUTELSAT, INTERSPUTNIK, etc. Global funds could be established into which all actors could contribute a certain sum. These sums do not need to be vast and would not impede the participation of all stakeholders in the space sector. Several fund models and calculation mechanisms have already been analysed and proposed. It has been proposed to follow the State-oriented model of space law, obligating States and international organisations to pay directly into the fund, and non-governmental actors pay to the State via licencing procedures. As best measure it was proposed all active actors should be required to pay into the fund, dispensing with the obligation for established space actors to pay more due to them being the main polluters of the past decades. This was decided as it would firstly generate resistance and secondly, as these have provided valuable services which are often offered free of charge (e.g. GPS, SSA). These payments could be augmented by any taxes on space objects, donations, space debris auctions, fines for causation of space debris through practices inconsistent with space debris mitigation measures, etc. UNCOPUOS for example proposed adoption of funds similar to the X-prize offered by the XPRIZE Foundations. The actual fee could depend on many factors. Launch operators could be required to pay a sum proportionate to their space activities and revenue. It could depend on type of object, e.g. manoeuvrable or not, crewed or not, commercial mission or non-profit mission, destination orbit with lowest fees for deep-space objects, whether the object has passive or active de-orbiting capabilities, calculated on mass and height of space objects, large or small objects as well as their evaluated danger for break-ups or danger to the space environment, or on percentage of entire estimated mission cost. It could be calculated on space operator and their activities, in particular whether or not the operator is providing SSA or other valuable services to other operators, whether or not the operator is undertaking space debris mitigation or remediation measures, or other measures that ensure continued accessibility of outer space. In this manner compliance with STM best practices could be considered or participation in STM related organisation structures, research etc. Furthermore, incentives could be provided in form of lowering

³³⁸ See e.g. Landsat, accessible at: <https://www.usgs.gov/landsat-missions/usgs-landsat-ground-stations>; Satellite Ground Stations, accessible at: <https://satellitegroundstation.com>; USradioguy, accessible at: <https://usradioguy.com/ground-station-map/>.



fees by 20% if mitigation measures are planned and executed, and enlarged by 20% in cases of non-compliance with international safety and mitigation standards. The latter could always include compliance with STM standards, practices, etc. Similarly, repayment could be affected if an object is successfully de-orbited, e.g. a 30% return of the initial sum paid into the fund. These funds could begin as national, grow to regional and ideally grow into global funds, or be focused on an orbit (e.g. LEO, GEO). Ultimately it is estimated that whichever model was chosen, mission cost would not increase more than 5% and furthermore hold immense potential to incentives compliance with STM as well as space debris mitigation measures, or even incentivise active debris removal and the building of SSA capacities in the northern as well as southern hemisphere.³³⁹

3. Human Capital

Sufficient qualitative human capital is another considerable hurdle required for operating such a system. Development of adequate human capacities can be achieved through employment of educational methods that produce required know-how and other needed capacities. Acquisition of appropriate quantities of qualitative human capital, however, is closely tied to geo-political and financing aspects and may be informed by the evolution of ICAO or other supranational agencies.³⁴⁰ At inter-State level, States may elect to provide their nationals. At industry level, operators as well as SSA information providers may contribute human capital.

4. Unified Strategy

The final issue, and potentially central to lack of geo-political support and consequently financial and human capital aspects, has (presently) been analysed as a lack of unified strategy. To be able to link existing national structures into an efficient STM chain a strategy is required, however, as of yet no such movement publicly known. A possible explanation for this and a further hurdle to STM could be the absence of true urgency (e.g. catastrophic collisions occurring). While it is the hope of the experts of the Cologne Manual that no such urgency presents itself, hope cannot be relied upon and the urgency to create a functioning and efficient STM system as presented, must be established to States by other means as incentives to cooperate, coordinate, invest, develop an appropriate strategy and adopt the Manual's recommendations. Therefore, the Manual will propose necessary steps for the linkage of existing capacities and establishment of a rudimentary international STM system in

³³⁹ Study on International Funds by Prof. Stephan Hobe (upcoming with the Hague Academy of International Law).

³⁴⁰ See e.g. Annex on Air Law and Air Traffic Management. For a general analysis of human capital acquisition see also Boadi Dankyi et al., "Acquisition of human capital for organizational stability" Sage Journals – International Journal of Engineering Business Management, 2020.



accordance with existing studied on STM requirements and capacities. It will not propose a full-scale detailed strategy as the focus of the Manual should be assisting international and national legislators as well as operators establish STM best practices, which could eventually lead to the creation of an international STM body akin to the ICAO and ITU. Capacity building measures should be employed *inter alia* by promotion in the UNCOPUOS, via workshops (in person and online), at the IAC, and other identified venues, starting with building blocks, such as the Cologne Manual, until sufficient trust can be fostered among nations to establish an international communication network and eventually even technical body. The setting up of an advising body as a first incremental step, is unlikely to hurt or threaten anyone. Furthermore, once it would be in existence, earning/receiving respect and trust, additional mandates could (more easily) follow (even a possible future orbit allocation system or other STM necessary tasks like space traffic coordination). ILO, ICAO, ITU and IMO can help advise during initial phases on how to formulate and incorporate/represent views of non-state stakeholders, employers and employees, etc. alongside States in the drafting process.

Discussing the strategy for linking capacities, initial proposal made was that governments would set the guiding principles (including prices), and the private entity would be in charge of the technical part, e.g. acquiring data, giving collision warnings, setting some operational rules (informing on space weather events, setting the forms to submit information on planned of satellite orbital corrections, and planned launches, informing all on upcoming launches of space objects, etc.), and construction of needed infrastructure, in accordance with the increase of the orbital space object population.

Commentary to Guideline 11 – Ensuring long-term accessibility and operational usability of the space environment

Recognising the forward-looking approach of Space Traffic Management, it is necessary to ensure the long-term accessibility and operational usability of outer space by implementing sustainable solutions to space debris and other comparable risks to space traffic.

1. Mitigation of Space Debris

Space actors able to participate in space traffic shall be deemed capable of implementing space debris mitigation measures and should therefore comply with relevant international standards, in particular the Space Mitigation Guidelines set out by the United Nations and the Inter-Agency Space Debris Coordination Committee. Space debris mit-



igation measures should be implemented during the mission planning, design, manufacturing and operational (launch, mission and disposal) phases of spacecraft and orbital stages. The implementation of mitigation measures should be regularly reviewed and adapted to best legal and technical practices.

2. Remediation of Space Debris

Remediation of space debris should be considered of common interest to be carried out for the benefit of all. All remediation activities should comply with the Guidelines of the Cologne Manual.

3. Environmental Provisions

International environmental standards related to space activities should be respected and observed.

4. Capacity Assessment and Planning

States are encouraged to cooperate in space traffic capacity assessment and planning in critically congested regions of outer space.

I. Introduction

Guideline 11 reflects the fact that space traffic management is not only about the present but also about the future. The increasing use of outer space, which constitutes a finite resource,³⁴¹ at least as far as orbits are concerned, makes sustainable use imperative.³⁴² Sustainability forms an essential part of the entire Cologne Manual³⁴³ and is explicitly mentioned, for example, in the Preamble and in Guideline 3. Guideline 11 completes the picture by addressing how to ensure safe and sustainable space activities in the future.

The safe conduct and cooperative coordination of space activities, including SSA, collision avoidance and cybersecurity issues, are primarily addressed by the other Guidelines of the Cologne Manual. In

³⁴¹ UNCOPUS, Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, 20.06.2019, UN-Document A/74/20, Annex II, p. 50; see also ESA, Zero Debris Charter, Paris 22.05.2024, https://esoc.esa.int/sites/default/files/Zero_Debris_Charter_EN.pdf.

³⁴² See also *Flohrer*, Due regard and the need for space traffic coordination, 2025; ESA, ESA's Annual Space Environment Report, 2025.

³⁴³ See in more detail Underlying Principles of the Cologne Manual – Working Group Sustainability.



addition to these present-oriented provisions of safe traffic, there is a particular need to ensure long-term accessibility and operational usability. The focus on long-term accessibility and operational usability emphasises that outer space must remain open and usable for all in the future. All measures and joint efforts for sustainable use should not be seen as obstacles to equal access, but rather as the basis for it. Ensuring this long-term accessibility and usability requires the effective management of space debris, compliance with environmental standards and a cooperative approach to capacity issues.

II. Structure of the Guideline

The Guideline is divided into four paragraphs reflecting the different areas of long-term accessibility, operational usability as well as sustainability in and through outer space. Paragraphs one and two deal with space debris as a key risk for all future space activities. Apart from the general risks of uncontrolled re-entry, accidents on Earth and the resulting personal injury, property damage or environmental pollution, space debris is literally an obstacle to safe and sustainable space activities. To keep space and orbits open, it is necessary to prevent further growth of space debris as much as possible and to take measures to reduce the amount already present. The central importance of both mitigation and remediation is emphasised by the positioning of the paragraphs at the beginning of the Guideline. Since dealing with space debris must begin with preventing its creation, mitigation is the first step and paragraph. Remediation follows in the second paragraph as a joint effort that goes beyond prevention but is nevertheless necessary and urgent.

The third paragraph refers to compliance with international environmental standards. This reference reflects, first, the need for a broader understanding of the safe and sustainable use of space, which is not only about sustainability in space, but also about sustainability through space. Second, the third paragraph refers to Article III of the OST, thus expressing the fact that many norms and principles of international environmental law are also of great relevance for space activities and STM.

Finally, the fourth paragraph addresses the fact that comprehensive provisions for space activities, on the one hand, and on space debris, on the other, may not be sufficient to keep all regions of space open and usable. As the use of space increases, certain orbits or areas may become highly congested regions, requiring further coordination. As in the other paragraphs, paragraph four again emphasises the forward-looking nature of the whole Guideline 11.

III. Rationale of the Guideline



The guiding principle of the Guideline is to ensure long-term accessibility and operational usability (1.). To this end, it addresses the mitigation (2.) and remediation of space debris (3.), the compliance with environmental standards and obligations (4.) and the question of capacity assessment and planning (5.).

1. Guiding principle: long-term accessibility and operational usability

The title itself makes it clear that Guideline 11 is based on the guiding principle of long-term accessibility and operational usability of outer space. The Guideline does not only address sustainability in a narrow sense or the protection of the (space) environment but takes a broader approach. This approach is in line with Article I of the OST, which emphasises the close link between freedom of exploration and use of space, the principles of non-discrimination and equality, and free access to all areas of celestial bodies. The character of outer space as *res communis*³⁴⁴ goes hand in hand with the protection of the space environment as “basic condition for guaranteeing equal opportunities in exploration and use by all countries”³⁴⁵. The LTS Guidelines of UNCOPUS also link their understanding of the sustainable use of space in the present and future closely to “the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes.”³⁴⁶ Overall, the increasing use of space and the associated growing amount of space debris and other comparable risks are best addressed by the concept of long-term accessibility and operational usability.³⁴⁷

The latter considers both the equal right of all actors and nations to use space, regardless of their current level of technological development, and the preservation of space as a domain for future generations. The emphasis on accessibility reflects the recognition that space is a finite and increasingly crowded environment, where current actions shape the possibilities for future users. For this reason, certain minimum requirements must be met in the present, providing sustainable solutions for dealing with space debris and other comparable risks.

2. Mitigation

³⁴⁴ Hobe, *Space Law*, 2nd edition 2019, p. 71 et seqq.

³⁴⁵ Viikari, *The Environmental Element in Space Law*, Brill 2008, p. 59.

³⁴⁶ UNCOPUS, *Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space*, 20.06.2019, UN-Document A/74/20, Annex II, p. 50.

³⁴⁷ Viikari, *The Environmental Element in Space Law*, Brill 2008, p. 34, 58 et seq.; 147 et seq.; see also Gillet/Grünfeld/Ramuš Cvetkovič, *Lex Ad Astra*, p. 79; de Zwar/Henderson/Neumann, *Griffith Law Review* 32 (2023), p. 481 (482) and Wilson/Vasile, *Journal of Cleaner Production* 423 (2023) 13886, p. 1 et seqq.



Paragraph one of the Guideline is intended to respond to the recognition that space debris is one of the biggest risks for the long-term accessibility and operational usability of outer space.³⁴⁸ In the Scientific and Technical Subcommittee of UNCOPUS, it was noted early on that in order to maintain “unrestricted access to outer space, all space-faring nations should be implementing space debris mitigation measures as expeditiously as possible.”³⁴⁹ This idea is taken up and consistently developed in Paragraph one. First, the paragraph emphasises that the ability to participate in space travel goes hand in hand with the ability to take appropriate measures to mitigate debris. In this respect, the paragraph clarifies that mitigation is a task that concerns all space actors equally. Secondly, the paragraph links the task to compliance with international standards. The paragraph explicitly highlights the Space Debris Mitigation Guidelines by the UN and the IADC as they are an established and globally recognised standard. However, the wording of the paragraph (“in particular”) leaves the door open for the further development of the established standards for mitigation. It is therefore possible that space actors will voluntarily adopt stricter standards³⁵⁰ or that new common standards will be established at the international level in the future. Nevertheless, the paragraph already emphasises that achieving a high level of compliance with the explicitly mentioned standards is one of the most important factors in ensuring the long-term accessibility and operational usability of outer space.

The second sentence, which refers directly to the Space Debris Mitigation Guidelines,³⁵¹ makes it clear that mitigation is a comprehensive task covering all phases of space activities. At this point, the close link with the other Guidelines of the Cologne Manual becomes clear. General provisions on STM – like collision avoidance – also help to minimise the problems caused by space debris. However, Guideline 11 emphasises that there is also a need for forward-looking measures, in particular with regard to mission planning, production and design on the one hand and end-of-life measures on the other hand. Several factors come into play when deciding which mitigation measures are appropriate. Of particular importance are the altitude and inclination of the space object. For example, air friction below an altitude of 600 km means that objects have a comparatively short lifetime, which leads to a kind of self-cleaning mechanism. However, this should not lead to a *laissez-faire* approach. On the contrary, close monitoring and effective action are required, to avoid uncontrolled re-entries

³⁴⁸ Report of the Committee on the Peaceful Uses of Outer Space, 49th Session, UN-Document A/61/20, para. 129; in general *Viikari*, *The Environmental Element in Space Law*, Brill 2008, p. 31 et seqq.

³⁴⁹ UNCOPUS, Report of the Scientific and Technical Subcommittee, 42nd Session, UN-Document A/AC.105/848, para. 97.

³⁵⁰ See also below part III.

³⁵¹ UNOOSA, *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, p. 2.



or collisions. At the same time, the risk potential increases with the height of the orbit. There, especially at altitudes of 800 km and above, mitigation measures such as passivation, i.e. the removal of energy sources, and disposal manoeuvres are particularly important. The latter becomes more important with increasing altitude. In general, there is a graded system. At low altitudes, the main consideration is passivation, which is cost effective. At altitudes above 600 km, the ability and reliability of disposal manoeuvres becomes crucial. It is at high and frequently used altitudes, such as 800 km, that the costly issue of remediation arises.³⁵²

The first paragraph concludes with the need for regular review and adjustment of the implementation of mitigation measures. The third sentence of the first paragraph is formulated in an open way and includes the space actors or operators themselves as well as the respective States. While space actors and operators are the ones who directly implement the measures, particularly in the areas of design and manufacturing, it is States that can monitor compliance with the standards through authorisation and supervision under Article VI of the OST. States have a key role to play here, as they can require the implementation of mitigation measures for their own space activities, and at the same time make them a condition for the authorisation of private space activities. In addition to preventive control (e.g. through licensing conditions), repressive instruments such as reporting requirements and regular audits are also useful for enforcement. In any case, the implementation through national space legislation is crucial.

Many countries with national space legislation³⁵³ already have such requirements in their respective laws. The UNOOSA compiles the national and international measures in a compendium to provide States with information on the existing instruments and measures at the national and international level.³⁵⁴ In the future, the aim will be to increase the number of States with comprehensive space laws, including strong mitigation measures.

Finally, the reference to the need to adapt to best legal and technical practices also ties in with the open-ended nature of the first sentence. Scientific technical progress can bring new challenges as well as solutions. Regardless of whether these have already been fully incorporated into international standards, constant review and adaptation remains crucial.

³⁵² See also below 3. and 5.

³⁵³ For a general overview of existing national laws, see the UNOOSA database <https://www.unoosa.org/oosa/en/our-work/spacelaw/nationalspacelaw/index.html> (last accessed 05.02.2025).

³⁵⁴ The Compendium may be found online <https://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html> (last accessed 05.02.2025).



3. Remediation

The second paragraph of Guideline 11 emphasises that mitigation alone is not enough to find a sustainable solution for space debris. Firstly, mitigation efforts are not 100% adhered to or successful.³⁵⁵ Secondly, mitigation minimises the future accumulation of debris, while the existing debris already increases risk of collision and can produce more debris through collisions with other debris or active space objects. Remediation is hereby understood as “Remediation activities can include retrieval of a space object from outer space environment or from a particular orbit, repairing/servicing a space object, refuelling missions to extend the life of the space object or salvaging a space object for recycling or other purposes.”³⁵⁶ Without remediation the accumulation of debris therefore increases the risk of collision, potentially rendering some orbits unusable and disproportionately affecting new space actors who depend on shared, accessible and usable orbits.

Paragraph two emphasises the common interest in active debris removal. This understanding reflects the fact that space debris is a global challenge and that its solution benefits all current and future users of outer space. In this sense, the removal of space debris is not only a technical necessity, but a collective responsibility that reinforces the core principles of international space law³⁵⁷ by preserving outer space as an area for peaceful and equitable use. In the spirit of common but differentiated responsibilities,³⁵⁸ this is particularly relevant to those States that have historically made a greater contribution to space debris, but also have a greater deal of experience and technology for its removal. This leads back to the idea of accessibility. Not only is it in everyone’s interest, but it also highlights the special responsibility that experienced space actors have towards new space actors. In the future, it will therefore also be a matter of creating possible incentives to approach the joint task of remediation constructively.³⁵⁹

³⁵⁵ While disposal practice in GEO is positive, LEO disposal practice is primarily effected by naturally compliant orbits, see *Flohner*, Due regard and the need for space traffic coordination, 2025; *ESA*, ESA’s Annual Space Environment Report, 2025. For a further analysis see also UNCOUOS Compendium (found online <https://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html> (last accessed 05.02.2025)); *Carns*, Orbital Debris Prevention and Mitigation Efforts Among Major Space Actors, 2023; *Gillet/Grünfeld/Ramuš Cvetkovič*, *Lex Ad Astra*, 2025.

³⁵⁶ *Chatterjee*, “Legal Issues Relating to Unauthorised Space Debris Remediation”, 65th International Astronautical Congress, Toronto, Canada 2014.

³⁵⁷ See above The Imperative of Space Traffic Management: A Comprehensive Framework Rooted in the Principles of International Space Law 18.

³⁵⁸ On relevance of the idea for space law see *Gillet/Grünfeld/Cvetkovič*, *Lex Ad Astra*, p. 99 et seqq. and *Viikari*, *The Environmental Element in Space Law*, Brill 2008, p. 178 et seqq.

³⁵⁹ See also below part III.



The second sentence of the paragraph demands compliance with the Guidelines of the Cologne Manual for all remediation activities. In most cases, this point is primarily declaratory in nature. To the extent that disposal operations are carried out directly through some form of space activity, they fall within the scope of the Guidelines of the Cologne Manual anyway. However, the reference to the other Guidelines considers that the active remediation of space debris by removal is a novel and not yet thoroughly tested activity.³⁶⁰ In order to establish such activities as safe and beneficial to the long-term accessibility and operational usability of outer space, and to ensure that they are not misinterpreted as nefarious activities, space actors undertaking such missions should communicate their plans transparently and publicly. In addition, there should be a prior agreement and common understanding between the actor conducting such a mission, and the actors whose space object is to be removed regarding the activity in general and its concrete implementation in particular.³⁶¹ However, as the Manual also sets out essential requirements in this regard, the Guidelines also provide the applicable standard of care for all remediation activities. The latter is clearly emphasised by the second sentence.

4. Environmental Provisions

The third paragraph is based on the recognition that ensuring long-term access to and sustainable use of outer space goes beyond the sustainable management of space debris. In this respect, it is at this point that the idea of sustainability in and through space is most clearly expressed. Environmental standards play a central role in both aspects and may become relevant not only on Earth but also in space law through Article III of the OST.³⁶²

To strengthen sustainability in outer space, established environmental principles from frameworks such as the Rio Declaration³⁶³ could be adapted and applied. Concepts such as *sustainable develop-*

³⁶⁰ Notably, the ESA (https://www.esa.int/Space_Safety/ClearSpace-1) and JAXA (<https://www.kenkai.jaxa.jp/eng/crd2/about/>) are presently testing remediation technologies. However, other actors are likewise developing programs, among other major space powers: USA (Orbital Stability Act), Russia (<https://www.eurasiantimes.com/russia-sets-2030-timeline-to-launch-its-nuclear-powered-space-tug-that-can-clean-mounting-space-debris/>); https://eng.globalaffairs.ru/articles/celestial-dump-oreshenkov/#_ftn15); China (<https://english.news.cn/20221120/58d4a8932e904a45be3c19964d9dd4e6/c.html>), India (https://www.isro.gov.in/Debris_Free_Space_Missions.html).

³⁶¹ Remediation or active debris removal is not without controversy, specifically with regard to Article VIII of the OST and State jurisdiction in space object, see e.g. *Lachs*, *The Law of Outer Space*, 2010; *Froehlich* (ed.), *Space Security and Legal Aspects of Active Debris Removal*, ESPI/Springer, Vienna, 2019.

³⁶² In general, see *Ribbelink*, “Article III”, in: Hobe/Schmidt-Tedd/Schrogl/(eds.) Goh (assist. ed.), *The Cologne Commentary on Space Law: Vol. 1*, 2009, pp. 66 et seqq.

³⁶³ Report of the UN Conference on Environment and Development, Annex I, Rio Declaration on Environment and Development, Doc. A/CONF.151/26 (Vol. I) of 12 August 1992.



ment, due diligence, the precautionary principle, the polluter pays principle and common but differentiated responsibilities are well suited to addressing the challenges of space law,³⁶⁴ including STM. Since outer space, like the Earth's environment, is a shared and finite resource, such legal principles could help to ensure that all States, present and future, have fair access to the benefits of space activities.

At the same time, sustainability through outer space emphasises the critical role of space-based activities in protecting the Earth – such as using satellites for climate monitoring, disaster relief or other environmental research. Compliance with international environmental instruments and standards also plays a role here. This is already evident in the globally agreed climate protection commitments under the Paris Agreement³⁶⁵. This second dimension of sustainability underlines that STM is not only about preserving the space environment, but also about harnessing the capabilities of space to address global challenges.

Many national space laws already refer to the need for environmental protection or compliance with environmental standards. In this regard, UNOOSA provides a schematic overview of national space laws from which environmental requirements can be derived.³⁶⁶ Accordingly, explicit references to environmental protection or the prevention of pollution, in particular as part of safety, can be found in the laws of Algeria, Argentina, Armenia, Azerbaijan, Finland, France, Indonesia, Kazakhstan, the Netherlands, Russia, Slovenia, Ukraine and the United Kingdom. In some cases, compliance with environmental standards is explicitly mentioned in the context of licensing or authorisation. This is, for example, the case in Austria, Finland, Lichtenstein, the Netherlands and Nigeria. In addition to this overview, detailed references to environmental protection can also be found in the (space) laws

³⁶⁴ *Gillet/Grünfeld/Cvetkovič*, *Lex Ad Astra*, p. 83 et seqq.; *Viikari*, *The Environmental Element in Space Law*, Brill 2008, p. 119 et seqq., 127 et seqq.

³⁶⁵ Paris Agreement of 12 December 2015, UNTS, Vol. 3156, p. 79.

³⁶⁶ UNOOSA, Schematic Overview of National Regulatory Frameworks for Space Activities, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/schematic-overview.html> (last accessed 07.02.2025).



of Australia³⁶⁷, Belgium,³⁶⁸ Brazil³⁶⁹, Canada³⁷⁰, Denmark³⁷¹, Italy³⁷², Philippines³⁷³, Portugal³⁷⁴, Turkey³⁷⁵, the and the United States of America³⁷⁶. In the future, the aim should be to further embed both dimensions of sustainability and the importance of environmental standards in national legislation of all space actors.

5. Capacity Assessment and Planning

The final paragraph of the Guideline emphasises the need for international cooperation in assessing and planning capacity, particularly in highly congested orbital regions. The paragraph builds on the previous parts of the Guideline by recognising that even with measures to prevent new debris (mitigation) and remove existing debris (remediation), space remains a dynamic environment where coordinated management is essential for long-term accessibility and operational usability. This is especially true for large constellations or a generally higher frequency in certain regions.

Space capacity assessment and planning could be essential tools to prevent collisions, optimise orbital resources and ensure that space remains a safe and secure place for all users. In highly congested regions, such as Low Earth Orbit (LEO) and certain geostationary slots, uncoordinated activities could lead to cascading risks and undermine both sustainable use and equitable access. A particularly high spatial density of objects is found in sun-synchronous orbits, often around 800 km altitude. The inclination of the orbit also plays an important role. By encouraging States to cooperate in this respect, the Guideline is in line with the overarching principle that space is a shared but finite environment in which the actions of one actor can have far-reaching consequences.

³⁶⁷ Articles 8, 35, 21, 55 and 101 Space (Launches and Returns) (General) Rules 2019, compilation date August 26, 2019; entered into force August 31, 2019; last amended on August 17, 2023.

³⁶⁸ Article 8, Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects (revised on Dec. 1, 2013), Belgian Official Journal of Jan. 15, 2014;

³⁶⁹ Article 9 of the Annex, Administrative Edict No. 96 of 30 November, 2011.

³⁷⁰ Section 9 Remote Sensing Space Systems Regulations SOR/2007-66 of 39 March 2007.

³⁷¹ Sections 3 and 7 Executive Order no. 552 of 31 May 2016 on requirements in connection with approval of activities in outer space, etc.

³⁷² Article 21 of Legislative Decree No. 128 of June 4, 2003, Reorganisation of the Italian Space Agency (A.S.I.). last amended by Law No. 7, 11 January 2018: Measures for the coordination of space and aerospace policy and provisions concerning the organisation and operation of the Italian Space Agency (18G00025) (Official Gazette, General Series, No. 34, 10 February 2018).

³⁷³ Section 2 Republic Act No. 10692 (The PAGASA Modernization Act of 2015).

³⁷⁴ Article 7 Decree-Law no. 16/2019, of 22 January, Legal regime of access to and exercise of space activities; Articles 15, 20, 22 Regulation no. 697/2019, of 5 September, regulation on access to and exercise of space activities.

³⁷⁵ Article 4 Presidential Decree on the Establishment of Turkish Space Agency (Türkiye Uzay Ajansı Hakkında Cumhurbaşkanlığı Kararnamesi).

³⁷⁶ Part 1216 Code of Federal Regulations, Title 14 (Aeronautics and Space); Parts 5, 25, and 9, Code of Federal Regulations, Titel 47 (Telecommunication).



Furthermore, this cooperative approach reflects the fact that mitigation, remediation or environmental protection alone cannot guarantee long-term accessibility and operational usability. Instead, effective space governance requires a proactive strategy that combines technical measures with legal and political coordination. However, the Guideline recognises that States have considerable latitude in deciding whether and how to address the issue of capacity in detail.

IV. Future developments

In the event of comprehensive international coordination, incentives could be used to achieve higher standards. For example, financial incentives in the case of a “remediation fund”, priority for launching or priority for frequency allocation through ITU. In addition, a sustainability rating system could be introduced to transparently demonstrate compliance with higher standards. In the future, a stronger consideration of (market) economic approaches could also play a role here. The cleaning of outer space could become an economic interest. On the one hand, because the resource “free orbits” might become increasingly scarce. On the other hand, large constellations in particular are likely to increase the need for regular maintenance and debris removal. Not only operators have an economic interest in (high) standards, but also insurance companies and investors. The question of insurability and financial security of investments may therefore become increasingly important. Especially in the case of large constellations, there is also the possibility of collisions within the constellation, which will increasingly raise the question of coordination and cooperation in the future.

However, in the short and medium term, the State authorisation and supervision component of Article VI of the OST is likely to remain most relevant. The focus should be on strengthening the various aspects of long-term accessibility and operational usability. This concerns international instruments and cooperation as well as implementation in national law. In particular, authorisation or licensing can and should be made dependent on compliance with the elements of mitigation, remediation and environmental protection. In the long term, especially with regard to an international agency for STM, the more comprehensive coordination and monitoring of mitigation as well as the implementation of remediation could play a central role.



Annex 1:
State practice

1. National Space Acts Collision Avoidance Provisions

Translation notes: This annex contains an overview of national legislation concerning collision avoidance. Wherever they were available, official translations by the competent authorities have been used. However, unofficial translations have been inserted when no authorised translated version was publicly accessible. For legal certainty, particularly regarding the precise formulation of the norms, the original statutory and regulatory texts should be referred to.

Purpose	<p><u>State:</u> Indonesia</p> <p>Article 1</p> <p>In this Law what is meant by:</p> <p>11. Safety is a state of fulfillment safety requirements in area utilization Indonesia, Spacecraft, Airport area Space, space transportation, navigation Space, society, and supporting facilities and other public facilities.</p> <p>12. Security is all the effort and commitment international for each Organizer Space to maintain and/or ensuring the utilization of space and objects other skies for peaceful purposes and does not cause damage to the earth's environment and Space through integrated utilization, human resources, facilities, and procedures.</p> <p>Article 51</p> <p>(1) Each Space Organizer is responsible for the security of the Implementation of Space.</p> <p>(2) To ensure the security of the Implementation Space, every Space Operator must meet the standards and procedures of Security.</p>
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(3) Institutions are required to oversee compliance with Security standards and procedures implemented by each Space Operator.

Article 52

(1) Every Space Implementation must be carried out in compliance with Safety standards.

(2) Institutions, Ministers, and / or ministers who are organizing government affairs in the field of national defense are obliged to provide information safety of Space Implementation.

(3) Institutions, in the interest of Safety Space, must inform the threat of Safety to the Space Operator.

National Space Law Act: Law No. 21 of 2013 on Space Activities

State: Lichtenstein

Article 1. Purpose

1. The purpose of this Act is to implement Liechtenstein's obligations under international law with respect to activities for the exploration and use of outer space and to prevent damage caused by space objects for which Liechtenstein may be held internationally liable.

2. It serves in particular:

[...]

c. ensuring the highest possible safety of space activities, in particular the prevention of personal injury and damage to property, ensuring public safety and health, and protecting the environment;

the preservation of the long-term usability of space and the prevention of space debris;



	<p>[...]</p> <p><u>National Space Law Act</u>: Act from 5th October 2023 “On the Authorization of Space Activities and the Registration of Space Objects</p>
Requirements for the carrying out space activities in general	<p><u>State</u>: Italy</p> <p>Article 6. Subjective requirements</p> <p>The authorization to carry out space activities is subject to the following subjective requirements:</p> <p>[...]</p> <p>e) Availability of a collision avoidance service either on its own or provided by a qualified supplier</p> <p><u>National Space Law Act</u>: Provisions on the Space Economy [not yet in force]</p> <p><u>State</u>: United States of America</p> <p>§ 25.114. Applications for space station authorizations</p> <p>[...]</p> <p>d) The following information in narrative form shall be contained in each application [...]:</p> <p>(14)A description of the design and operational strategies that will be used to mitigate orbital debris, including the following information:</p> <p>i. A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a</p>



source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal;

- ii. (ii) A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application
- iii. A statement that the space station operator has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact and ascertain the likelihood of successful coordination of physical operations with, the other system. The statement



must disclose the accuracy—if any—with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances, *i.e.*, it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. Where a space station requests the assignment of a geostationary-Earth orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions;

- iv. A statement detailing the post-mission disposal plans for the space station at end of life, including the quantity of fuel—if any—that will be reserved for post-mission disposal maneuvers. For geostationary-Earth orbit space stations, the statement must disclose the altitude selected for a post-mission disposal orbit and the calculations that are used in deriving the disposal altitude. The statement must also include a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether portions of the spacecraft will survive re-entry and reach



	<p>the surface of the Earth, as well as an estimate of the resulting probability of human casualty. Applicants for space stations to be used only for commercial remote sensing may, in lieu of submitting detailed post-mission disposal plans to the Commission, certify that they have submitted such plans to the National Oceanic and Atmospheric Administration for review.</p> <p>v. For non-U.S.-licensed space stations, the requirement to describe the design and operational strategies to minimise orbital debris risk can be satisfied by demonstrating that debris mitigation plans for the space station(s) for which U.S. market access is requested are subject to direct and effective regulatory oversight by the national licensing authority.</p> <p><u>National space law act</u>: US <i>Code of Federal Regulations</i>, Title 47 – Telecommunication, US 47CFR25, last amended 2024</p>
<p>Requirements, for launch authorisations</p>	<p><u>State</u>: Indonesia</p> <p>Article 53</p> <p>(1) Institutions are obliged to appoint and assign launch safety officer for each launch facility that has a license.</p> <p>(2) Each launch safety officer as referred to in paragraph (1) may be assigned to several launch facilities.</p> <p><u>National Space Law Act</u>: Law No. 21 of 2013 on Space Activities</p> <p><u>State</u>: Liechtenstein</p> <p>Article 4 Information and Documents</p> <p>1. The approval application must include the following information and documents:</p>



[...]

c. for a detailed description of space activity and proof of financial capability to conduct space activity under Art. 5 para. 1 lit. b of the Act:

2. [...]

3. a detailed concept, including system descriptions, processes, mechanisms, and methods, to present the planned tasks, purposes, and goals of space activity; the operator must provide information in particular about:

aa) the conduct of the launch into orbit or beyond, including an assessment of associated risks, proof that the launch and operation of the space object will be conducted safely and sustainably, and proof that the launch does not pose an unacceptable danger to the public;

bb) the assessment of liability risk and details about approaches to other space objects, the likelihood of collision, resulting damage claims, and a description of measures taken against these risks;

cc) the safe conduct of activities in orbit or beyond, the deployment of the space object from the launch vehicle, as well as altitude control, steering, and orientation of the space object, especially its propulsion system for ascent, including information on meeting conditions and responsibilities for conducting corresponding “Command & Control” activities or command, control, and telemetry systems;

dd) maintenance of space objects or their replacement, in particular in the case of satellite constellations;

ee) an adequate quality management system for ongoing monitoring and implementation of activities;

ff) planned and unplanned termination, processes and mechanisms for disposal, as well as prevention of collisions and other damages,



4. technical details of space activity, in particular power supply, description of the intended payload, communication strategy, geographic location, technical details of ground stations, and technologies used at the subsystem level; To demonstrate that the space object, in accordance with Art. 5, para. 1 lit. f of the Act, does not contain dangerous or harmful substances that could lead to harmful contamination of outer space or detrimental changes to the environment, the appropriate documentation is required;

To demonstrate corresponding measures to prevent space debris in accordance with Article 5, para. 1 lit. g of the Act:

A report on measures taken in accordance with the state of the art and considering internationally recognized guidelines, such as those of the Inter-Agency Debris Coordination Committee (IADC), especially:

aa) to prevent space debris and mission residues during normal operations;

bb) to prevent the disintegration of the space object in orbit;

cc) for the removal of the space object after the end of space activity, either through controlled re-entry or descent or by placing it in a sufficiently high orbit ("graveyard orbit"). For non-maneuverable space objects, the orbit should be chosen so that they are expected to remain in orbit for no longer than 25 years after the end of their operation;

An overview of measures taken to avoid collisions with other space objects in outer space;

[...]

National space law act: Ordinance dated 4th December 2023 “On the Authorization of Space Activities and the Registration of Space Objects”



State: United States of America

Title 47 – Telecommunication

§ 25.117 Modification of station license.

h. Unless otherwise ordered by the Commission, an application for any of the following kinds of modification of the operation of a GSO space station will be deemed granted 35 days after the date of the public notice that the application has been accepted [...]

(1) Relocation of a DBS or GSO FSS space station by no more than 0.15° from the initially authorized orbital location, provided the application includes a signed certification that:

(i) The space station operator has assessed and limited the probability of the satellite becoming a source of debris as a result of collisions with large debris or other operational satellites at the new orbital location; and

(ii) The proposed station-keeping volume of the satellite following relocation will not overlap a station-keeping volume reasonably expected to be occupied by any other satellite, including those authorized by the Commission, applied for and pending before the Commission, or otherwise the subject of an ITU filing and either in orbit or progressing towards launch.

(2) Repositioning one or more antenna beams by no more than 0.3 angular degrees from a line between the space station and the initially authorized boresight location(s).

§ 25.122 Applications for streamlined small space station authorization.

(a) This section shall only apply to applicants for NGSO [...] systems that are able to certify compliance with the certifications set forth in paragraph (c) of this section. For applicants seeking to



be authorized under this section, a comprehensive proposal for Commission evaluation must be submitted for each space station in the proposed system on FCC Form 312, Main Form and Schedule S, as described in § 25.114(a) through (c), together with the certifications described in paragraph (c) of this section and the narrative requirements described in paragraph (d) of this section.

(b) Applications for NGSO systems may be filed under this section, provided that the total number of space stations requested in the application is ten or fewer.

(1) To the extent that space stations in the satellite system will be technically identical, the applicant may submit an application for blanket-licensed space stations.

(2) Where the space stations in the satellite system are not technically identical, the applicant must certify that each space station satisfies the criteria in paragraph (c) of this section, and submit technical information for each type of space station.

(c) Applicants filing for authorization under the streamlined procedure described in this section must include with their applications certifications that the following criteria will be met for all space stations to be operated under the license:

(1) The space station(s) will operate only in non-geostationary orbit;

(2) The total in-orbit lifetime for any individual space station will be six years or less;

(3) The space station(s):

(i) Will be deployed at an orbital altitude of 600 km or below; or

(ii) Will maintain a propulsion system and have the ability to make collision avoidance and deorbit maneuvers using propulsion;



- (4) Each space station will be identifiable by a unique signal-based telemetry marker distinguishing it from other space stations or space objects;
- (5) The space station(s) will release no operational debris;
- (6) The space station operator has assessed and limited the probability of accidental explosions, including those resulting from the conversion of energy sources on board the space station(s) into energy that fragments the spacecraft;
- (7) The probability of a collision between each space station and any other large object (10 centimeters or larger) during the orbital lifetime of the space station is 0.001 or less as calculated using current National Aeronautics and Space Administration (NASA) software or other higher fidelity model;
- (8) The space station(s) will be disposed of post-mission through atmospheric re-entry. The probability of human casualty from portions of the spacecraft surviving re-entry and reaching the surface of the Earth is zero as calculated using current NASA software or higher fidelity models;
- (9) Operation of the space station(s) will be compatible with existing operations in the authorized frequency band(s). Operations will not materially constrain future space station entrants from using the authorized frequency band(s);
- (10) The space station(s) can be commanded by command originating from the ground to immediately cease transmissions and the licensee will have the capability to eliminate harmful interference when required under the terms of the license or other applicable regulations;
- (11) Each space station is 10 cm or larger in its smallest dimension; and



(12) Each space station will have a mass of 180 kg or less, including any propellant.

§ 25.123 Applications for streamlined small spacecraft authorization.

(a) This section shall only apply to applicants for space stations that will operate beyond Earth's orbit and that are able to certify compliance with the certifications set forth in paragraph (b) of this section. For applicants seeking to be authorized under this section, a comprehensive proposal for Commission evaluation must be submitted for each space station in the proposed system on FCC Form 312, Main Form and Schedule S, as described in § 25.114(a) through (c), together with the certifications described in paragraph (b) of this section and the requirements described in paragraph (c) of this section.

(b) Applicants filing for authorization under the streamlined procedure described in this section must include with their applications certifications that the following criteria will be met for all space stations to be operated under the license:

- (1) The space station(s) will operate and be disposed of beyond Earth's orbit;
- (2) The total lifetime from deployment to spacecraft end-of-life for any individual space station will be six years or less;
- (3) Each space station will be identifiable by a unique signal-based telemetry marker distinguishing it from other space stations or space objects;
- (4) The space station(s) will release no operational debris;
- (5) No debris will be generated in an accidental explosion resulting from the conversion of energy sources on board the space station(s) into energy that fragments the spacecraft;



(6) The probability of a collision between each space station and any other large object (10 centimeters or larger) during the lifetime of the space station is 0.001 or less as calculated using current NASA software or higher fidelity models;

(7) Operation of the space station(s) will be compatible with existing operations in the authorized frequency band(s). Operations will not materially constrain future space station entrants from using the authorized frequency band(s);

(8) The space station(s) can be commanded by command originating from the ground to immediately cease transmissions and the licensee will have the capability to eliminate harmful interference when required under the terms of the license or other applicable regulations;

(9) Each space station is 10 cm or larger in its smallest dimension; and

(10) Each space station will have a mass of 500 kg or less, including any propellant

25.280 Inclined orbit operations.

(a) Satellite operators may commence operation in inclined orbit mode without obtaining prior Commission authorization provided that the Commission is notified by letter within 30 days after the last north-south station keeping maneuver. The notification shall include:

(1) The operator's name;

(2) The date of commencement of inclined orbit operation;

(3) The initial inclination;

(4) The rate of change in inclination per year; and



(5) The expected end-of-life of the satellite accounting for inclined orbit operation, and the maneuvers specified under § 25.283 of the Commission's rules.

(b) Licensees operating in inclined-orbit are required to:

(1) Periodically correct the satellite attitude to achieve a stationary spacecraft antenna pattern on the surface of the Earth and centered on the satellite's designated service area;

(2) Control all electrical interference to adjacent satellites, as a result of operating in an inclined orbit, to levels not to exceed that which would be caused by the satellite operating without an inclined orbit;

(3) Not claim protection in excess of the protection that would be received by the satellite network operating without an inclined orbit; and

(4) Continue to maintain the space station at the authorized longitude orbital location in the geostationary satellite arc with the appropriate east-west station-keeping tolerance.

§ 25.282 Orbit raising maneuvers.

A space station authorized to operate in the geostationary satellite orbit under this part is also authorized to transmit in connection with short-term, transitory maneuvers directly related to post-launch, orbit-raising maneuvers, provided that the following conditions are met:

(a) Authority is limited to those tracking, telemetry, and control frequencies in which the space station is authorized to operate once it reaches its assigned geostationary orbital location;

(b) The space station operator will coordinate on an operator-to-operator basis with any potentially affected satellite networks.



(c) The space station licensee is required to accept interference from any lawfully operating satellite network or radio communication system.

National space law act: *US Code of Federal Regulations*, Title 47 – Telecommunication, US 47CFR25, last amended 2024

§ 450.101 Safety criteria.

(e) Protection of people and property on orbit.

(1) A launch or reentry operator must prevent the collision between a launch or reentry vehicle stage or component and people or property on orbit, in accordance with the requirements in § 450.169(a).

(2) For any launch vehicle stage or component that reaches Earth orbit, a launch operator must prevent the creation of debris through the conversion of energy sources into energy that fragments the stage or component, in accordance with the requirements in § 450.171.

(f) Notification of planned impacts. For any launch, reentry, or disposal, an operator must notify the public of any region of land, sea, or air that contains, with 97 percent probability of containment, all debris resulting from normal flight events capable of causing a casualty.

§ 450.103 System safety program.

An operator must implement and document a system safety program throughout the lifecycle of a launch or reentry system that includes the following:

(a) Safety organization. An operator must maintain a safety organization that has clearly defined lines of communication and



approval authority for all public safety decisions. At a minimum, the safety organization must have the following positions:

(1) Mission director. For each launch or reentry, an operator must designate a position responsible for the safe conduct of all licensed activities and authorized to provide final approval to proceed with licensed activities. This position is referred to as the mission director in this part.

(2) Safety official. For each launch or reentry, an operator must designate a position with direct access to the mission director who is—

(i) Responsible for communicating potential safety and non-compliance issues to the mission director; and

(ii) Authorized to examine all aspects of the operator's ground and flight safety operations, and to independently monitor compliance with the operator's safety policies, safety procedures, and licensing requirements.

(3) Addressing safety official concerns. The mission director must ensure that all of the safety official's concerns are addressed.

(b) Hazard management. For hazard management:

(1) An operator must implement methods to assess the system to ensure the validity of the hazard control strategy determination and any flight hazard or flight safety analysis throughout the lifecycle of the launch or reentry system;

(2) An operator must implement methods for communicating and implementing any updates throughout the organization; and

(3) Additionally, an operator required to conduct a flight hazard analysis must implement a process for tracking hazards, risks, mitigation measures, and verification activities



§ 450.147 Agreements.

(a) General. An operator must establish a written agreement with an entity that provides a service or property that meets a requirement in this part, including;

(1) Launch and reentry site use agreements. A Federal launch or reentry site operator, a licensed launch or reentry site operator, or any other person that provides services or access to or use of property required to support the safe launch or reentry under this part;

(2) Agreements for notices to mariners. Unless otherwise addressed in agreements with the site operator, for overflight of navigable water, the U.S. Coast Guard or other applicable maritime authority to establish procedures for the issuance of a Notice to Mariners prior to a launch or reentry and other measures necessary to protect public health and safety;

(3) Agreements for notices to airmen. Unless otherwise addressed in agreements with the site operator, the FAA Air Traffic Organization or other applicable air navigation authority to establish procedures for the issuance of a Notice to Airmen prior to a launch or reentry, for closing of air routes during the respective launch and reentry windows, and for other measures necessary to protect public health and safety; [...]

§ 450.169 Launch and reentry collision avoidance analysis requirements.

(a) Criteria. Except as provided in paragraph (d) of this section, for an orbital or suborbital launch or reentry, an operator must establish window closures needed to ensure that the launch or reentry vehicle, any jettisoned components, or payloads meet the



following requirements with respect to orbiting objects, not including any object being launched or reentered.

(1) For inhabitable objects, one of three criteria below must be met:

(i) The probability of collision between the launching or reentering objects and any inhabitable object must not exceed 1×10^{-6} ;

(ii) The launching or reentering objects must maintain an ellipsoidal separation distance of 200 km in-track and 50 km cross-track and radially from the inhabitable object; or

(iii) The launching or reentering objects must maintain a spherical separation distance of 200 km from the inhabitable object.

(2) For objects that are neither orbital debris nor inhabitable, one of the two criteria below must be met:

(i) The probability of collision between the launching or reentering objects and any object must not exceed 1×10^{-5} ;
or

(ii) The launching or reentering objects must maintain a spherical separation distance of 25 km from the object.

(3) For all other known orbital debris identified by the FAA or other Federal Government entity as large objects with radar cross section greater than 1 m^2 and medium objects with radar cross section 0.1 m^2 to 1 m^2 :

(i) The probability of collision between the launching or reentering objects and any known orbital debris must not exceed 1×10^{-5} ; or

(ii) The launching or reentering objects must maintain a spherical separation distance of 2.5 km.



(b) Screening time. A launch or reentry operator must ensure the requirements of paragraph (a) of this section are met as follows:

(1) Through the entire segment of flight of a suborbital launch vehicle above 150 km;

(2) For an orbital launch, during ascent from a minimum of 150 km to initial orbital insertion and for a minimum of 3 hours from liftoff;

(3) For reentry, during descent from initial reentry burn to 150 km altitude; and

(4) For disposal, during descent from initial disposal burn to 150 km altitude.

(c) Rendezvous. Planned rendezvous operations that occur within the screening time frame are not considered a violation of collision avoidance if the involved operators have pre-coordinated the rendezvous or close approach.

(d) Exception. A launch collision avoidance analysis is not required for any launched object if the maximum planned altitude by that object is less than 150 km.

(e) Analysis. Collision avoidance analysis must be obtained for each launch or reentry from a Federal entity identified by the FAA, or another entity agreed to by the Administrator.

(1) An operator must use the results of the collision avoidance analysis to establish flight commit criteria for collision avoidance; and

(2) The collision avoidance analysis must account for uncertainties associated with launch or reentry vehicle performance and timing, and ensure that each window closure incorporates all additional time periods associated with such uncertainties.

(f) Timing and information required. An operator must prepare a collision avoidance analysis worksheet for each launch or reentry



using a standardized format that contains the input data required by appendix A to this part, as follows:

(1) Except as specified in paragraphs (f)(1)(i) and (ii) of this section, an operator must file the input data with an entity identified in paragraph (e) of this section and the FAA at least 7 days before the first attempt at the flight of a launch vehicle or the reentry of a reentry vehicle.

(i) Operators that have never received a launch or reentry conjunction assessment from the entity identified in paragraph (e) of this section, must file the input data at least 15 days in advance.

(ii) The Administrator may agree to an alternative time frame in accordance with § 404.15;

(2) An operator must obtain a collision avoidance analysis performed by an entity identified in paragraph (e) of this section, no later than 3 hours before the beginning of a launch or reentry window; and

(3) If an operator needs an updated collision avoidance analysis due to a launch or reentry delay, the operator must file the request with the entity identified in paragraph (e) of this section and the FAA at least 12 hours prior to the beginning of the new launch or reentry window.

National space law act: United States of America, *US Code of Federal Regulations, Title 14 — Aeronautics and Space*, last amended on May 31, 2024



	<p><u>State:</u> Slovakia</p> <p>§ 4</p> <p>[...]</p> <p>3) No later than 30 days before the planned launch of the space object, the applicant shall submit to the application for a permit</p> <ul style="list-style-type: none">a) information on the concluded contract with the launch facility operator in the scope of identification of the contracting parties, the location of the space object launch, the launch schedule,b) A protocol on the performance of tests to verify the technical capability of the space object,c) information on the concluded cooperation agreement, if the permitted regulated space activity is carried out on the basis of an agreement with other states,d) [...]e) a certificate of special professional competence for operating selected radio equipment, if required by the regulated space activity that is the subject of the application for a permit <p><u>National Space Law Act:</u> Regulation of Space Activities (Slovak Space Act) 2024</p>
Duty to inform before the launch	<p><u>State:</u> Australia</p> <p>37. Launch information and notice of changes</p> <p>(1) The holder of the permit must, at least 2 days before a launch but not more than 10 days before, give the Minister:</p> <p>[...]</p> <ul style="list-style-type: none">(c) confirmation of the day the launch is scheduled to take place and the launch window on that day; and



(d) information about any subsequent days, and the launch window on each of those days, that the launch may be attempted if it does not occur on the scheduled day; and

(e) confirmation of the planned trajectory of the space object.

(2) If the launch does not occur on the scheduled day mentioned in paragraph (1)(a) and the holder of the permit intends to attempt the launch on a day mentioned in paragraph (1)(b), the holder must notify the Minister as soon as practicable.

47. Information about flight path

(1) The application must include the following information for each launch:

[...]

(c) a description of the flight path;

(d) the name and location of any critical asset that is:

(i) directly under the flight path; or

(ii) within an area of reasonable probability in which any debris may land (both scheduled debris within the meaning of the Flight Safety Code and unscheduled debris);

(e) for critical assets referred to in paragraph (b) - an explanation of why the applicant considers the flight path is appropriate and safe given the location of the assets.

(2) The application must include, for each launch that has a connected return, information about the following in relation to each space object to be returned:

(a) a description of the path of the space object;

(b) the ground track for re-entry;

(c) staging events for the return;



(d) predicted errors in accuracy for the re-entry and landing of the space object.

53. Flight safety plan

(1) The application must include a flight safety plan for the launch or series of launches and any connected return.

(2) The plan must include the following:

(a) the strategies and arrangements to be used by the applicant to ensure that the launch or launches, the operation of the launch vehicle on the flight path and any connected return will be conducted:

(i) in a way that reduces the level of risk to third parties to as low as is reasonably practicable; and

(ii) within the launch safety standards set out in the Flight Safety Code;

(b) arrangements for reporting to the Minister any changes in:

(i) the arrangements for conducting the launch or launches and any connected return; or

(ii) the assumptions and data used in the risk hazard analysis for each launch and connected return;

(c) arrangements for subsequent reporting to the Minister on the compliance of the launch or launches, the operation of the launch vehicle on the flight path and any connected return with:

(i) the launch safety standards; and

(ii) the assumptions and data used in the risk hazard analysis for each launch and connected return.

(4) The application must include written confirmation by a suitably qualified expert, who is approved by the Minister, that



the launch or launches, the operation of the launch vehicle on the flight path and any connected return will fall within the launch safety standards if carried out in accordance with the flight safety plan.

National space law act: Australia, *Space (Launches and Returns) (General) Rules 2019*, compilation date August 26, 2019; entered into force August 31, 2019; last amended on August 17, 2023.

State: United States of America

§ 450.213 Pre-flight reporting.

(e) Collision avoidance analysis. A licensee must submit to a Federal entity identified by the FAA and to the FAA the collision avoidance information in appendix A to part 450 in accordance with § 450.169(f).

[...]

Appendix A to Part 450—Collision Analysis Worksheet

(a) Launch or reentry information. An operator must file the following information:

- (1) Mission name. A mnemonic given to the launch vehicle/payload combination identifying the launch mission distinctly from all others;
- (2) Launch location. Launch site location in latitude and longitude;



(3) Launch or reentry window. The launch or reentry window opening and closing times in Greenwich Mean Time (referred to as ZULU time) and the Julian dates for each scheduled launch or reentry attempts including primary and secondary launch or reentry dates;

(4) Epoch. The epoch time, in Greenwich Mean Time (GMT), of the expected launch vehicle liftoff time;

(5) Segment number. A segment is defined as a launch vehicle stage or payload after the thrusting portion of its flight has ended. This includes the jettison or deployment of any stage or payload. For each segment, an operator must determine the orbital parameters;

(6) Orbital parameters. An operator must identify the orbital parameters for all objects achieving orbit including the parameters for each segment after thrust ends;

(7) Orbiting objects to evaluate. An operator must identify all orbiting object descriptions including object name, length, width, depth, diameter, and mass;

(8) Time of powered flight and sequence of events. The elapsed time in hours, minutes, and seconds, from liftoff to passivation or disposal. The input data must include the time of powered flight for each stage or jettisoned component measured from liftoff; and

(9) Point of contact. The person or office within an operator's organization that collects, analyzes, and distributes collision avoidance analysis results.

(b) Collision avoidance analysis results transmission medium. An operator must identify the transmission medium, such as voice or email, for receiving results.



(c) Deliverable schedule/need dates. An operator must identify the times before flight, referred to as “L-times,” for which the operator requests a collision avoidance analysis. The final collision avoidance analysis must be used to establish flight commit criteria for a launch.

(d) Trajectory files. Individual position and velocity trajectory files, including:

(1) The position coordinates in the Earth-Fixed Greenwich (EFG) coordinates system measured in kilometers and the EFG velocity components measured in kilometers per second, of each launch vehicle stage or payload starting below 150 km through screening time frame;

(2) Radar cross section values for each individual file;

(3) Position Covariance, if probability of impact analysis option is desired; and

(4) Separate trajectory files identified by valid window time frames, if launch or reentry trajectory changes during launch or reentry window.

(e) Screening. An operator must select spherical, ellipsoidal, or collision probability screening as defined in this paragraph for determining any conjunction:

(1) Spherical screening. Spherical screening centers a sphere on each orbiting object's center-of-mass to determine any conjunction;

(2) Ellipsoidal screening. Ellipsoidal screening utilizes an impact exclusion ellipsoid of revolution centered on the orbiting object's center-of-mass to determine any conjunction. An operator must provide input in the UVW coordinate system in kilo-



	<p>meters. The operator must provide delta-U measured in the radial-track direction, delta-V measured in the in-track direction, and delta-W measured in the cross-track direction; or</p> <p>(3) Probability of Collision. Collision probability is calculated using position and velocity information with covariance in position.</p> <p><u>National space law act</u>: United States of America, <i>US Code of Federal Regulations, Title 14 — Aeronautics and Space</i>, last amended on May 31, 2024</p>
Duty to inform during and after launches	<p><u>State</u>: Australia</p> <p>46L. Giving a return authorization</p> <p>(1) The Minister may give a person a return authorization that authorizes:</p> <p>(a) the return of a space object to a specified place or area in Australia or outside Australia; or</p> <p>(b) a particular series of such returns that, in the Minister's opinion, having regard to the nature of the space objects to be returned, may appropriately be authorized by a single return authorization.</p> <p><u>National space law act</u>: Australia, <i>An Act about space activities and high power rockets, and for related purposes</i> (Space (Launches and Returns) Act 2018), compilation date August 31, 2019; entered into force on August 31, 2019; Act No. 92, 2018.</p> <p>39. Information that must be given after launch</p> <p>The holder of the permit must give the Minister the following as soon as practicable after the launch of a space object authorized by the permit:</p>



	<p>(a) the information about the orbital parameters of the space object mentioned in paragraph 1(d) of Article IV of the Registration Convention;</p> <p>(b) if a country other than Australia is a launching state for the space object—whether the other launching state has indicated it wishes to register the space object;</p> <p>(c) a report on the compliance of the launch with the launch safety standards in the Flight Safety Code and with the assumptions and data used in the risk hazard analysis for the launch.</p> <p><u>National space law act:</u> Australia, <i>Space (Launches and Returns) (General) Rules 2019</i>, compilation date August 26, 2019; entered into force August 31, 2019; last amended on August 17, 2023.</p>
Design of the space object in itself	<p><u>State:</u> France</p> <p>Article 41</p> <p>The systems must be designed, produced and implemented, and their mission defined in such a way as to limit, during the space operation and three days following the end of the operation, the risks of accidental collision with inhabited objects and satellites in the geostationary orbit whose orbital parameters are precisely known and available.</p> <p><u>National space law act:</u> France, <i>Technical Regulations to the French Space Operations Act</i>, last amended 2022, unofficial translation into English.</p>
Requirement of a supervisor	<p><u>State:</u> United States of America</p> <p>§ 405.1 Monitoring of licensed, permitted, and other activities.</p>



Each licensee or permittee must allow access by and cooperate with Federal officers or employees or other individuals authorized by the Associate Administrator to observe licensed facilities and activities, including launch sites and reentry sites, as well as manufacturing, production, testing, and training facilities, or assembly sites used by any contractor, licensee, or permittee to produce, assemble, or test a launch or reentry vehicle and to integrate a payload with its launch or reentry vehicle. Observations are conducted to monitor the activities of the licensee, permittee, or contractor at such time and to such extent as the Associate Administrator considers reasonable and necessary to determine compliance with the license or permit or to perform the Associate Administrator's responsibilities pertaining to payloads for which no Federal license, authorization, or permit is required.

National space law act: United States of America, *US Code of Federal Regulations, Title 14 — Aeronautics and Space*, last amended on May 31, 2024

State: Indonesia

Article 53

(3) Institutions are obliged to appoint and assign launch safety officer for each launch facility that has a license.

(4) Each launch safety officer as referred to in paragraph (1) may be assigned to several launch facilities.

Article 54

The launch safety officer, as referred to in Article 53 paragraph (1) is tasked with ensuring:

a. the launch has been carried out in accordance with standard operational procedures;



- b. b. the launch process until the Space Object has reached or passed through orbit does not endanger people or objects; and
- c. compliance with a Space activity license or launch license.

Article 55

(1) Based on the duties as referred to in Article 54, launch safety officers are authorized to take actions deemed necessary in accordance with his duties.

(2) Launch safety officers at launch facilities as referred to in paragraph (1) is authorized to:

- a. enter and inspect the facility and any Space Objects and test other equipment located at the facility with the approval of the Space activity license holder or his/her appointed;
- b. obtain information or assistance deemed necessary from the license holder, employees, and agents or contractors; and
- c. provide instructions regarding the launch of Spacecraft, or planned launches, at such facilities as deemed necessary, including providing instructions for termination of the launch or destruction of the Space Objects, both before and after launch.

(3) The launch safety officer at the launch facility in carrying out his duties shall show identity to the license holder Space activities.

(4) Launch safety officers are prohibited from having business relationships and other relationships that are binding with the holder of the Space activity license holder or launch license.

Article 56

Every Space activity license holder, employee, and agents or contractors shall comply with the instructions given by the launch safety officer at the launch facility.

National Space Law Act: Law No. 21 of 2013 on Space Activities



Introduction of a national registry

State: Italy

Article 15: National registry of Launched Space Objects in Outer Space

(3) Space objects for which the state of launch is Italy need to be registered in the national registry of objects launched into outer space, established pursuant to Art. 3 of Law No. 153/2005.

[...]

Article 16: Information for registering thrown objects in outer space

(1) The operator shall communicate to the Agency the following information, as required by Article IV of the Convention on the Registration of Objects Launched into Outer Space

- a) The name of the launching State or States (letter a);
- b) An appropriate naming of the space object (letter b);
- c) The international space object designator number (letter c);
- d) The date, territory or place of launch (letter d);
- e) The basic orbital parameters of the space object, including nodal period, inclination, apogee and perigee (lit. e);
- f) The general function of the spatial object (lit. f)

(2) The operator is also required to communicate the following to the Agency:

- a) The launcher and the time of the launch, expressed in Coordinated Universal Time (UTC) (lit.a)
- b) The longitude in geostationary orbit, if appropriate (lit. b)
- c) The owner, the manufacturer of the launched space object and the address web to get official information (lit. c)
- d) If the object is part of a constellation of satellites (lit. d)



e) Any other useful information relating to its operation or to the end of the mission, including the abandonment of Earth orbit or the re-entry of the space object (lit. e)

f) The possible date of transfer of the management or ownership of a space object registered in the National Registry to another operator or owner (lit. f)

g) Any other information that the Agency deems necessary to request, also taking into account the evolution of international legislation and practices relating to the registration of space objects (lit.g)

(3) The operator is required to indicate the details of the authorization provision for the exercise of space activity.

National Space Law Act: Provisions on the Space Economy [not yet in force]

State: Italy

Article 15 Registration and information

1. The following information shall be entered in the register:

- a. The name of the launching state or states;
- b. An appropriate designation of the space object and its registration number and, if applicable, its ITU designation;
- c. The date and territory or location of the launch;
- d. The basic parameters of the orbit, including orbital period, orbital inclination, maximum Earth distance (apogee) and minimum Earth distance (perigee)
- e. The general function of the space object

[...]



National Space Law Act: Act from 5th October 2023 “On the Authorization of Space Activities and the Registration of Space Objects

State: Slovakia

§ 9

- 1) A register is hereby established, which shall be administered and operated by the Ministry of Transport.
- 2) All space objects for which the Slovak Republic is a party shall be entered into the register by the releasing state under an international treaty by which the Slovak Republic is bound and to which a valid permit applies.
- 3) If the issuing state is a state other than the Slovak Republic, the person participating in the regulated space activity on behalf of the Slovak Republic is obliged to send information on the launch of the space object, together with a copy of the agreement on cooperation on the launch of the space object, to the Ministry of Transport no later than the day of the launch of the space object.
- 4) During the stay of a space object in outer space, a space object that is registered in the register, and its crew, under the jurisdiction of the authorities of the Slovak Republic.
- 5) The register is publicly accessible on the website of the Ministry of Transport.

§ 10

- 1) The following shall be entered in the register:

[...]

- (c) territory, place, date and coordinate universal time of the launch of the space object,



	<p>(d) main orbital parameters including</p> <ol style="list-style-type: none">1. circulation time,2. runway slope,3. apogee,4. perigee <p><u>National Space Law Act: Regulation of Space Activities (Slovak Space Act) 2024</u></p>
Notification of changes, especially debris or collision risks	<p><u>State:</u> China</p> <p>Changes of the conditions of the space object</p> <p>Article 9</p> <p>[...]</p> <p>When major changes (e.g. change of orbit, break up, cease working or reentry into atmosphere) of the conditions of the space object registered in accordance with these measures occur, the registrant of the space object shall amend the information of the registration within sixty days after the conditions of the space object have been exchanged.</p> <p><u>National space law act: Measures for the Administration of Registration of Objects Launched into Outer Space</u>, February 8, 2001. Unofficial Translation into English by Yun Zhao, “National Space Legislation in Mainland China”, <i>Journal of Space Law</i>, vol. 33, num. 2, 2007.</p>



	<p><u>State:</u> United Arab Emirates</p> <p>Article 19</p> <p>[...]</p> <p>2. Each Authorized Operator in accordance with clause of this Article, shall immediately notify the Agency of the following:</p> <p style="padding-left: 40px;">(a) Any Space Debris resulting from any of the Space Objects participating in the authorized activities.</p> <p style="padding-left: 40px;">(b) Exposure of any of the Space Objects participating in the authorized activities, to a highly potential risk, loss of control, or collision with a Space Debris or other Space Objects in Outer Space. [...]</p> <p><u>National space law act:</u> United Arab Emirates, <i>Federal Law No. (12) of 2019 on the Regulation of the Space Sector</i>, December 19, 2019</p>
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2. National Space Acts Environmental Provisions

General principle concerning environmental protection	<p><u>State:</u> Denmark</p> <p>Part. 4. Environmental requirements</p> <p>7. Space activities must be performed with due consideration for the surrounding environment. The Danish Agency for Science, Technology and Innovation may stipulate requirements, and request a description of:</p> <p style="padding-left: 40px;">(1) [...]</p> <p style="padding-left: 40px;">(2) The potential environmental impact in outer space of the space activity.</p>
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(3) The operator's measures to minimise the impact on the environment on the Earth, in the atmosphere and in outer space

National space law act: Denmark, *Executive Order on requirements in connection with approval of activities in outer space, etc.* Executive Order no. 552 of 31 May 2016 on requirements in connection with approval of activities in outer space, etc.

State: Estonia

§ 1. Purpose and scope of the Act

(1) The purpose of this Act is to promote the sustainable development of the economy, science and technology and to ensure the safety and environmental sustainability of space activities.

[...]

§ 5. Safety principle

(1) Space activities and space objects are safe if they do not pose a threat to people, property, the environment, public order or national security.

(2) In space activities, the operator shall take the necessary measures to prevent, identify, combat and eliminate threats and to eliminate possible damage.

§ 6. Principle of environmental sustainability

(1) Space activities shall prevent the generation of space debris and adverse environmental impacts on the ground, in the atmosphere, in orbit, in space and celestial bodies or mitigate adverse effects through remediation or other compensation.



- (2) Space activities shall take into account the General Part of the Environmental Code Act, European Union law, and international standards and principles.

§ 7. Principle of Expertise

(1) [...]

- (2) When carrying out space activities, the operator and other persons related to space activities or space objects shall fulfil a duty of care to ensure the safety and environmental sustainability of space activities and the consistent consideration of the requirements for space activities and space objects.

National space law act: Estonian Space Act (draft from 24.09.2024)

State: Liechtenstein

Article 1. Purpose

- I. The purpose of this Act is to implement Liechtenstein's obligations under international law with respect to activities for the exploration and use of outer space and to prevent damage caused by space objects for which Liechtenstein may be held internationally liable.
- II. It serves in particular:
- (a) [...]
- (b) [...]
- (c) ensuring the highest possible safety of space activities, in particular the prevention of personal injury and damage to property, ensuring public safety and health, and protecting the environment;



(d) the reservation of the long-term usability of space and the prevention of space debris

(e) the establishment of a public registry for space objects.

National Space Law Act: Act from 5th October 2023 “On the Authorization of Space Activities and the Registration of Space Objects

State: Portugal

Article 1

This Decree-Law establishes the regime of access to and exercise of space activities, with a view to:

[...]

a) Ensuring that space activities are sustainable, guaranteeing the benefits of space for future generations, in accordance with applicable international principles

National Space Law Act: Decree-Law No.20/2024, of February, Amending the regime of access to and exercise of space activities

State: Russia

III. Principles of state policy in the field of space activities

[...]

7. State policy in the field of space activities is implemented in accordance with the following principles:

i) ensuring the safety and long-term sustainable development of space activities, compliance with environmental protection measures, including near-Earth space and deep space.



VII. Tasks of international cooperation in the field of space activities

[...]

19. The objectives of international cooperation in the field of space activities are:

[...]

- e) active participation in the consideration and resolution at the international level of problems related to man-made pollution of near-Earth space, including issues of preventing the formation and removal of space debris from the zone of operational orbits of spacecraft;

VIII. Tasks of international cooperation in the field of space activities

20. The tasks in the field of ensuring the safety of space activities are:

[...]

- (a) ensuring environmental safety of space activities, introducing technologies and designs that reduce the formation of space debris during launches and operation of rocket and space technology products.

National Space Law Act: Main Provisions of the Fundamentals of the Russian Federation State Policy in the Field of Space Activities for the Period up to 2030 and beyond" (approved by the President of the Russian Federation on 19 April 2013 No. Pr-906)

State: Ukraine

Article 21. Public safety and environmental protection



	<p>In the pursuit of space activity, space activity shall comply with safety requirements with regard to the life and health of the public, the property of citizens, enterprises, institutions and organizations and protection of the environment.</p> <p>Subjects of space activity shall ensure that the necessary measures are taken in order to prevent environmental damage as the result of space activity in accordance with Ukrainian legislation currently in force.</p> <p><u>National Space Law Act</u>: Law of Ukraine of 15 November 1996: Ordinance of the Supreme Soviet of Ukraine on Space Activity Section V: Ensuring the Safety of Space Activity</p>
Environmental factors as requirements for authorisation/licenses	<p><u>State:</u> Belgium</p> <p>Article 8, § 2</p> <p>An initial study shall be carried out before an authorization is granted pursuant to this law. The aim of this study is to assess the potential impact on the environment on earth or in outer space of launching or operating the space object.</p> <p><u>National space law act</u>: Belgium, <i>Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects</i> (revised on Dec. 1, 2013), Belgian Official Journal of Jan. 15, 2014</p> <p>Article 8, § 1</p> <p>The impact study referred to in Article 8, § 2, of the law, comprises four parts:</p> <p>(1) The first part consists of:</p>



- (a) a description of the activity and its objectives and the use of the data and derived products generated by the activity,
- (b) a description of the technologies, components, systems design and critical design review of the object (“Critical Design Review”),
- (c) a report of the functional tests of the infrastructure and software carried out as part of the flight model (“Flight Model”) and the flight readiness review (“Flight Readiness Review”),
- (d) a description of the technical characteristics and operational of the activity and the object by which the operator demonstrates their compatibility with:

the recommendations adopted by the United Nations Committee on the Peaceful Uses of Outer Space and published on the website referred to in Article 14, § 2, to the extent that these recommendations are applicable to the activities concerned, where applicable, with any other models or any other technical standards identified by the Minister prior to the introduction of the authorization request.

(2) [...]

(3) the third part concerns the potential impacts of the activity on the outer environment, and includes a description of the measures taken or planned to reduce or limit these impacts as well as, where applicable, measures taken or planned to ensure the sustainable and rational use of natural resources in the space environment;

[...]

Article 8, § 5

Where applicable, the impact study includes a description of the measures taken to ensure the rational use, within the framework of the



activity, of limited natural resources, in particular the geostationary orbit.

National space law act: Belgium, *Arrêté royal portant exécution de certaines dispositions de la Loi du 17 septembre 2005 relative aux activités de lancement, d'opération de vol ou de guidage d'objets spatiaux*

[Royal Decree implementing certain provisions of the Law of 17 September 2005 on the activities of launching, flight operations and guidance of space objects], updated on May 12, 2022.

State: Estonia

§ 15. Documents to be attached to the application

(1) The following shall be attached to the application for a space permit:

[...]

4) Information on the environmental impact expected from space activities and an action plan explaining measures to prevent the generation of space debris and adverse environmental impacts on the ground, in the atmosphere and in space;

[...]

§ 26. Grounds for suspension of space activity permit

(1) The competent authority may suspend the validity of a space activity license for up to six calendar months and set a deadline for eliminating the circumstances that were the basis for the suspension if: [...]



4) circumstances emerge that a space activity or space object may cause a significant adverse environmental impact;

[...]

National space law act: Estonian Space Act (draft from 24.09.2024)

State: Finland

Section 5: Environmental requirements

The conditions for authorization are that

[...]

- (a) The operator has provided a risk assessment concerning its space activities to the Ministry and, according to the assessment, the activities will not cause any particular risk to persons, property or public safety;
- (b) The operator seeks to prevent the generation of space debris and adverse environmental impacts on the earth, in the atmosphere and in outer space in accordance with section 10;
- (c) The operator has made a plan for discontinuing the space activities and for the related measures;

Section 10: Environmental protection and space debris

Space activities shall be carried on in a manner that is environmentally sustainable and promotes the sustainable use of outer space. In its application for authorization of space activities, the operator shall assess the environmental impacts of the activities on the earth, in the atmosphere and in outer space, and present a plan for measures to counter and reduce adverse environmental impacts. Any nuclear materials and other



radioactive materials used in the space object shall be specified in the application for authorization.

In accordance with generally accepted international guidelines, the operator shall seek to ensure that the space activities do not generate space debris. In particular, the operator shall restrict the generation of space debris during the normal operations of the space object, reduce the risks of in-orbit break-ups and in-orbit collisions and, after the space object has completed its mission, seek to move it into a less used orbit or into the atmosphere.

Further provisions on the environmental impact assessment and measures necessary to avoid the generation of space debris may be laid down by a decree of the Ministry of Economic Affairs and Employment.

National space law act: Finland, *Act on Space Activities*, Jan. 23, 2018.

Space debris mitigation measures

Section 2, Application for authorization:

In addition to what is provided in section 5 of the Space Activities Act, the operator shall, in its application for authorization, provide the following information for assessing eligibility for authorization:

[...]

- (9) the estimated functional operating period of the space object, and the planned end-of-life measures; [...]

In its application for authorization, the operator shall assess the risk of personal injury and material damage that the space activities may cause on the earth, in the airspace and in outer space and the risk of danger to public safety. The risk assessment shall describe the tests, and any other



measures conducted on the space object to ensure its safety and durability and include a plan for failure situations. The risk identification and management shall cover the entire life cycle of the space object.

National space law act: Finland, *Decree of the Ministry of Economic Affairs and Employment on Space Activities*, 74/2018, Jan. 23, 2018.

State: Greece

Article 4. Licensing conditions

(1) The authorization shall be granted for an indefinite period or for a fixed and renewable period, that the following conditions are met:

(d) adequate provision has been made for the mitigation and management of space waste or submaterials in accordance with technological developments and international practices,

(e) space activity does not cause contamination of space or celestial bodies or adverse changes in the environment.

(2) By decision of the Minister of Digital Policy, Telecommunications and Information, additional special conditions for licensing may be laid down in order to ensure the safety of people and substances and to protect the environment, ensure the optimal use of the atmosphere and Outer Space, safeguard the strategic geopolitical and financial interests of the Greek State and comply with the obligations of the Greek State under international law.

Article 6. Environmental impact report

(1) For each space activity, the operator is required to submit to the Minister for Digital Policy, Telecommunications and Information, in successive stages, reports on the impact of the space object on the environment. The Minister for Digital Policy, Telecommunications and



Information and the relevant Minister may appoint one or more experts to assess the reports.

(2) The initial report shall be drawn up before the license is granted in order to assess the potential environmental impact on the Earth or on extra-terrestrial space resulting from the launch or operation of the space object.

(3) After the launch of the space object or during its operation, an intermediate report shall be prepared on the actual consequences for the Earth's environment or the extra-atmospheric space of the space activities concerned.

(4) Upon return of the space object to the Earth's atmosphere, termination or cessation of operations, a final report shall be drawn up and submitted.

(5) A joint decision of the Ministers of Digital Policy, Telecommunications and Information and Environment and Energy shall determine the content of the reports, the requirements and the technical standards with which the operator's activity must comply. Pending the adoption of the above decision, the relevant applicable national, European and international standards and the corresponding applicable good practices shall apply. Compliance with the requirements of the Act, in terms of environmental impact and the relevant permit conditions, may be demonstrated by compliance with the relevant standards.

[...]

National space law act: Law 4508/2017 (Government GazeΣe 200/A'/22-12-2017) on "Authorization of space activities -Registration in the National Register of Space Objects- Establishment of a Greek Space Organization and other provisions," as amended by Law 4712/2020/146/A'/29-07-2020)



State: Italy

Article 5. Objective Requirements of space activities

The authorization of the exercise of space activities is subject to the possession of the objective requirements of technical suitability defined pursuant to Article 13, in compliance with the following principles and criteria:

- a) Safety of space activities in all its phases and aspects: from the design of the space object and its components to the management of the activities, providing for a specific analysis of the impacts on safety, as well as an assessment of the light and radio pollution of space objects and the mitigation of space debris, including the methods to ensure their eventual re-entry into the atmosphere in a safe and, where possible, controlled manner
- b) Satellite infrastructure resilience with respect to cyber, physical and interference risks, resulting in the ability to identify and manage space objects, detect incidents, ensure control of access rights, ensure the protection of assets, in particular with encryption measures, and testing and incident management
- c) Environmental sustainability of space activities: through the verification of the environmental footprint of all the activities carried out during the entire life cycle, from the design, development and production phases to the operational and end-of-life phases

National Space Law Act: Provisions on the Space Economy (not in force yet)

State: Liechtenstein

Article 5. Authorization requirements and issuance



(1) The Supervisory Authority shall grant authorization if:

[...]

(a) The space activity does not cause harmful contamination of outer space, including celestial bodies, or harmful alteration of the environment on Earth;

(b) Adequate measures have been taken to prevent space debris, in particular mission debris;

(c) (...)

(2) The Supervisory Authority shall decide on the application for authorization after receiving all required information and documents pursuant to Art. 4. The authorization may be granted subject to conditions and requirements.

(3) The Government may specify the details of the authorization requirements and issuance by ordinance.

Article 11. Modification or revocation of the authorization

(1) The authorization shall be modified or revoked in terms of its content if:

(a) The requirements set forth in Art. 5 Para. 1 are no longer met;
or

(b) The requirements and conditions specified in Art. 5 Para. 2 are not complied with.

(2) In the event of a modification or revocation of the authorization, measures may be ordered for the temporary continuation or safe termination of the space activity. If the operator fails to comply with these orders, control of the space activity shall be transferred by order to another operator. The operator shall provide the documentation necessary for the temporary continuation or safe termination of the space activity to the new operator and shall bear the resulting costs.



National Space Law Act: Act from 5th October 2023 “On the Authorization of Space Activities and the Registration of Space Objects

Article 4. Information and Documents

(1) The approval application must include the following information and documents:

[...]

(a) To demonstrate that the space object, in accordance with Art. 5, para. 1 lit. f of the Act, does not contain dangerous or harmful substances that could lead to harmful contamination of outer space or detrimental changes to the environment, the appropriate documentation is required;

(b) To demonstrate corresponding measures to prevent space debris in accordance with Article 5, para. 1 lit. g of the Act:

1. A report on measures taken in accordance with the state of the art and considering internationally recognized guidelines, such as those of the Inter-Agency Debris Coordination Committee (IADC), especially:

a. to prevent space debris and mission residues during normal operations;

b. to prevent the disintegration of space objects in orbit;

c. for the removal of the space object after the end of space activity, either through controlled re-entry or descent or by placing it in a sufficiently high orbit ("graveyard orbit"). For non-maneuverable space objects, the orbit should be chosen so that they are expected to remain in orbit for no longer than 25 years after the end of their operation;

[...]

(2) An overview of measures taken to avoid collisions with other space objects in outer space.



[...]

National space law act: Ordinance dated 4th December 2023 “On the Authorization of Space Activities and the Registration of Space Objects”

State: Slovakia

§ 3 Permission

[...]

(1) The Ministry shall issue a permit if

[...]

(g) the applicant demonstrates that it has taken appropriate measures to limit the generation of space debris and that the regulated space activity will not cause undue pollution of outer space or adverse changes in the Earth’s environment and its atmosphere.

§ 4 Permit

(1) [...]

(2) The annex to the application for a permit shall be

(a) A detailed description of the regulated space activity, for example in the form of a business plan or project plan, for which authorization is sought, in particular

[...]

5. The expected lifetime of the space objects,

[...]



	<p>(d) A detailed description of the termination of the regulated space activity</p> <p>[...]</p> <p>(h) A description of appropriate measures to limit the generation of space debris and excessive pollution of outer space, space bodies or adverse changes in the Earth's environment and its atmosphere,</p> <p><u>National Space Law Act: Regulation of Space Activities (Slovak Space Act) 2024</u></p> <p>State: United States of America</p> <p>§ 25.114. Applications for space station authorizations</p> <p>[...]</p> <p>e) The following information in narrative form shall be contained in each application [...]:</p> <p>(15) A description of the design and operational strategies that will be used to mitigate orbital debris, including the following information:</p> <p>vi. A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal;</p> <p>vii. (ii) A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board</p>
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the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application

- viii. A statement that the space station operator has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact and ascertain the likelihood of successful coordination of physical operations with, the other system. The statement must disclose the accuracy—if any—with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances, *i.e.*, it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. Where a space station



requests the assignment of a geostationary-Earth orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions;

- ix. A statement detailing the post-mission disposal plans for the space station at end of life, including the quantity of fuel—if any—that will be reserved for post-mission disposal maneuvers. For geostationary-Earth orbit space stations, the statement must disclose the altitude selected for a post-mission disposal orbit and the calculations that are used in deriving the disposal altitude. The statement must also include a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether portions of the spacecraft will survive re-entry and reach the surface of the Earth, as well as an estimate of the resulting probability of human casualty. Applicants for space stations to be used only for commercial remote sensing may, in lieu of submitting detailed post-mission disposal plans to the Commission, certify that they have submitted such plans to the National Oceanic and Atmospheric Administration for review.
- x. For non-U.S.-licensed space stations, the requirement to describe the design and operational strategies to minimise orbital debris risk can be satisfied by demonstrating that debris mitigation plans for the space station(s) for which



	<p>U.S. market access is requested are subject to direct and effective regulatory oversight by the national licensing authority.</p> <p><u>National space law act</u>: US <i>Code of Federal Regulations</i>, Title 47 – Telecommunication, US 47CFR25, last amended 2024</p>
Environmental factors as requirements for the launch permit	<p><u>State</u>: Australia</p> <p>Article 34. Applying for the grant, variation or transfer of an Australian launch permit</p> <p>(1) An application for the grant, variation or transfer of an Australian launch permit must be made in accordance with the rules.</p> <p><i>Debris mitigation strategy</i></p> <p>(2) Without limiting subsection (1), an application for the grant of an Australian launch permit must include a strategy for debris mitigation.</p> <p><u>National space law act</u>: Australia, <i>An Act about space activities and high power rockets, and for related purposes</i> (Space (Launches and Returns) Act 2018), compilation date August 31, 2019; entered into force on August 31, 2019; Act No. 92, 2018</p> <p>Article 55. Environment</p> <p>For each launch, the application must include one of the following (whichever is applicable to the launch):</p> <p>(a) evidence that the environmental impact of the launch and any connected return is addressed by the environmental plan of the licensed launch facility from which the launch is proposed;</p>



(b) information about environmental approvals required for the launch under any other law of the Commonwealth or a law of a State or Territory;

(c) an assessment of the likely impact of the launch and any connected return on the environment, and information on how any adverse effects on the environment are to be monitored and mitigated.

National space law act: Australia, *Space (Launches and Returns) (General) Rules 2019*, compilation date August 26, 2019; entered into force August 31, 2019; last amended on August 17, 2023

Article 54. Debris mitigation strategy

(1) The strategy for debris mitigation in the application must be based on an internationally recognized guideline or standard for debris mitigation, and identify the guideline or standard being used.

(2) Note: Subsection 34(2) of the Act requires an application for the grant of an Australian launch permit to include a strategy for debris mitigation.

(3) The strategy must describe any mitigation measures planned for orbital debris arising from the proposed launch or launches (including from payloads).

Note: Examples of appropriate measures include measures to address the following:

- (a) how debris may be limited during normal operations;
- (b) how the potential for break-ups during operational phases will be minimised;
- (c) how the probability of accidental collision in orbit will be limited;
- (d) how the potential for post-mission break-ups as a result of stored energy will be minimised;



(e) how the long-term presence of payloads and launch vehicle orbital stages in the low-earth orbit region or in geosynchronous earth orbit will be limited after the end of the mission.

(4) The strategy must include an orbital debris assessment based on an internationally recognized model.

Article 79. Debris mitigation strategy

[...]

(3) The strategy must include an orbital debris assessment

National space law act: Australia, *Space (Launches and Returns) (General) Rules 2019*, compilation date August 26, 2019; entered into force August 31, 2019; last amended on August 17, 2023.

State: Denmark

Part. 3. Space debris management

6.

(1) The Danish Agency for Science, Technology and Innovation may stipulate requirements that space activities which involve the launch of space objects into earth orbit meet relevant standards and guidelines for space debris management, such as standards published by the European Cooperation for Space Standardization (ECSS) or the International Organization for Standardization (ISO).

(2) As a general rule, within 25 years of the end date of the functional operating period of the space object, the space object must either safely leave its earth orbit again or safely be placed into an orbit where it is deemed not to constitute a danger to other space activities.



National space law act: Denmark, *Executive Order on requirements in connection with approval of activities in outer space, etc.* Executive Order no. 552 of 31 May 2016 on requirements in connection with approval of activities in outer space, etc.

State: Portugal

Article 9b. Conditions for the granting of licenses

(2) The License for launch centre operation shall be granted after the Space Authority has verified that:

a) [...]

b) The proposed location of the launch site, its installation, infrastructure and operation

i) Adequately ensure the safety of the launch and/or return operations;

ii) Are consistent with applicable public safety standards, including those relating to public health and the safety of persons and property;

iii) Ensure environmental protection and waste management and minimise space debris to the maximum extent possible, in accordance with applicable international principles and obligations.

[...]

National Space Law Act: Decree-Law No.20/2024, of February, Amending the regime of access to and exercise of space activities



<p>Environmental protection of the territory on Earth where the space activities are conducted</p>	<p><u>State:</u> Kazakhstan</p> <p>Article 29. Ecological control of the environment and level of health of population in regions, subject to influence of space activities</p> <p>(1) Space monitoring of the environment and natural resources during the realization of space activities is conducted by authorized state bodies in the field of environmental protection, management of land resources within the limits of the Unified state system for monitoring of the environment and natural resources together with the specially authorized state bodies.</p> <p>(2) The participants of space activities are obliged to exercise industrial ecological control of the environment following the procedures established by the ecological legislation of the Republic of Kazakhstan.</p> <p>(3) State control in the field of environmental protection and health of population during the implementation of the space activities is carried out by the authorized bodies in the field of environmental protection and public health services.</p> <p>(4) The information on environmental protection and emergency situations is opened in connection with realization of space activities on the territory of the Republic of Kazakhstan, and it is a subject to distribution through mass media by using of the system of notifications and communications.</p> <p><u>National Space Law Act:</u> Law of the Republic of Kazakhstan on Space Activities (No. 528-IV of 6 January 2012)</p>
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State: Russia

Article 7 of the Corporation in the field of space activity management

In order to achieve the goals established by this Federal Law, the Corporation shall exercise the following powers and functions in the area of space activity management:

[...]

- (41) ensures in relation to objects and land plots under the jurisdiction Corporations, fulfillment of the obligations of the Russian Federation under international treaties to comply with environmental safety requirements, rules in the field of environmental protection and nature management on the territory of the Baikonur complex, leased by the Russian Federation from the Republic of Kazakhstan, including:
- a) monitors compliance with environmental management and protections standards;
 - b) determines the procedure for developing standards for maximum permissible emissions, discharges of pollutants into the environment and the disposal of production and consumption waste;
 - c) determines the procedure for the use of land plots in cases related to their intended use;
 - d) establishes the procedure for handling production and consumption waste and monitors compliance with it;
 - e) coordinates with the authorized bodies of the Republic of Kazakhstan in the field of environmental protection the forms of documents on environmental monitoring and statistical reporting in the field of environmental protection and nature management



	<p>and establishes the procedure for their submission, as well as coordinates the forms of environmental passports and establishes the procedure for their development.</p> <p><u>National Space Law Act</u>: Federal Law No. 215-FZ "On the State Space Corporation "Roscosmos" of 13 July 2015</p>
<p>Specific regulations regarding the space object tasked with preventing space debris</p>	<p><u>State</u>: France</p> <p>Article 21: Limitation of space debris [launch vehicles]</p> <p>The launch system implemented by the launch operator must be designed, produced and implemented to comply with the following provisions for elements operating in outer space:</p> <p>(1) The launcher must be designed, produced and implemented in such a way as to limit the production of debris as much as possible during nominal operations, including beyond the end-of-life of the launcher and its constituent elements. The launch operator implements the following provisions:</p> <ul style="list-style-type: none">• as part of the launch of a single space object, only one element (for example, a stage) of the launcher can be placed in orbit;• in the context of the launch of several space objects, a maximum of two elements (for example, a stage or the adaptation structure) of the launcher can be placed in orbit. <p>The above provisions are not applicable to:</p> <ul style="list-style-type: none">• pyrotechnic systems. However, these must not generate products of a size greater than or equal to 1 mm in their largest dimension;• powder propellants. However, these must not generate combustion debris of size greater than or equal to 1 mm in protected region B. Regarding the design and use of powder propellants, the



launch operator implements methods to avoid putting solid combustion products into orbit that could contaminate protected region A.

(2) The launcher must be designed, produced and implemented in such a way that the debris produced in compliance with the provisions of 1 above which manages to reach the surface of the Earth does not present an excessive risk to people, property, public health or the environment, in particular due to environmental pollution by dangerous substances.

(3) The probability of occurrence of accidental disintegration must be less than 10^{-3} until the end of the life of the space object; its calculation must include the failure modes of propulsion and power systems, mechanisms and structures, but does not consider external impacts. Deliberate fragmentation of a launcher elements is prohibited.

(4) The launcher must be designed, produced and implemented so that, at the end of the withdrawal from service phase:

- all energy reserves on board are permanently exhausted, or placed in a state such that the depletion of energy reserves on board is inevitable, or in a state such that they do not present a risk of generating waste;
- all means of energy production on board are permanently deactivated.

(5) Concerning Zone A [Low Earth Orbit]

(a) The launcher must be designed, produced and implemented in such a way that, after the end of the launch phase, its constituent elements placed in orbits crossing the protected region A are deorbited as part of an atmospheric controlled reentry.

(b) In the exceptional case of non-compliance with this provision, it must be designed, produced and implemented in such a way that its constituent elements are no longer present in protected region



A, twenty-five years after the end of the period of the launch phase. This result is preferably obtained by an uncontrolled atmospheric reentry or, failing that, by placing it in an orbit whose perigee remains, in the hundred years following the end of the operation, above the protected region A.

(c) If the orbit targeted by the constituent elements of the launcher after the withdrawal from service maneuvers is in or crosses zone A and has an eccentricity less than 0.25, it must allow compliance with the requirements set out in a) and b) of 5 of this article, with a probability of at least 0.5, taking into account the effect of natural orbital disturbances.

(d) If the orbit targeted by the constituent elements of the launcher after the withdrawal from service maneuvers has an eccentricity greater than 0.25, it must allow compliance with the requirements set out in a) and b) of 5 of this article with a probability of at least 0.9, taking into account the effect of natural orbital disturbances and associated uncertainties.

(6) Concerning Zone B [GEO]

(a) The launcher must be designed, produced and implemented in such a way that, after the end of the launch phase, its constituent elements placed in an orbit included in or crossing the protected region B are placed in an orbit not interfering with this region beyond a year. This orbit must be such that, under the effect of natural disturbances, the launcher or its constituent elements do not return to protected region B within a hundred years following the end of the operation.

(b) If the orbit targeted by the constituent elements of the launcher after the withdrawal from service maneuvers has an eccentricity greater than 0.25, it must allow compliance with the requirements set out in a) of 6 of this article with a probability of at least 0.9



taking into account the effect of natural orbital disturbances and associated uncertainties.

(7) The probability of being able to successfully carry out the withdrawal from service maneuvers mentioned in 4.5 and 6 of this article must be at least 0.9. This probability is evaluated over the total duration of the operation; its calculation, carried out before the start of the space operation, must consider all the systems, subsystems and equipment usable for these maneuvers, their possible levels of redundancy and their reliability, considering the effects of aging reached at the time. where it is planned that these maneuvers will be carried out, as well as the availability of the means and energy resources necessary for these maneuvers.

Article 40

The systems implemented by the operator must be designed, produced and implemented so as to comply with the following provisions:

(1) Systems must be designed, produced and implemented so as not to generate debris during nominal operations of the space object.

The above provision is not applicable to:

- pyrotechnic systems. However, these must not generate products of a size greater than or equal to 1 mm in their largest dimension;
- powder propellants. However, these must not generate combustion debris of size greater than or equal to 1 mm in protected region B. Regarding the design and use of powder propellants, the operator must implement methods to avoid releasing solid combustion products into orbit on a long-term basis which could contaminate protected region A.

The release into orbit of a single additional propulsion module is permitted. This module, as a space object, must comply with all the provisions of the third part of this order.



(2) The probability of occurrence of accidental disintegration must be less than 10^{-3} until the end-of-life of the space object. Its calculation must include the failure modes of propulsion and power systems, mechanisms and structures, but not taking into account external impacts. If a situation leading to such a failure is detected, the operator must be able to plan and implement corrective measures to prevent disintegration.

(3) The systems must be designed, produced and implemented in such a way that, at the end of the service phase:

- all energy reserves on board are permanently exhausted or placed in a state such that they do not present a risk of generating debris;
- all means of energy production on board are permanently deactivated;
- all radio transmission capabilities of the platform and payload must be permanently interrupted.

The provisions of 3 of this article are not applicable to controlled re-returns.

(4) Concerning zone A [Low Earth Orbit]

(a) Systems equipped with propulsion elements allowing orbit modification must be designed, produced and implemented in such a way that the space object is no longer present in the protected region twenty-five years after having completed its operational phase in an orbit crossing protected region A.

(b) This result is obtained, preferably, by atmospheric re-entry or [...] by placing it in a stable orbit whose perigee remains above the region protected A, at least one hundred years following the end of the operation.

(c) Systems not equipped with a propulsion element [that does not make possible the] modification of the orbit, must be designed,



produced and implemented in such a way that the space object is no longer present in the protected region at least twenty-five years after the injection into orbit.

(d) If the targeted orbit of the space object after the disposal maneuvers is in or crosses zone A and has an eccentricity less than 0.25, such orbit must allow compliance with the requirements set out in a), b) and c) 4 of this article with a probability of at least 0.5, taking into account the effects of natural orbital disturbances.

(e) If the orbit targeted by the space object after the disposal maneuvers has an eccentricity greater than 0.25, such orbit must allow compliance with the requirements set out in a), b) and c) of 4 of this article with a probability of at least 0.9 taking into account the effects of natural orbital disturbances and associated uncertainties.

(5) Concerning zone B [GEO]

(a) The space object shall be designed, produced and operated in such a way that, when it has completed its operational phase in an orbit, including an orbit in or passing through the Protected Area B, shall be transferred into an orbit not interfering with this region. This orbit must be such that, under the effect of natural disturbances, the object does not return to protected area B within one hundred years after the end of the operation.

(b) If the targeted orbit of the space object after the disposal maneuvers has an eccentricity greater than 0.25, such orbit must allow compliance with the requirements set out in 5 of this article with a probability of at least 0,9 taking into account the effects of natural orbital disturbances and the associated uncertainties.

(c) If the targeted orbit of the space object after the disposal maneuvers has an eccentricity less than 0.1, it must allow compliance with the requirements set out in 5 of this article and be located above the zone B.



(6) The probability of being able to successfully carry out the disposal maneuvers mentioned in 3.4 and 5 of this article must be at least 0.85. This probability, which does not include the availability of consumable energy resources, must be calculated before launch by the operator over the duration of the maneuverability phase for which the system has been qualified and takes into account all systems, subsystems and equipment that can be used for these maneuvers, their possible redundancy levels and their reliability.

(7) The probability of achieving successful disposal maneuvers, which requires having the necessary available consumable energy resources, needs to be calculated before the launch, considering each moment during the mission, and when initiating the disposal maneuvers mentioned in 3, 4 and 5 of this article. The probability of success must be at least 0.99.

National space law act: France, *Technical Regulations to the French Space Operations Act*, last amended 2022, unofficial translation into

State: Slovakia:

§ 17

The operator is obliged to adopt and comply with appropriate measures to limit the occurrence of space debris depending on the technical condition of the space object, while being obliged to take into account international guidelines for limiting the generation of space debris.

National Space Law Act: Regulation of Space Activities (Slovak Space Act) 2024



State: United Arab Emirates

Article 19

- (1) Each Operator authorized to own or develop a Space Object, or carry out or participate in Space Activities, shall take the necessary measures and plans to mitigate Space Debris and reduce the effects thereof, as determined by a resolution issued by the Board of Directors.
- (2) Each Authorized Operator in accordance with clause (1) of this Article, shall immediately notify the Agency of the following:
 - (a) Any Space Debris resulting from any of the Space Objects participating in the authorized activities.
 - (b) Exposure of any of the Space Objects participating in the authorized activities, to a highly potential risk, loss of control, or collision with a Space Debris or other Space Objects in Outer Space.
 - (c) Any measures or plans taken to mitigate the risks resulting from any of the paragraphs (a) and (b) of this clause or to reduce its effects.
 - (d) Any modifications to the measures and plans taken to mitigate Space Debris or reduce its effects.
- (3) Each Authorized Operator shall provide the Agency with periodic reports that are updated annually, or as required by the Agency, regarding any warnings or risks related to any Space Objects participating in any Space Activities authorized.

National space law act: United Arab Emirates, *Federal Law No. (12) of 2019 on the Regulation of the Space Sector*, December 19, 2019.



Termination of space activities	<p><u>State:</u> China</p> <p>Regulations for Hong Kong on space debris mitigation Guidelines for De-commissioning, Sections 10 and 11:</p> <p>Specific references to the IADC Guidelines and the ITU recommendation ‘Environmental Protection of the Geostationary-Satellite Orbit’. The Guidelines for Hong Kong stipulate that for the disposal of satellites launched before the 31 of July 2007, licensees have to submit, as soon as possible, a plan for the end-of-life before any disposal operation takes place.</p> <p><u>National space law act:</u> China, Hong Kong, Guidelines for De-commissioning of Satellite and Mitigation of Space Debris, Office of the Communications Authority (OFCA), July 31, 2007.</p> <p><u>State:</u> Estonia</p> <p>§ 43. Requirements for termination of space activities</p> <ol style="list-style-type: none">(1) Space activities shall be terminated on the basis of the space activities termination plan that forms the basis for the granting of the space activities license or approved by the competent authority, preventing the generation and retention of space debris and eliminating possible damage.(2) A plan for the termination of space activities shall be prepared for each space object.(3) The plan for the termination of space activities shall describe the manner and schedule for the termination of space activities, the activities related to the termination, the potential hazards and en-
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vironmental impacts associated with it, and the measures and activities to comply with the principles and requirements provided for in this Act.

§ 46. Report on the termination of space activities

[...]

(4) In the report, the operator shall explain and describe:

- 1) The time of space activities, with the accuracy of the date of the last action taken for this purpose;
- 2) Potential hazards and environmental impacts associated with and after the cessation of space activities;
- 3) [...]
- 4) The report includes a document issued by an international independent organization, which shows that the space object no longer exists in space.

National space law act: Estonian Space Act (draft from 24.09.2024)

State: Finland

Section 5:

The conditions for authorization are that

[...]

- (4) The operator has made a plan for discontinuing the space activities and for the related measures;

National space law act: Finland, *Act on Space Activities*, Jan. 23, 2018.



State: Germany

Part B, 2.7: Operation at the end-of-life: Re-orbiting and de-orbiting at end-of-life

The operation of satellites until end-of-life should be set up in such a way that sufficient reserves (energy, fuel and functionality) remain for ‘decommissioning’ according to international standards. Special attention is drawn to the need of transferring [geostationary] satellites to safe graveyard orbit for the protection of other operational geostationary satellite systems, as well as considering the planning of re-entry scenarios for larger space objects in low (non-geostationary) Earth orbits. The authorized user can be given operational specifications for the implementation of international standards for the prevention of ‘space debris’. The Federal Network Agency can issue appropriate instructions to the user regarding end-of-life operations in order to specifically enforce the aforementioned international standards.

National space law act: *Verwaltungsvorschrift für die Anmeldung, Koordinierung und Notifizierung von Satellitensystemen im deutschen Namen und für die Übertragung der Orbit- und Frequenznutzungsrechte (VVSatSys)*, 05.07.2018 (Administrative Provision for the Registration, Coordination and Notification of Satellite Systems in the German Name and for the Transfer of Rights to Use Orbits and Frequencies, last updated: January 24, 2022. Unofficial translation into English.

State: Greece

Article 6. Environmental impact report

(1) For each space activity, the operator is required to submit to the Minister for Digital Policy, Telecommunications and Information, in



successive stages, reports on the impact of the space object on the environment. The Minister for Digital Policy, Telecommunications and Information and the relevant Minister may appoint one or more experts to assess the reports.

- (2) The initial report shall be drawn up before the license is granted in order to assess the potential environmental impact on the Earth or on extra-terrestrial space resulting from the launch or operation of the space object.
- (3) After the launch of the space object or during its operation, an intermediate report shall be prepared on the actual consequences for the Earth's environment or the extra-atmospheric space of the space activities concerned.
- (4) Upon return of the space object to the Earth's atmosphere, termination or cessation of operations, a final report shall be drawn up and submitted.
- (5) A joint decision of the Ministers of Digital Policy, Telecommunications and Information and Environment and Energy shall determine the content of the reports, the requirements and the technical standards with which the operator's activity must comply. Pending the adoption of the above decision, the relevant applicable national, European and international standards and the corresponding applicable good practices shall apply. Compliance with the requirements of the Act, in terms of environmental impact and the relevant permit conditions, may be demonstrated by compliance with the relevant standards.
- (6) The cost of the above reports shall be borne by the institution.
- (7) The operator shall sign a declaration of compliance with the above standards and practices, as well as with the environmental requirements in general, which in any case shall commit the operator to the accuracy and completeness of the reports.



National space law act: Law 4508/2017 (Government Gazette 200/A' / 22-12-2017) on "Authorization of space activities -Registration in the National Register of Space Objects- Establishment of a Greek Space Organization and other provisions," as amended by Law 4712/2020/146/A' /29-07-2020)

State: United States of America

§ 25.283. End-of-life disposal

(a) Geostationary orbit space stations. Unless otherwise explicitly specified in an authorization, a space station authorized to operate in the geostationary satellite orbit under this part shall be relocated, at the end of its useful life, barring catastrophic failure of satellite components, to an orbit with a perigee with an altitude of no less than:

$36,021 \text{ km} + (1000 \cdot C_R \cdot A/m)$

where C_R is the solar radiation pressure coefficient of the spacecraft, and A/m is the Area to mass ratio, in square meters per kilogram, of the spacecraft.

(b) A space station authorized to operate in the geostationary satellite orbit under this part may operate using its authorized tracking, telemetry and control frequencies, and outside of its assigned orbital location, for the purpose of removing the satellite from the geostationary satellite orbit at the end of its useful life, provided that the conditions of paragraph (a) of this section are met, and on the condition that the space station's tracking, telemetry and control transmissions are planned so as to avoid electrical interference to other space stations, and coordinated with any potentially affected satellite networks.



(c) **All space stations.** Upon completion of any relocation authorized by paragraph (b) of this section, or any relocation at end-of-life specified in an authorization, or upon a spacecraft otherwise completing its authorized mission, a space station licensee shall ensure, unless prevented by technical failures beyond its control, that stored energy sources on board the satellite are discharged, by venting excess propellant, discharging batteries, relieving pressure vessels, or other appropriate measures.

(d) The minimum perigee requirement of paragraph (a) of this section shall not apply to space stations launched prior to March 18, 2002.

National space law act: *US Code of Federal Regulations*, Title 47 – Telecommunication, US 47CFR25, last amended 2024

State: United States of America

§ 450.171. Safety at end of launch

(a) Orbital debris mitigation. An operator must ensure for any proposed launch that for all vehicle stages or components that reach Earth orbit—

(1) There is no unplanned physical contact between the vehicle or any of its components and the payload after payload separation;

(2) Debris generation does not result from the conversion of energy sources into energy that fragments the vehicle or its components. Energy sources include chemical, pressure, and kinetic energy; and

(3) For all vehicle stages or components that are left in orbit, stored energy is removed by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all



	<p>batteries in a permanent discharge state, and removing any remaining source of stored energy.</p> <p><u>National space law act</u>: United States of America, <i>US Code of Federal Regulations, Title 14 — Aeronautics and Space</i>, last amended on May 31, 2024</p>
Spaceport	<p><u>State</u>: Indonesia</p> <p>Article 45</p> <p>[...]</p> <p>(2) In determining the location, design, planning, and construction of the design, planning, and construction of the Spaceport, including the area around it, shall pay attention to national interests, Security and Safety of the launch of the Spacecraft, as well as environmental sustainability of the Spaceport area.</p> <p>Article 48</p> <p>(1) Space Organizer in building the Spaceport must have an environmental impact analysis.</p> <p>(2) Analysis of environmental impact as referred to in paragraph (1) shall be carried out in accordance with provisions of laws and regulations.</p> <p><u>National Space Act</u>: Law No. 21 of 2013 on Space Activities</p>
Prohibition	<p><u>State</u>: Indonesia</p> <p>Article 8</p>



Any Space activities are prohibited:

conducting activities that may result in environmental pollution and/or damage earth and space and jeopardize activities Space including the destruction of Objects Space.

Article 87

Each Space Organizer is obliged to maintain and ensure the preservation of environmental functions life.

Article 88

(1) To avoid damage to the earth's environment from contamination caused by the Organization Space, every Space Organizer prohibited from violating quality standards and standard criteria environmental damage.

(2) Provisions regarding quality standards and standard criteria environmental damage as referred to in paragraph (1) shall be implemented in accordance with the provisions of laws and regulations.

National Space Act: Law No. 21 of 2013 on Space Activities

State: Kazakhstan:

Article 30. Interdictions and restrictions on the space activities

(1) During the implementation of space activities, the following actions are prohibited:

- (a) Creation of immediate threat to life and health of people;
- (b) Injection into the orbit, deployment of mass destruction weapon in the outer space;
- (c) Use of space engineering and (or) celestial bodies for negative influence on the environment.



(d) Infringement of the international norms and standards on pollution of outer space.

(2) Space activities within the limits of a separate project at the occurrence of threat to life and health of people, cause damage to property or damage to the environment is limited or is prohibited according to the ecological legislation of the Republic of Kazakhstan.

National Space Law Act: Law of the Republic of Kazakhstan on Space Activities (No. 528-IV of 6 January 2012)

State: Ukraine

Article 9

The following shall be prohibited in connection with the conduct of space activity in Ukraine

- [...]
- The violation of international norms and standards regarding pollution of outer space;
- [...]

Space activity conducted under a specific project which has led to the loss of human lives, substantial material damage or substantial damage to the environment may be restricted or prohibited in conformity with the legislation of Ukraine currently in force.

National Space Law Act: Law of Ukraine of 15 November 1996: Ordinance of the Supreme Soviet of Ukraine on Space Activity: Section II: Organization of Space Activities



<p>Punishment</p>	<p><u>State:</u> Indonesia</p> <p>Article 98</p> <p>(1) Any person who violates quality standards and criteria standard of environmental damage as referred to in Article 88, which results in polluted or contaminated environment life, shall be punished with a maximum prison sentence 2 (two) years or a maximum fine Rp. 2,000,000,000.00 (two billion rupiah).</p> <p><u>National Space Act:</u> Law No. 21 of 2013 on Space Activities</p> <p><u>State:</u> Italy</p> <p>Article 9. Suspension or revocation of authorization for failure to comply of the authorization requirements</p> <p>(1) The responsible authority can suspend authorization to the exercise of space activities or declare the decadence of the entitled party, without prejudice to the provisions of Article 8 regarding modification of the authorization for supervening reasons. Suspension of the authorization or declaration of forfeiture of the entitled party are provided for in the event of:</p> <p>[...]</p> <p>(f) violation from the measures of caution suitable to minimise the risks for the safety of people and property, including during the re-entry phase of the space object into the atmosphere, as well as to protect the environment, safeguard public health, national security interests and the continuity of international relations;</p> <p>[...]</p> <p>(2) The responsible Authority informs the operator before adding a decision of suspension or forfeiture. The latter may, within an appropriate period indicated by the Authority itself, provide explanations</p>
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and produce documentation. The operator's information is not required if the violation concerns the provisions of paragraph 1, letter h), or the denial of the release, the revocation or the suspension of security authorizations, if they are necessary for the exercise of space activities.

(3) The responsible Authority, when deciding on the suspension or termination of the operator, may impose necessary conditions for the continuation or the interruption in safety of the space activities, also being able to order the operator to adopt at his own expense appropriate measures to minimise the risks to the safety of people and property, including during the re-entry into the atmosphere, as well as to protect the environment, safeguard public health, national security interests and the continuity of international relations as provided for in paragraph 1, letter f). [...]

(4) Each burden which may arise from the suspension, revocation or expiry of the authorization is the load of the operator.

National Space Law Act: Provisions on the Space Economy (not in force yet)

3. Collision Avoidance and Environmental practices

Several States have by now passed some governance instrument addressing directly or indirectly STM. In these, States have adopted different approaches in varying degrees of detail regarding collision avoidance measures in practice and in national space acts. For example, the French National Space Act, Art. 21 on “Limitation des Debris Spatiaux et Prevention des Risques de Collision” goes into more detail, while some, like for example the Finnish, Slovenian and Austrian national space acts generally obligate their actors to observe international guidelines, standards and relevant recommendations (for example ISO standards addressing space debris mitigation measures and collision avoidance with technical descriptions (ISO 24113:2023, ISO/TR 16158:2021, ISO 20893:2021, ISO 24330:2022, ISO 26872:2019, etc.)).



In the following several practices of States and space agencies will be very briefly summarised: 3.1) UNCOPUOS LTS Guidelines, 3.2) USA, 3.3) ESA, 3.4) JAXA. Finally, a list of existing studies or soft-law instruments on STM will be added (demonstrative and unexhaustive), which can be consulted for further reading.

3.1) UNCOPUOS Long-term Sustainability Guidelines

The UNCOPUOS 2018 LTS Guidelines recognised imperative to improve on communication, coordination, cooperation as well as tracking and monitoring capacities for purposes of space traffic safety and STM. In section B the LTS in this manner recognise necessity for exchanging contact information and sharing information on space objects and orbital events (B.1), sharing orbital information (B.2), performance of conjunction assessment (B.4), and pre-launch conjunction assessment (B.5).³⁷⁷ The aforementioned activities of evaluations and sharing of information are already being performed by numerous space actors, including space agencies, on an ad hoc basis. Therefore, standardisation and education of new actors is primarily required.

3.2) USA

The USA has enacted Space Policy Directive 3 and NASA has produced the Best Practices Handbook to guide its national operators. NASA thereby for example advises all actors to rely on USSPACECOM and maintain a space-track.org account. Operators may develop their own capabilities or contract these. In absence of own capabilities, high level of cooperation and coordination with USSPACECOM is mandated. For example, operators should share e.g. mission information, spacecraft design (e.g. “understanding of the flight control and navigation paradigm, principally whether a ground-based control approach is followed or some degree of (or full) autonomous control”) as well as orbital maintenance strategy and predicted ephemeris including any planned manoeuvres with USSPACECOM. Operators are furthermore required to develop or acquire ability to process CDMs and compute conjunction risk assessments as well as validate these tools well before launch (6-12 months prior). Operators are also advised to perform a pre-launch spacecraft collocation, orbit selection (analysis), mission planning and space object design. For example, space object design should ensure that the object will be trackable by US tracking and monitoring systems, that it is reliable (i.e. that the likelihood that it will be fully functional until it can be disposed is 99%) and by determining what risk mitigation capabilities it has, operators are advised to develop collision risk mitigation plan.

³⁷⁷ For an example of implementation, see: Annex Synopsis LTS implementation reports on guidelines B.1-B.5.



Furthermore, in instances where the collocation indicates a high probability of systematic conjunctions in the selected orbit, actors are advised to contact other operators utilising the same orbital region and agree on a risk mitigation planning. Special caution is advised for mega-constellations, which may need to adopt variations of the standard proposed approach for single satellite operations. With regard to the launch phase, operators should provide USSPACECOM launch-related information (e.g. injection vectors) and coordinate any issues and anomalies. During on-orbit phase operators should undergo the USSPACECOM process of e.g. arranging for conjunction analysis data exchange including manoeuvre notification reports and CDMs. Equally any anomalies or difficulties in operating a space object should be reported. Large constellations should coordinate with NASA and the screening provider. In summation, NASA advises all operators to coordinate and inform USSPACECOM through all phases of space activity and additional consultations with NASA regarding more difficult or complex cases.

Recently, it has furthermore become the practice of SpaceX to perform all collision avoidance maneuvers, however, this is not advisable as long-term strategy, not least for fears of creating a monopoly on STC, but furthermore, because if only one actor performs collision avoidance measures, the capacity and capability of others to perform the same will likely stagnate and create problems in STC measures with objects that do not belong to SpaceX. Overall education and experience with STC are desired.

Finally, the US Government has, since 2021, discussed reducing the 25-year orbital life after end of mission to 5 years, for objects orbiting below 2,000 km, to “ minimise the collision risk”.³⁷⁸ In 2022, the US Federal Communications Commission adopted the 5-year de-orbiting rule,³⁷⁹ with the FCC even issuing the first space debris fine to DISH.³⁸⁰

3.3) ESA

For ESA, the Space Debris office coordinates any orbital manoeuvres from a technical perspective, including operating a conjunction risk assessment system for ESA and third parties, making orbital manoeuvre recommendations to the supported missions from a technical perspective. The ESA Legal Department liaises with the Space Debris Office and exchanges information when necessary or so requested. ESA standard approach focuses on contacting the other operator and coordinating the manoeuvre or in absence of successful contact, evading (especially in instances where the object operator

³⁷⁸ For the latest version of the ‘proposal’ (Sep. 2022), see: <https://docs.fcc.gov/public/attachments/DOC-387024A1.pdf>.

³⁷⁹ See <https://www.fcc.gov/document/fcc-adopts-new-5-year-rule-deorbiting-satellites-0>.

³⁸⁰ See <https://docs.fcc.gov/public/attachments/DOC-397412A1.pdf>.



or owner is unknown, or the object has not been identified). However, ESA especially reported some issues in communication, especially in relation to language and terminology. Uncertainties have arisen on several occasions on whether all parties share the same understanding of a word or terminology used. It is therefore advisable to develop standard definitions and standardised collision avoidance measures that can be shared internationally to, at the very least, inform the emerging actors with less experience. Finally, through its extensive practice and annual space environment reports, ESA has excellent insight into STC and STM challenges as well as the state of the orbital environment, emphasising the need for further development of technology, verifiable and reliable catalogues of space objects and geo-political confidence and trust building for global coordination efforts instead of the present best practices case-by-case negotiation in an increasingly congested orbital environment.

3.4) JAXA

JAXA practice reiterates the importance of the launch campaign, during which the launch vehicle is not trying to avoid every spacecraft or every space debris (as it would not be possible to avoid everything.) However, it is instead focusing on not colliding or meeting with any human (crewed) spacecraft, including the ISS, in effect creating priorities. The launch vehicle is calculating (through the COLA evaluations, or pre-launch COLA evaluation), to avoid collision with any manned or human spaceflight.

This demonstrates the three main elements crucial for collision avoidance: space object, orbit and operator. To explain, for effective STC, clarity regarding what qualities a space object possesses (e.g. manoeuvrability capabilities), in which orbit it is flown (e.g. trajectory and updated ephemeris) and which rules the operator has to or should follow (including e.g. communication manner, designated person and existing plans for manoeuvres to correct orbits or other orbit maintenance measures) form preconditions.³⁸¹

3.5) Studies and soft-law instruments on or relating to STM

Further studies and soft-law instruments sharing best practices have furthermore been issued over the last decade. These have been consulted during the Cologne Manual project, including, but not limited to:

- International Academy of Astronautics (IAA), Cosmic Study on Space Traffic Management, 2006.

³⁸¹ See also Guidelines on Pre-Launch Activities and Notification as well as on Information Acquisition and Dissemination and associated Commentaries.



- IAA, Space Traffic Management: A Roadmap for Implementation, 2018.
- NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook.
- The Space Safety Coalition, Best Practices for the Sustainability of Space Operations” (undersigned by several NSAs), 2023.
- ESPI, ESPI Report 71 - Towards a European Approach to Space Traffic Management, 2020.
- EU STM, EU STM Final Report: Space Traffic Management for XXI Century Space Operations, DO3_D13, 2022.
- Iridium/OneWeb/SpaceX facilitated by AIAA, Satellite Orbital Safety Best Practices, 2022.
- IISL/IAF/IAA, Space Traffic Management Report, Acta Astronautica, Vol. 232, 2025.
- RAND, International Space Traffic Management (Research Report), 2023.
- Spaceways, D7.6 Three “STM briefs” papers published online, 2020 (research funded by EU Horizon 2020 Project).
- Aerospace, Space Agenda 2021: Space Traffic Management, 2021.

Related: NASA’s Space Security: Best Practices Guide.



Annex 2:

Analysis of Space Traffic Coordination Challenges

Categorising (of different space objects and/or operators)

Article I of the OST determines that the exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all humankind.

“Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.”

There is no indication that a prohibition of categorisation of space objects, activities, operators, etc. exists within existing *corpus iuris spatialis*, in so far as categorisation does not obstruct a certain group’s access to outer space and in so far as this is done for the benefit of all. This is confirmed by the text of the space law treaties as well as doctrine and State practice. Specifically for STM purposes to ensure sustainability and safety of space traffic, categorisation of space traffic may, therefore, not only be permitted, but indeed required. For purposes of STM categorisation can be linked to the allocation of orbital slots, and the setting of priorities or priority traffic, so that in an event of close conjunction, clear rules exist as to which space object should maneuver out of the way of the other.

The OST predicts an equal access and not an equitable access to outer space, with economics and technological development often determine actual access to space. This indicates there is no legal requirement in existing space law that actually mandates equitable access or differentiation between space actors. Rather, differentiation or differing obligations is discouraged and disliked in area of ultra-hazardous activities, such as space activities. Upon examination of State practice, numerous emerging space States such as Argentina, Egypt, Kazakhstan, Mauritius, Turkey have adhered to the de-orbiting practices (of GEO satellites) in spite of their technological and financial situations. National legislation does not differentiate on the part of applicant. Nonetheless, under the principle of common but differentiated responsibilities, applicable to outer space under Article III of the OST, often manifest as temporary double standards, for example establishing “different substantive rights and obligations or provide for differences in timing the implementation of substantive provisions” or transfer-of-technology obligations can be implemented and access to additional funding. Some common but differentiated responsibilities provisions have been adopted at international level in treaties, however, those treaties have not been very effective or widely accepted. States normally adopt requirements proposed at international level on the national level, especially in the space sector. For



example, the USA, consider in national law ‘transition periods’ to reduce the impact of new norms to certain actors.

In view of the examined, it is advised, that ultimately no differentiation should exist between emerging and established space actors as any substantive obligation would harm the sustainability and safety of space traffic, as well as impact the efficiency of STM. The possibility of transition periods where required is in line with the principle of common but differentiated responsibilities and could assist in acceptance of STM. However, in view of the examined (that practice indicates these elements are normally enacted at national level in the space sector, that numerous emerging space States have kept to mitigation obligations, and that for an efficient STM system any differentiation would be detrimental) it is the recommendation no differentiation or proposed different standards/categories for different actors. Efforts should be made to present a position that does not allow exceptions at least at level of basic rules. Any space actor, independently of their technical and financial possibilities, should adhere to the space debris mitigation guidelines, as a minimum, and should be legally obliged to do so at international as well as national level. Attempts have been made by developing States, for example China, to place space debris mitigation standards on developed/industrialised States rather than themselves, however, it is the opinion of the experts of this Manual, that such exceptions should not be supported and space actors like China not encouraged to not adhere to space debris measures or STM as this will negatively impact the safety and sustainability of space traffic and outer space environment. If a State has the possibility to place a space object in orbit, it should adhere to STM as well as space debris mitigation standards as this will be in its own interest as well as the interest of the international community.

Possible categories identified: human (crewed) vs. non-human (non-crewed) spaceflight, human (manned) vs non-human (non-manned) launcher, celestial vs orbital traffic, terrestrial traffic (LEO, MEO, GEO), transfer orbits vs. destination orbits, transient space and/or traffic, maneuverable vs non-maneuverable objects, rockets vs. functional objects, reusable vs. non-reusable rockets, private vs. governmental actors, civil or commercial vs. military activity, objects created on Earth vs. objects created in outer space.

By identifying categories of space traffic, it should be possible to establish priorities for purposes of collision avoidance. Here, analogy to rules of the road and the act of driving a car are of immense assistance to give form to otherwise abstract notions. Analogy to driving a car, traffic rules and duties of the driver, should be considered for possible translation into space traffic. The rule of “priority to the right side” can’t be applied to outer space equally well as to terrestrial road traffic due to orbital



mechanics making it impossible to identify right from left. Nonetheless other analogies to terrestrial traffic, such as the necessity for car drivers having to stay or ‘get informed’ throughout the entire travel process. For example, before entering a street, the driver of a car stops and looks to see if there is someone or something he can collide with. Instead priorities should focus on the characteristics of the space object and mission.³⁸²

Evaluated as of main value for STM are: human and non-human, maneuverable and non-maneuverable, malfunctioning objects, re-entry, orbital insertion, launch.

It has furthermore been considered whether communications traffic and inherent harmful interference are relevant for STM, however, in line with existing studies on STM (see for example ESPI Report “Towards a European Approach to Space Traffic Management”) the primal concern of STM should be collision avoidance of physical objects during launch, operation on-orbit and re-entry phases. However, it should be recalled that communications problems may lead to deficiency or anomaly in the control ability and thereby impact the physical object and the physical domain. As communication traffic is considered out of scope of the Cologne Manual as well as adequately regulated and administered by the ITU, the Cologne Manual simply proposes that appropriate cooperation, coordination and consultation should be undertaken with the ITU. For more details see the Guideline on Cooperation, Coordination and Consultation and its associated Commentary.

(a) Allocation of orbit slots:

The obligation to respect the freedoms of others contains the necessity to internationally coordinate space traffic. This can be done in the form of an international allocation system for orbits according to their carrying capacity, which includes differentiating between different categories of space objects. For example, scientific investigations via satellites seem to enjoy some kind of privileges based on Article I paragraph 3 and could be given priority when applying for a certain orbit slot. However, the allocation of orbital slots would require the existence of capacities (institutional, human, etc.) and agreement between States (for an example see the ITU system) and is therefore evaluated as problematic (at minimum in the short term) and therefore unlikely. It should be stressed that this is only a theoretical proposal for the long-term evolution, should it be deemed technically viable and logical. It can nonetheless be considered by States for national licencing procedures if so desired.

³⁸² See also *Frandsen*, *The Regulation of Space Traffic*, 2023.



(b) Some restrictions have been physical in nature. For instance, avoiding to the right is for example impossible as right is indistinguishable from left, above from below, in outer space. Similarly, coordination by sight is not possible. Therefore, direct transference of terrestrial solutions has proven impossible. Finally, some objections have been raised with regard to difficulty in defining and allocating an object. For instance, such proposals as differentiating on level of beneficence raises questions as to who or which entity is entitled to decide what is beneficial and what isn't, and by which criteria this is to be decided. Furthermore, a proposal has been made that governmental objects or missions should be given priority over non-governmental, and scientific missions could be given priority over purely commercial ones. The latter especially could be substantiated by Article I of the OST as scientific mission benefit humanity at large, while commercial missions gather income from provision of services and are therefore furthermore in a better position to expand cost on manoeuvres than non-profit actors. However, the associated problem becomes how and who defines these, as well as how can dual-use aspects be factored in. Lengthy discussions as well as consideration of existing proposals (including rejected proposals) have shown that this type of categorisation is unlikely to succeed or be efficient, and therefore it is advisable to rather encourage operator to operator STC and adoption of collision manoeuvre strategies, whereby operators could also address the question of cost of a manoeuvre and its possible financial or non-financial compensation. For example, operators could exchange the manoeuvre obligation.

Prioritisation

Non-maneuverable objects must be evaded. In the question of non-maneuverable versus a maneuverable object, the maneuverable object must always give way. Within "non-maneuverable" category, all objects in distress as well as all malfunctioning objects should be included and given priority.

Questions have been raised regarding fuel costs required for maneuvering a space object and whether the operator of the non-maneuverable object should owe compensation to the operator of the maneuverable object that was required to make a maneuver for safety reasons.

Positive context: This proposal is made in favor of a sense of fairness and justice, and to encourage operators to design space objects with maneuverability capabilities.

Negative context: Orbital maintenance is performed on a regular basis by all or at least majority actors. A compensation scheme would therefore be potentially disruption and difficult to determine parameters. Maneuvering in outer space takes a toll on the space objects, e.g. fuel, costs. However, maneuverability implies additional technological development in relation to certain objects and also access to that technology that somehow may not be accessible to certain States or actors. It must be



considered that some launching States and actors may not have that capability not because they do not think that the capability is viable or necessary, but because they do not possess requisite capacities or do not have the resources or the technical knowledge (“know-how”) to apply to those objects in order for them to be able not only to handle those red conjunction alerts, or even to change orbit in certain manners or situations. Concerns have already been raised in the UNCOPUOS that certain States view STM as a manner of placing limitations on space actors and their right under space law to launch space objects. Therefore, such requirement could be seen as an imposition of limitations on space actors. (In terms of liability provisions from Article VII of the OST and the Liability Convention it could be argued that loss of fuel constitutes damage as it lessens the useful life of a satellite, however, this is not without issue or opposition and remains an open question. Doctrine has generally maintained that only direct damage is granted by the Liability Convention. However, an argument could be made that because Article I of the LIAB defines damage as “damage to property” and Article XII refers determination of compensation to international law, that as shown in jurisprudence of international tribunals, including the International Court of Justice, damage to property is normally evaluated as including operational costs as well as loss of profits in instances of commercial property.)

In an ideal case, an international fund would be established into which operators of non-maneuverable objects would pay a certain amount. From this fund the operators of maneuverable objects would then be compensated for maneuver-associated cost. This would furthermore (at least in part) solve the issue of space debris and non-identifiable non-maneuverable objects as well. However, as this concerns an ideal situation, unlikely to be established in the near-term at least, this is a theoretical proposal to national legislators to include such considerations during the licensing phase. Non-governmental operators and/or owners of non-maneuverable objects could be required through national provisions to provide a certain amount in cases where they would be required to maneuver, but due to the non-maneuverability of their object, another operator has been required to maneuver. The obligation to pay this amount could be evaluated on a case-to-case basis and even dispensed with if the non-maneuverable object is a scientific mission in the benefit of all countries and humankind and/or is operated by a small operator, for example a public university. On the contrary, if the non-maneuverable object is commercial in nature and the operator is receiving income from the services it offers, then the amount would need to be paid. In this manner, national legislators could incentivise use of innovative technologies and maneuverability in space objects, advancing space technology, while at the same time still enabling smaller actors to take part in the space exploration and use thus incentivising space missions of general benefit for all. At an international forum, governmental actors could achieve a comparable effect through use of agreements, bilateral or multilateral, that would further



cooperation and capacity-building, assuring innovation as well as that no State is left behind. Another option could be that for every conjunction it is calculated the manoeuvring of which object is less costly, and the other part reimbursed the manoeuvring operator for half of the cost. The owed amount for satellites of universities, etc. could be paid by the proposed fund.³⁸³

A further proposal made has been restricting non-maneuvrable space objects to a certain orbital plane, for example below 350 km. The possibility has been suggested that small satellites without maneuvering capabilities should not be allowed or should at least be discouraged from being placed beyond 350 km in order to protect astronauts on the ISS and the Chinese space station (both at ca. 400 km). Discussions elaborated that possible exceptions could be permitted and determined on a case-to-case basis, following an evaluation of benefit to all, for example, objects like the Hubble Space Telescope that is immensely beneficial to humanity and which requires placement above 500 km, but has no motors thus no maneuvering capability, would be permitted on account of its beneficial nature. However, 1) problems are likely to arise as to the determination of the factor of benefit and who determines what is beneficial. In accordance with present practice, it is evaluated that most likely this would be taken over by national legislators, while agreement at international level is unlikely at present case. 2) It is likely that this might be perceived as a limitation on the freedom of space exploration and use from Article I of the OST by certain States and thus face opposition. Again, such proposals are unlikely to find international support but could be considered by national legislators for the licensing procedures and governmental mission planning.

The focus of this proposal is mainly small satellites, 10s and cube satellites, from universities or companies (like those from an Argentinian and a Paraguay company that have no motors). The satellites of OneWeb and SpaceX, have motors, and fly at 1,200 and 500-550 km respectively.

Argument in favour of restriction: There are a few examples that could support such a proposition. IADC limit it to 600 km. In the United States, 400 km orbit limit for space objects with no propulsion has been under discussion since 2020,³⁸⁴ but so far, no final decision has been adopted.

Argumentation against limitation: Space missions are normally either military use, commercial or scientific use. An Earth observation mission above 350 kilometers, while beneficial, will not be able

³⁸³ See also S. Hobe, Perspectives for Space Law in the Twenty-First Century (upcoming with the Hague Academy of International Law).

³⁸⁴ See Rule by the Federal Communications Commission, available at: <https://www.federalregister.gov/documents/2020/07/20/2020-12013/streamlining-licensing-procedures-for-small-satellites>.



to be realized if there is a regime, which does not allow the satellite above 350 kilometers simply because it does not have motors.

A possible solution to the argumentation against limitation is 1) permission of exceptions on basis of benefit and 2) not writing hard figures into documentation/guidelines. Example: The IADC in Space Debris Mitigation Guidelines adopted a hard figure of 25 years after which a satellite should be removed from orbit. This was a political compromise arrived at after a long and arduous process of negotiation. Normally, the IADC prefers to avoid including hard numbers in documents (historically an approach often adopted by the IADC, it presently seems to be shifting toward a greater openness to e.g. releasing documents, preparing consensus statements etc.).

In event of manoeuvrable vs. manoeuvrable object,

- a. Objects in distress or otherwise malfunctioning should be given priority over those functioning normally/traveling on its planned trajectory, as their maneuverability may be impaired.
- b. "Ambulance" objects, whether crewed or uncrewed, when on a rescue/assistance mission should be given priority over all normal missions, including human (crewed) ones. Historical examples of space objects in distress include Apollo 13 and Salyut 7. In the case of the latter, a specifically designed/prepared mission to save Salyut 7 was sent to the rescue, similar to ambulances on terrestrial roads. This prioritisation is furthermore supported by experience in ATM and air law.
- c. Human (crewed) space objects should be given priority over non-human (uncrewed) objects. (This prioritisation is supported by existing State practice in the space sector.) In event of same-tier objects, it is advisable and evaluated as most viable and supported by State practice that operators communicate and establish collision avoidance plans as early as development and design phase.³⁸⁵

Decision with regard to these type of plans could be made on the identity of the operator, e.g. NASA has priority over SpaceX assets, or they could be based on a calculation of different indicators, including use of Artificial Intelligence by space object or objects, orbital parameters, whether one operators is more experience or in a position that makes a manoeuvre easier to undertake, reliability of safety procedures, "costs" for propellant and loss of operational time, risks to third objects, economic factors (e.g. For which object is the manoeuvre less costly or whether the operator is commercial or non-profit), etc. depending on the result, it would be clear by the numbers which object (or possible even both objects) should manoeuvre, and reimbursement would be necessary (taking into account that commercial entities generate revenue from their space assets while many others such as scientific

³⁸⁵ See also Guideline on Pre-launch Activities and Notifications and associated Commentary for more information.



entities or even governmental entities do not). This might, of course, require internationally agreed indicators and procedures both for such a calculation as well as for the reimbursement process. However, it (or a variation of it) may nonetheless prove a best cost-effective option amiable to States and operators. For these calculations to be a viable basis, the conjunction alerts would need to be sufficiently advance (as in the case of ESA/SpaceX where the alert was issued ten days in advance of projected encounter) or would need to be able to be carried out quickly. Otherwise *ad hoc* agreement between the operators will need to supplement it.

It is the recommendation of the Cologne Manual that operators regulate all associated questions including economic aspects, e.g. possibility of taking over part of manoeuvre costs, sharing costs, compensations schemes – whether financial or non-financial (e.g. manoeuvre for manoeuvre) – and liability questions be address in collision avoidance agreements alongside collision avoidance plans that detail priorities and how manoeuvre shall be undertaken in event of two or more space objects possible conjunction event.

Note: Regarding questions on whether in a situation of manoeuvrable non-human vs. manoeuvrable non-human space object, missions for the benefit of humanity should be given priority (for example navigational satellites due to their importance to global commerce and Earth applications), it is evaluated that presently capacities do not exist for this proposal to be viable. This would require consensus at an international level on which missions are deemed beneficial to humanity and who decides. In absence of a global central STM agency this is evaluated as unrealistic and not sufficiently relevant to present discussions. At national level, the national legislator can determine such parameters as desired and enforce these during licensing procedures, requiring certain operators to yield priority to other in cases of conjunction. At international level, presently only bilateral and multilateral agreements could enable such prioritisation. Such agreements are as mentioned encouraged.



Annex 3:

Air Law and Air Traffic Management

A. Defining Air Law and Air Traffic Management

I. Terminology

‘The dynamic, integrated management of air traffic and airspace including air traffic services, air-space management and air traffic flow management – safely, economically and efficiently – through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.’³⁸⁶

Air traffic management comprises three primary services:

- Air traffic services (ATS), with the general purpose of ensuring safe and orderly traffic flow (facilitated by the air traffic control (ATC) service) as well as providing the necessary information to flight crews (flight information service, FIS) and, in case of an emergency, to the appropriate (e.g. SAR) bodies (alerting service). ATS is mainly performed by air traffic controllers. Their main functions are to prevent collisions by, e.g. applying appropriate separation standards and issuing timely clearances and instructions that create an orderly flow of air traffic (e.g. accommodate crew requests for desired levels and flight paths, ensure continuous climb and descent operations, reduce holding times in the air and on the ground). ATS relies on tactical interventions by the controllers and direct communication with the flight crews, usually during the entire flight.
- Air traffic flow management (ATFM), the primary objective of which is to regulate the flow of aircraft as efficiently as possible in order to avoid the congestion of certain control sectors. The ways and means used are increasingly directed towards ensuring the best possible match between supply and demand by staggering the demand over time and space and also by ensuring better planning of the control capacities to be deployed to meet the demand. Supply and demand can be managed by imposing various restrictions on certain traffic flows (e.g. assigning CTOTs or requiring flights matching certain criteria to use specific routes). Also, supply can be increased by appropriate sector management (e.g. increasing the number of controllers working at the same time). AFTM measures

³⁸⁶ ICAO Doc 4444 PANS-AT.



can be seen as pre-tactical, as they do not affect the current situation but rather the near future.

- Airspace management (ASM), the purpose of which is to manage airspace - a scarce resource - as efficiently as possible in order to satisfy its many users, both civil and military. This service concerns both the way airspace is allocated to its various users (by means of routes, zones, flight levels, etc.) and the way in which it is structured in order to provide air traffic services.

II. The History of the International Civil Aviation Organization

In moving forward space object operators and States may find it useful to understand how the present ATM landscape, in particular ICAO, which oversees the international harmonisation processes and aids in coordination, developed.

The ICAO was formally established in 1944 through the Convention on International Civil Aviation, commonly known as the Chicago Convention. This marked the successful culmination of efforts to create a permanent international body to regulate civil aviation. Prior to ICAO, several attempts had been made to establish international aviation organisations, most notably the International Commission for Air Navigation (ICAN), founded in 1919 under the Paris Convention. However, ICAN suffered from limited membership, weak enforcement mechanisms, and a lack of global reach.

The Chicago Convention represented a significant departure from these earlier efforts by bringing together 52 nations with the explicit aim of establishing a permanent, global organisation to oversee international civil aviation. ICAO emerged directly from this convention and became a specialised agency of the United Nations in 1947. Its creation marked a move toward a more harmonised global framework, with ICAO providing technical guidance, operational standards, and a forum for cooperation.

In its early stages, the ICAO primarily acquired its personnel through secondments and appointments from Member States, especially those with more advanced civil aviation sectors at the time. After the Chicago Convention was signed in 1944, a Provisional International Civil Aviation Organization (PICA0) was established in 1945 to serve as a temporary body until ICAO was formally constituted in 1947.

During this transitional period:



- Personnel were drawn from existing national aviation authorities, such as the U.S. Civil Aeronautics Administration, the UK's Ministry of Civil Aviation, and counterparts in Canada, France, and other founding signatories.
- Some staff were sourced from the defunct ICAN, bringing prior experience in international aviation regulation.
- The United Nations also played a role, as ICAO became a specialized UN agency in 1947. This integration provided ICAO with access to the broader administrative standards of the international civil service system and reinforced its global status. However, in its formative years, staffing relied primarily on secondments and support from Member States and host country arrangements.
- Canada, as the host country, provided initial logistical support and local hires, particularly for administrative and operational roles, when ICAO's headquarters were established in Montreal.

In summary, ICAO's early workforce was a mix of experienced personnel from national civil aviation agencies, international aviation bodies, and support from the host country. This workforce gradually became more professionalised under ICAO's own recruitment framework as the organisation matured.

III. The main principles of Air Traffic Management

1. General principles

- **Safety:** The paramount priority in Air Traffic Management (ATM) is safety. Ensuring the safety of passengers, crew, and aircraft is the primary responsibility of air traffic controllers and all aviation professionals. Controllers must maintain safe separation between aircraft and provide timely and accurate instructions to prevent collisions and other incidents.
- **Separation:** Controllers prioritise maintaining appropriate separation between aircraft to avoid any possibility of collision. This includes lateral, vertical, and longitudinal separation based on the type of airspace and the level of traffic density.
- **Efficiency:** ATM also aims to optimise the efficiency of air traffic operations. This includes minimising delays, providing direct flight paths whenever possible, and optimising airspace design to accommodate the flow of traffic smoothly.
- **Capacity:** Airspace and airport capacity are critical factors in ATM. Efforts are made to maximise the use of available airspace and runways to accommodate the growing demand for air travel while maintaining safe operations.



- **Compliance with Regulations:** All air traffic operations must comply with national and international regulations and airspace procedures. This includes adherence to flight plans, route assignments, and communication protocols.
- **Collaborative Decision Making:** Collaborative Decision Making involves the cooperation and coordination of various stakeholders, including airlines, airports, and air traffic control units, to make informed decisions that benefit the entire aviation system. Collaborative decision-making aims to reduce delays, improve efficiency, and enhance overall performance.
- **Weather Management:** Weather conditions can significantly impact air traffic operations. ATM priorities include proactive management of weather-related challenges by re-routing flights, adjusting altitudes, and making other operational decisions to ensure safety and minimise disruptions.
- **Emergency Handling:** Preparedness for emergencies and contingency planning are essential priorities in ATM. Controllers and other aviation professionals are trained to respond quickly and effectively to handle emergencies, diversions, and other unexpected situations.
- **Environmental considerations:** ATM increasingly takes environmental considerations into account. Efforts are made to optimise flight profiles, reduce fuel consumption, and minimise emissions to mitigate the environmental impact of aviation.
- **Customer Service:** Controllers and aviation professionals aim to communicate clearly, provide timely information to pilots, and assist airlines and passengers as needed to ensure a positive travel experience.

2. Principles regarding cooperation and communication

In reference to the Cooperation and Communication between ATM ground stations, air traffic control facilities coordinate and communicate with one another through a variety of means to ensure the safe and efficient movement of aircraft in the airspace they manage. The coordination and communication methods include:

- **Radio Communication:** The primary means of communication in ATC is through radio frequencies. Each ATC facility operates on specific radio frequencies designated for different purposes, such as ground control, tower control, approach control, and en-route control. Controllers use two-way radio communication to talk to pilots and other controllers to issue clearances, instructions, and updates on aircraft movements.



- **Standard Phraseology:** Controllers and pilots use standardised phraseology to ensure clear and concise communication. This helps to reduce misunderstandings and confusion during high-pressure situations.
- **Radar Systems:** Radar is used to monitor and track aircraft positions in real-time. Different ATC facilities can share radar data with one another to ensure seamless transitions as aircraft move through different airspace sectors.
- **Flight Data Processing Systems:** ATC facilities use flight data processing systems to manage flight plans, track aircraft, and share information with other ATC units. These systems help controllers to have a comprehensive view of the airspace and the planned routes of aircraft.
- **Data Link Communication:** In more advanced ATC systems, data link communication allows for the exchange of digital information between aircraft and ATC facilities. This can include the automatic reporting of aircraft positions and other data, enhancing situational awareness and reducing radio frequency congestion.
- **Coordination Meetings:** Controllers from different ATC units hold regular coordination meetings to discuss airspace utilisation, traffic management, and potential issues. These meetings help ensure that all units are aware of the overall air traffic situation and can plan accordingly.
- **Letters of Agreement (LOAs):** LOAs are formal agreements between ATC facilities that outline procedures for the transfer of control of aircraft between different sectors. These agreements specify how coordination will occur and what actions each facility should take in specific situations.
- **Emergency Procedures:** ATC facilities have established emergency communication procedures to handle urgent situations. This includes coordination with other ATC units, emergency services, and relevant authorities to manage emergency landings or other critical incidents.

B. Connection between Air Law and Space Law

There are two Main Aspects of Space traffic that are connected to air traffic management (ATM). The first concerns space object integration into airspace (e.g. launch vehicles; rockets cross airspace to reach outer space). Within the second aspect insight into aviation practices and regulation could provide inspiration for the future development and operation of space traffic management.



I. Space Object Integration into Airspace

During this time appropriate communication and coordination between space object operators and ATM must take effect to guarantee safety in airspace. Space object prioritisation and transit through airspace is normally nationally regulated and space objects are considered for the duration of their stay in airspace as convention aircraft, e.g. German legislation considers rockets as conventional aircraft for the duration of their stay in airspace and thus subject to regular ATM regulation. Most often airspace is closed during launch activity. Therefore, see Guideline on International Cooperation, Coordination and Communication and associated commentary for advised action and more detail.

1. Domain of integration of launch and re-entry operations into the airspace

Domain of integration of launch and re-entry operations into the airspace concerning safety informs that space operations such as launch and re-entries do not meet aviation safety standards. Furthermore, the risk in certain areas cannot be considered a "background risk"; compared to other daily risks for people on the ground. Therefore, safety measures must be taken to protect aircraft and the public in general. The first option to increase safety should be to increase technical reliability. Other options are operational safety measures, such as excluding air traffic from high-risk areas. This requires a risk assessment to identify areas where safety criteria are not being met. These areas are then communicated to aviation and should be kept clear of air traffic during the launch. The launch operator must monitor these areas, as in international airspace entering cannot be prohibited. If these areas are not clear at time of launch, the launch must be aborted. There is no international standard for carrying out the risk assessment to identify hazardous region to aircraft. The safety criteria that the operator must comply with also vary from country to country. Both aspects could compromise safety and prolong the licensing process. International harmonization of handling launch and re-entry risks in spaceflight would simplify the access to space and the required planning and certification processes while ensuring safety.

2. Specific Field: Legal Aspects for Launch over International Seas

Legal aspects for launch over international seas informs that the launch of rockets or rocket planes over the high seas is currently being discussed, with a special focus on the North Sea.

This case is taken as example to discuss legal over international seas. The launch areas under discussion are generally located outside the sovereign national territories in so-called functional areas (FIR, Flight Information Region), which are, however, assigned to the air traffic control authorities of individual states. The same applies to a take-off area within an Exclusive Economic Zone (EEZ). The EEZ is not a national territory, but also a so-called functional sovereignty area in which no territorial



sovereignty applies. In the EEZ, the state bordering the territorial sea has certain limited use-related rights and powers (see Art. 33 and Art. 56 of the Convention on the Law of the Sea, UNCLOS).

The airspace in the EEZ, on the other hand, remains free (as does the airspace over the high seas). The right of free overflight applies, as can be inferred from Art. 56 UNCLOS in conjunction with Art. 87 para. 1 letter b). Art 87 para. 1 letter b) UNCLOS.

The question therefore arises as to what rights and obligations arise for an operator wishing to launch or operate aircraft from or over the high seas. The relevant ICAO agreements, which may also apply between state aircraft and normal transport aircraft, must also be observed. Other international legal standards must also be consulted.

3. International collaboration and data exchange

With regard to international collaboration and data exchange from the air sector provides an insight that most launch and re-entry operations (to or from orbit) involve multi-stakeholder international/cross border coordination. Launches to orbit and re-entries from orbit are operations of global scope and scale. The vehicles cross territorial, national and airspace boundaries on their way to and from space. While it may take a vehicle just a few seconds to move across these boundaries, the effects on the airspace below can linger for minutes or even hours in the event of a non-nominal occurrence. The former special event of a space launch has become daily business. Due to the nature and physical requirements of space operations, the impact of a non-nominal situation cannot always be limited to national boundaries and jurisdictions. This must be considered when adapting processes that simultaneously permit a rapid response capability to incidents to ensure safety, while maintaining the necessary airspace capacity for air traffic. Efficient and reliable provision of all information required for this purpose is crucial. Due to the global nature of spaceflight events, national solutions are not sufficient in this respect today. Affected and involved stakeholders must be included in future concepts for addressing this issue in a cross-border and interoperable manner. Timely, efficient and effective data sharing across participating entities therefore is a critical enabler to effectively prepare and execute their responsibilities for safe and efficient airspace management, particularly in non-nominal scenarios. On the foundation of a cooperative agreement, the FAA and DLR have demonstrated that U.S. and European ANSPs can respond adequately to a non-nominal event during a launch or re-entry operation that presents a hazard to the airspace system. The outcome of the project leveraged existing international data standards and infrastructures by using a data exchange approach



based on SWIM. It has been shown that the systems on both sides of the Atlantic could be connected via standardised protocols and used successfully for exercises in different scenarios.

The EU has recognised the need to understand launch and re-entry events as part of a group of new technologies, mission types and vehicle types whose integration into the air transport system requires novel operational procedures and regulations. These new higher airspace operations will be conducted generally above FL550 and are expected to be deployed globally. The European Commission in cooperation with EUROCONTROL, the European Union Aviation Safety Agency (EASA), the SESAR Joint Undertaking (SJU), the European Defence Agency (EDA) and the European Space Agency (ESA) organised the European Higher Airspace Operations Symposium in April 2019. The symposium concluded that two actions were required to further advance the development and introduction of new entrant operations in HA: the development of a European Concept of Operations for Higher Airspace and the exploratory work of a regulatory framework underpinning such operations. As a consequence, the EU had launched a two-year project as part of the European SESAR research program, called ECHO, which delivered a comprehensive Demand Analysis, User Requirements and a Concept of Operations (ConOps) for Higher Airspace Operations (HAO), to allow safe, efficient and scalable operations in this evolving environment. The ECHO ConOps has been published as a deliverable of the project in January 2023. In parallel EASA had set up a regulatory task force to explore the regulatory aspects of higher airspace operations. The Task Force has developed a Proposed Roadmap on Higher Airspace Operations which has been published by EASA on March 10th, 2023.

C. Sources of Inspiration

Air Law may be drawn upon as inspiration for establishment of collision avoidance plans and structures, but it should be stressed that solutions from air traffic cannot be directly mirrored to space traffic due to the severally different technical capabilities and orbital mechanics. Therefore, due to aforementioned significant technical differences between air and space travel, no relevant manoeuvrability issues in air travel that could assist space travel questions were identified. For example, beside right of way rules discussed below, questions raised regarding fuel consumption and associated cost resulting from orbital manoeuvres for active collision avoidance could not find appropriate aviation comparison. Compensation for fuel consumption in air traffic or rather the issue of fuel is not practically or legally an aviation issue, due to the nature of air travel i.e. the fact that in aviation an aircraft always has the option of landing and refuelling while the same is not an option in outer



space. In outer space when an object has been stationed the fuel has already been fixed beforehand and should therefore be considered during development and design phase.

Most relevant aviation regulations and practices have been gathered in three main topics: I) Regulation of Safety under Air Law, II) Right of Way Rules and III) Present Coordination Practices between Space Object Operators and ATM: NOTAMs, IV) Regulation of Military Activities in Outer Space, V) Aviation Security, VI) Sustainability/environment with special focus on the Carbon Emission System in Aviation

I. Regulation of Safety under Air Law

These regulations of aviation safety are in line with the Standards and Recommended Practices (SARPs) established by the International Civil Aviation Organization to establish and maintain a State Safety Program.³⁸⁷

In addition to regulatory oversight, aviation safety regulations also cover areas such as pilot licensing, crew fatigue management, and the maintenance of aircraft to uphold safety standards.³⁸⁸ Aviation safety regulations extend to the oversight and management of safety within civil aviation operations, including airlines and airports. These regulations are continuously evolving to address emerging challenges and technological advancements in the aviation industry. Regulatory bodies such as the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) play a crucial role in setting and enforcing safety standards to minimize risks and ensure operational integrity.³⁸⁹ FAA standards and regulations include the Pilot Records Improvement Act (PRIA) for good hiring decisions, the Drug and Alcohol Abuse Prevention Programme to ensure pilots are not under the influence, and duty time limits to prevent exhausted pilots from flying.³⁹⁰

³⁸⁷ H. Kazemi, "Aviation Safety International Standards in the Framework of National Air Law," *IJRRS*, vol. 5, no. 1, pp. 59–67, 2022, doi: 10.30699/IJRRS.5.1.8.

³⁸⁸ A. Valko, O. Soloviova, G. Volkovska, and I. Herasymenko, "Constructing a system of integrated management of aviation safety as a key element of airport service quality," *EEJET*, vol. 4, 3(112), pp. 13–26, 2021, doi: 10.15587/1729-4061.2021.239168.

³⁸⁹ A. V. Chatzi, "Safety management systems: an opportunity and a challenge for military aviation organisations," *AEAT*, vol. 91, no. 1, pp. 190–196, 2018, doi: 10.1108/AEAT-05-2018-0146; T. Silitonga, R. W. S. Sumadinata, A. Sudirman, and T. Hidayat, "Civil aviation safety evaluation based on the principle of ICAO", *ijhs*, pp. 10188–10210, 2022, doi: 10.53730/ijhs.v6nS4.11037.

³⁹⁰ C. Culmone, *Safety vs. Security: Is there a difference?* [Online]. Available: <https://info.natacs.aero/natacs-blog/safety-vs.-security-is-there-a-difference>.



Safety management systems have been implemented in general aviation to address safety risks comprehensively and to ensure that safety remains a top priority for all aviation stakeholders.³⁹¹ This concept is increasingly also being adopted in urban air mobility (UAM).³⁹²

II. Right of Way Rules in Aviation

Determining right of way in air traffic is provided by SERA³⁹³, Annex 2 of Chicago Convention 44 (particularly Section 3.2.2, which deals with right of way) as well as the recent Space Safety Coalition document.

The “right of way” in aviation refers to a set of rules that determine which aircraft has priority to continue its flight path when two or more aircrafts are on converging or potentially conflicting paths, especially in visual flight conditions (VFR). These rules aim to prevent collisions and ensure orderly flow of air traffic, particularly where ATC is not providing direct separation (e.g. in uncontrolled airspace). The rules are defined in ICAO Annex 2 (3.2.2 Right-of-way) – Rules of the Air, and are generally consistent with national regulations (e.g. FAA, EASA).

1. ICAO Right-of-Way Rules

The aircraft that has the right-of-way shall maintain its heading and speed.

3.2.2.1 An aircraft that is obliged by the following rules to keep out of the way of another shall avoid passing over, under or in front of the other, unless it passes well clear and takes into account the effect of aircraft wake turbulence.

3.2.2.2 Approaching head-on. When two aircrafts are approaching head-on or approximately so and there is danger of collision, each shall alter its heading to the right.

3.2.2.3 Converging. When two aircraft are converging at approximately the same level, the aircraft that has the other on its right shall give way, except as follows: a) power-driven heavier-than-air aircraft shall give way to airships, gliders and balloons; b) airships shall give way to gliders and balloons; c) gliders shall give way to balloons; d) power-driven aircraft shall give way to aircraft which are seen to be towing other aircraft or objects.

3.2.2.4 Overtaking. An overtaking aircraft is an aircraft that approaches another from the rear on a line forming an angle of less than 70 degrees with the plane of symmetry of the latter, i.e. is in such

³⁹¹ A. J. Stolzer, J. J. Goglia, and R. L. Sumwalt, *Safety management systems in aviation*. Boca Raton, London, New York: CRC Press, 2023.

³⁹² Y. Shi, "Aviation Safety for Urban Air Mobility: Pilot Licensing and Fatigue Management," (in En;en), *J Intell Robot Syst*, vol. 110, no. 1, pp. 1–10, 2024, doi: 10.1007/s10846-024-02070-x.

³⁹³ Standardised European Rules of the Air.



a position with reference to the other aircraft that at night it should be unable to see either of the aircraft's left (port) or right (starboard) navigation lights. An aircraft that is being overtaken has the right-of-way and the overtaking aircraft, whether climbing, descending or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.

2. Prioritisation of Emergency Services

With regard to prioritisation, aviation likewise confirms prioritisation of emergency missions. Thereby, an analogy can be made with terrestrial traffic, where ambulances may operate either as emergency vehicles that require priority or as regular transport units during routine operations. Similarly, in aviation, certain aircraft are given priority in air traffic management based on their mission status, such as medical evacuations or humanitarian flights. This type of operational prioritisation is well established within air traffic management procedures and is supported by provisions in air law.

3. Application and Enforcement

These rules primarily apply under VFR, especially in uncontrolled or advisory airspace. In controlled airspace, ATC provides separation, but pilots must still be familiar with right-of-way rules in case of loss of communication or during visual approaches.

III. Present Coordination Practices between Space Object Operators and ATM: Notices to Airmen

In practice, communication between space object (i.e. launch) operators and ATM typically involves a combination of filing NOTAMs (Notice to Airmen), direct coordination with ATC, and compliance with national spaceflight-ATM protocols. In the context of ATM, NOTAMS are the primary formal tool recognised by ICAO for issuing operational notifications. However real-time coordination is often essential for safe integration of space operations with civil aviation.

1. Purpose

A NOTAM is an official, time-sensitive advisory issued to alert aviation personnel of temporary or urgent changes to the normal operation of airspace, aerodromes, navigation aids, procedures, or hazards that could affect flight operations. The primary function of a NOTAM is to provide real-time information that is not known far enough in advance to be published in the Aeronautical Information Publication (AIP) but is essential for safe and efficient flight planning and execution. They cover both scheduled and unscheduled events, examples include:

- Temporary airspace closures (e.g. for rocket launches or military exercises),
- Inoperative navigation aids or lighting systems,



- Runway closures or obstructions,
- Launch or re-entry of space vehicles,
- Natural hazards (e.g. volcanic ash, wildfires),
- Unforeseen dangers (e.g. bird activity, drones, obstructions)

2. Functioning of the System

The NOTAM system, governed by Annex 15 of the ICAO Convention, is an integral part of the global Aeronautical Information Services (AIS). It is an electronic, standardised global system. States use national AIS platforms to input NOTAMs, following ICAO formatting rules (using ICAO codes, standardised abbreviations, and message structure). These notices are distributed digitally via international aeronautical networks (e.g. AFTN – Aeronautical Fixed Telecommunication Network).

NOTAMs are typically issued by air navigation service providers (ANSPs), airport operators, or governmental aviation authorities (e.g. FAA, EASA,). The information is submitted in a standard ICAO format to ensure global interoperability. It includes details such as location, time of effectivity, duration, altitude, and nature of the hazard or change.

Once issued, NOTAMs are disseminated through aeronautical information systems connected to flight planning and dispatch services. They are intended for:

- Pilots and aircraft operators, to aid in pre-flight planning and en-route decision-making.
- Air Traffic Controllers, to ensure safe coordination of aircraft movements. They are notified through internal systems and may relay critical NOTAM information directly to aircraft in-flight.
- Flight Dispatchers
- Airport and airline operations personnel, to adjust logistics or contingency planning. The Software automatically integrates NOTAM data.

However, they are generally publicly accessible, and many national authorities publish NOTAMs via online portals (e.g. FAA, Eurocontrol). Some data is also integrated into flight planning software and apps, used by commercial and general aviation alike.

IV. Regulation of Military Activities in Outer Space

1. Coexistence between military and civilian activities in outer space

In considering the possibility of coexistence between military and civilian activities in outer space, the group suggested that the model of coexistence that has been established in airspace (such as the



concept of 'Flexible Use of Airspace') could serve as a useful example with appropriate modifications to account for the unique challenges posed by the absence of a concept of sovereignty in outer space. Fundamental principles underlying air law are (i) sovereignty of airspace, (ii) aircraft nationality, and (iii) certification of aircraft, crew and other stakeholders involved (including manufacturers or ATS providers).

- Airspace sovereignty means complete and exclusive sovereignty of every State over the airspace above its territory, thus entitling every State to exercise legislative, administrative, and judicial authority within the national airspace. The principle of airspace sovereignty also makes states responsible for developing safety, regulatory measures, and operational efficiency, which becomes problematic considering the lack of airspace's upper limits where the rule of states' sovereignty no longer applies.
- Aircraft nationality is directly linked to the State where a particular aircraft is registered. This is one of the most significant foundations for assessing aircraft's airworthiness. Transposing aircraft's nationality concept to space law may be particularly important given that more and more entities and individuals are looking to engage in space activity.

Air operations and transportation are heavily regulated with the aim to unify, or at least harmonise, all conditions for aircraft operations in order to enable them to operate in various jurisdictions under the same conditions. Such requirements and conditions can be divided into the following broad categories that provide helpful guidance for future development of space activity regulations: (i) conditions in respect of the aircraft and other technology involved; (ii) conditions in respect of the type of operation; (iii) conditions in respect of the personnel involved; (iv) conditions for the actual operations. The Space Law WG deemed it necessary to seek the Air Law Working Group's input regarding the legal implications surrounding aerospace objects and their treatment under air law. Aerospace objects, like space shuttles or spaceplanes, are subject to space law; however, this does not automatically preclude the application of air law while such aerospace object operates in airspace. Generally, space objects need to pass through the airspace over the continents and/or the high seas to enter space, thus posing the question of what legal regime and when should apply to avoid interference with civil aviation given that the legal realms of outer space and air space differ significantly and yet no universally agreed and established legal boundary exists between the two. Furthermore, if an aerospace object can take off in a manner like an aircraft, then it falls under the regulatory framework of air law. In this respect, it may be disputable whether such an aerospace object could be considered 'launched' in the traditional sense and whether it is subject to the REG or Article VIII of the OST. This raises an



additional question of double registration obligation for aerospace objects to operate both in airspace and outer space.

2. Assessment procedure for military objects and operations

The Space Law Working Group has expressed apprehension over the assessment procedure for military objects and operations. The Air WG supports that the evaluation and sorting of military space objects and missions should occur at various stages to ensure responsible and safe conduct in outer space. These evaluations should consider the nature of the mission, its potential impacts, and compliance with international space law and agreements. Aspects to be reviewed may include the mission's objectives, its technical capabilities, potential risks to space and other space users, and compliance with relevant international treaties and agreements, the mission's trajectory, space debris generation potential, and any potential interference with other space activities. In particular, military missions should follow space debris mitigation guidelines to limit the creation of space debris. This includes designing satellites and launch vehicles with post-mission disposal plans to remove objects from valuable orbits. It is essential to comply with international conventions, in particular as to the prohibition to place weapons of mass destruction in space and to make peaceful use of outer space. When evaluating military space missions, one should consider whether the technologies used have dual-use capabilities that could be employed for both civilian and military purposes. Proper safeguards should be in place to prevent misuse of such technologies.

V. Aviation Security

Aviation security is regulated under air law through a combination of national and international rules and standards. These regulations are crucial for ensuring the protection of passengers, crew, and aircraft. National and international laws play a significant role in setting the framework for aviation security.³⁹⁴ The ICAO is a key player in establishing global standards and recommended practices for aviation security.³⁹⁵

There are several key aspects essential to safe and secure air traffic management. Understanding these aspects is crucial for any professional operating in this field. In particular:

³⁹⁴ Y. Kareng, "INTERNATIONAL AVIATION/AIRSPACE LAW AN OVERVIEW," *IJLR*, vol. 4, no. 1, p. 56, 2020, doi: 10.26532/ijlr.v4i1.10941.

³⁹⁵ M. Strohmeier, V. Lenders, and I. Martinovic, "On the Security of the Automatic Dependent Surveillance Broadcast Protocol," *IEEE Communications Surveys & Tutorials*, vol. 17, no. 2, pp. 1066–1087, 2015, doi: 10.1109/COMST.2014.2365951.



- **Data Protection:** protection from unauthorized access, theft, or misuse of privacy of sensitive data and protection of individual rights
- **Cybersecurity:** requirements for robust encryption, firewalls, intrusion detection systems, and other security mechanisms to safeguard critical infrastructure and data.
- **Incident reporting/response:** promptly reporting requirements for any incidents to the relevant authorities.
- **Liability and Tort law:** accountability in case of cyber incidents that may lead to disruptions in air traffic management operations or compromise safety.
- **Awareness and training:** training ATM staff to ensure that employees are well-informed about potential cyber threats and know how to respond to them appropriately.

Risk management techniques are developed to address safety and security concerns in the aviation sector, emphasizing the importance of preparedness for potential threats.³⁹⁶ The responsibility for maintaining aviation security lies not only with airlines but also with aviation authorities and governments. Airlines are required to comply with security protocols and standards set forth by national and international regulations.³⁹⁷ Governments play a crucial role in regulating air transportation, issuing rules, certifications, and conducting supervision to ensure compliance with safety standards.³⁹⁸ Moreover, the ratification of international conventions, such as the Montreal Convention, further strengthens the legal framework for aviation security.³⁹⁹

National and international regulations, along with the efforts of organisations such as ICAO, are instrumental in establishing and maintaining security standards in civil aviation. By addressing cybersecurity threats, implementing risk management strategies and ensuring compliance with security regulations, the aviation industry can continue to improve security measures and safeguard the integrity of air transport

VI. Domain of sustainability/environment, Carbon Emission System in Aviation

³⁹⁶ J. Woodlock, "Safe but not Secure? Risk Management, Communication and Preparedness for a Pandemic in Aviation," in *Combining the Legal and the Social in Sociology of Law*, H. Hydén, R. Cotterrell, D. Nelken, and U. Schultz, Eds.: Hart Publishing, 2023.

³⁹⁷ F. Fitriyanti, Y. Gunawan, and A. Armansyah, "Responsibility of Airlines Company to the Passenger After The Ratification of the Montreal Convention 1999 by Indonesia," *JCH*, vol. 9, no. 1, 2021, doi: 10.15408/jch.v9i1.17274.

³⁹⁸ D. Nusraningrum, T. M. Mekar, and J. Gunawijaya, "An Industry 4.0: Strategy Direction Of An Airline Operations Performance," *jmi*, vol. 21, no. 3, p. 278, 2021, doi: 10.25124/jmi.v21i3.2820.

³⁹⁹ F. Fitriyanti, Y. Gunawan, and A. Armansyah, "Responsibility of Airlines Company to the Passenger After The Ratification of the Montreal Convention 1999 by Indonesia," *JCH*, vol. 9, no. 1, 2021, doi: 10.15408/jch.v9i1.17274.



Carbon emissions systems in aviation are designed to track, report, and manage the greenhouse gas emissions produced by aircraft during their operations.

1. Main Features

The following features are ordinarily used to address the issue of global carbon dioxide (CO₂) in air transportation:

- **Emission Calculation:** Airlines and aircraft operators are required to calculate the amount of CO₂ emissions produced by each flight. This calculation considers factors such as the aircraft type, distance travelled, passenger and cargo load, and specific operational data. The data can be obtained from various sources, including fuel consumption records, flight plans, and on-board monitoring systems.
- **Reporting and Verification:** Once the emissions are calculated, airlines are required to report their carbon emissions to the relevant authorities, which can be government agencies or international organisations. The reported emissions data are then verified by independent auditors to ensure accuracy and compliance with the reporting requirements.
- **Cap-and-trade Schemes:** Some regions or countries have implemented cap-and-trade schemes for aviation emissions. Under these systems, a cap is set on the total amount of emissions that airlines can produce collectively. Airlines are allocated allowances corresponding to their share of the cap. If an airline emits more than its allocated allowances, it must purchase additional allowances from other airlines that have emitted less than their allocated quotas. This creates an economic incentive for airlines to reduce their emissions.
- **Carbon Offsetting:** Carbon offsetting allows airlines to compensate for their emissions by investing in projects that reduce greenhouse gas emissions elsewhere. These projects could involve renewable energy production, reforestation, energy efficiency initiatives, or waste management projects. By funding such projects, airlines can effectively balance their emissions, making their operations "carbon-neutral" or "carbon-offset."

In addition, airlines may be mandated to explore the use of sustainable aviation fuels (SAF) to reduce emissions or to invest into innovative ways to reduce aviation emissions further through, for example, exploring advanced aircraft design, electric or hybrid propulsion systems, and improving air traffic management to optimize flight routes and reduce fuel consumption.

2. The European Union's Approach

Since 2012, have been included CO₂ emissions from the Aviation sector in the EU emissions trading systems (EU ETS), under which all air carriers operating in Europe (whether Community Carrier or not) are required to monitor, report, and verify their emissions, and to surrender allowances against



those emissions. They all receive tradeable allowances to cover certain levels of emissions from their flights each year.

The EU, however, decided to limit the scope of the EU Emissions Trading System (EU ETS) to flights within Europe until 2016 in order to support the development of a global measure by ICAO.⁴⁰⁰ In light of a Resolution by the 2016 Assembly on a global measure, the EU decided to keep the scope of EU ETS limited to intra-European flights even after 2017. EU ETS is subject to further view in the light of the UN measure, in particular as to how to implement the global measures through an update of or change to EU ETS. In the absence of a new amendment, EU ETS would, however, revert back to its original full scope.

3. The ICAO's Approach

ICAO agreed in October 2016 on a Resolution for a global market-based measure to address CO₂ emissions from international Aviation as of 2021. It sets out the objective and key design elements of the global scheme, as well as a roadmap for completing the work on implementation of modalities. The so-called Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) aims to stabilise CO₂ emissions at levels of 2020 by requiring air carriers to offset the growth of their emissions after 2020. They are required to (i) monitor emissions on all international routes and (ii) offset emissions from routes included in the scheme by purchasing eligible emission units generated by projects that reduce emissions in other sectors.

⁴⁰⁰ For further information, see: https://climate.ec.europa.eu/eu-action/transport-decarbonisation/reducing-emissions-aviation_en.



Annex 4:

Synopsis LTS implementation reports on guidelines B.1-B.5

Country	Report Document(s)	<p style="text-align: center;">B.1</p> <p style="text-align: center;">Provide updated contact information and share information on space objects and orbital events</p>
<p style="text-align: center;">Germany</p>	<p style="text-align: center;">A/A.C.105/C.1/2023/CRP.9 (6 February 2023)</p>	<ul style="list-style-type: none"> - German Space Situational Awareness Center (GSSAC), operated by GER Federal Government is tasked with creation of operational space situational awareness (SSA) services for governmental recipients - Exchange of SSA data with France and USA via bilateral SSA sharing agreements - Exchange of national sensor data within EU SST -> provides operational services to European users - Future discussions with other states on data exchange for R&D, under the EU Space Regulation, EU SST services also to be made available to non-European users - SSA data is exchanged in standardised formats (e.g. tracking data messages, TDM) -> enables merging and validation of data from multiple sources and the generation of products from them, such as autonomous European collision warnings - The German Space Operations Centre (GSOC) in Oberpfaffenhofen actively shares contact information and satellite ephemeris data with conjunction service providers (e.g. EU SST, the Space Data Association, United States entities) and actively contacts other satellite operators in order to harmonize collision avoidance (COLA) measures. On the R&D side, GSOC is supported by an SSA group providing data based on optical and laser ranging ground stations for low-Earth orbit (LEO) to geostationary orbit (GEO). - A number of GER academic and commercial satellites whose operators use their own infrastructure, some of them already use EU SST services - The Government of Japan is developing a Space Situation Awareness (SSA) system for public and private satellite operating organizations. Within this system, a scheme will be established to provide SSA information from the Ministry of Defense to satellite operating organizations. Under this scheme, contact information will be updated on a regular basis - As for Japan's space agency's activities, JAXA provides the Cabinet Office with information on any anomalies noted in JAXA's operational spacecraft based on the Act on Launching of Spacecraft, etc. and Control of Spacecraft (Act No. 76 of 2016) - JAXA exchanges information and coordinates with CSPOC regarding the operation of JAXA's spacecraft
<p style="text-align: center;">Japan</p>	<p style="text-align: center;">A/A.C.105/C.1/2023/CRP.28 (8 February 2023)</p>	
<p style="text-align: center;">United Kingdom</p>	<p style="text-align: center;">A/A.C.105/C.1/2021/CRP.16 (19 April 2021)</p> <p style="text-align: center;">A/A.C.105/C.1/2022/CRP.22 (14 February 2022)</p> <p style="text-align: center;">A/A.C.105/C.1/2024/CRP.21 (1 February 2024)</p>	<p style="text-align: center;">X (no information in the reports)</p>
<p style="text-align: center;">USA</p>	<p style="text-align: center;">A/A.C.105/C.1/2023/CRP.22 (6 February 2023)</p>	<ul style="list-style-type: none"> - Whole-of-government approach to improve SSA information sharing efforts, to include making readily available national contact information, information on on-orbit spacecraft operations, conjunction assessments, and the monitoring of objects and events in outer space - USG will continue to provide USG-derived SSA data and basic space traffic coordination services free of direct user fees - The 2021 United States Space Priorities Framework directed a transition of SSA sharing responsibilities to a civil agency -> this process is underway for civil and non-governmental entities - This should improve data sharing, transparency, and consistency in understanding/use of such information - It is also supposed to facilitate effective responses to orbital collisions, orbital break-ups, and other events that might increase the probability of accidental collisions or may pose a risk to human lives, property, or the environment (in case of uncontrolled re-entry of space objects) - For more detailed information on the efforts of specific government agencies and the private sector see the report.



Country	Report Document(s)	<p style="text-align: center;">B.2</p> <p style="text-align: center;">Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects</p>
<p style="text-align: center;">Germany</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.9 (6 February 2023)</p>	<ul style="list-style-type: none"> - The German Experimental Space Surveillance and Tracking Radar (GESTRA) allows monitoring LEO independently and generating orbital data of space objects in this orbital area at the GSS-AC information obtained with GESTRA will be made available to German universities and research institutions; provision of orbital data in the context of bi- and multilateral cooperation is intended - GESTRA will be integrated into EU SST and expanded its sensor architecture - Additionally, the Tracking and Imaging Radar (TIRA) of the Fraunhofer Society is an important instrument for tracking and characterising individual objects with high precision - GSOC is operating two telescope stations in South Africa and Eastern Australia within the Small Aperture Robotic Telescope Network (SMARTnet) to improve the accuracy and precision of orbital data, their measurements proved to be a significant improvement of the accuracy of derived orbit information in GEO - GSOC is operating SMARTnet together with the Astronomical Institute of the University of Bern since 2017. It is an international and open platform to exchange Level 1b measurements of resident space objects using the international standard TDM, and currently two additional partners are contributing with data of telescope stations located in Spain and Slovakia. The data allow for deriving highly accurate ephemeris data which is used in the context of satellite safety. Scientific research of GEO will also be pursued - In addition to these operational capacities, several scientific institutions are conducting research on improved capacity to collect orbital data from space objects. These projects include the development of laser-based precision tracking techniques to better determine the path of debris objects and to better plan evasive manoeuvres. In addition, a research observatory as well as a satellite laser station contribute to the position and orbit determination of space debris. - Commercial companies are also developing capacities to collect SST data
<p style="text-align: center;">Japan</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.28 (6 February 2023)</p>	<ul style="list-style-type: none"> - The Government of Japan improves and maintains the accuracy of satellite orbit information managed by Japanese satellite operating organisations by updating it as necessary through the SSA information provision scheme described in B.1. In addition to Japan's own SSA, the accuracy of orbit information on space objects will be improved and maintained through information sharing with the United States. - JAXA carries out research and development of related technology such as space situational awareness under the plan of the Government of Japan. - JAXA issued a space debris mitigation standard JIMR-003, which calls for improvements in tracking JAXA's spacecraft and launch vehicles
<p style="text-align: center;">United Kingdom</p>	<p style="text-align: center;">A/AC.105/C.1/2021/CRP.16 (19 April 2021)</p> <p style="text-align: center;">A/AC.105/C.1/2022/CRP.22 (14 February 2022)</p> <p style="text-align: center;">A/AC.105/C.1/2024/CRP.21 (1 February 2024)</p>	<ul style="list-style-type: none"> - The UK continues to implement this guideline through its Space Surveillance and Tracking (SST) capability. - The UK is continuing to invest in its national SST capability, having recently (November 2021) placed new contracts with Commercial sensor providers like Numera, giving the UK access to more data on objects in orbit and this supplements existing sensor capabilities provided by UK government-owned assets. - UKSA provides satellite collision warning services to government, and is rolling out a service to commercial operators in 2022 - Civil analysts work alongside their military counterparts in the UK Space Operation Centre, liaising with international partners and contributing to the UK Space Agency's support of organisations like the IADC.
<p style="text-align: center;">USA</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.22 (6 February 2023)</p>	<ul style="list-style-type: none"> - Department and agencies across the US government are working to improve their space catalogues by improving the accuracy of orbital data for spaceflight safety and leading in the development and implementation of open, transparent, and credible international standards, policies and practices, as well as working to launch a streamlined open data platform to enable collaboration and information exchange - The National Oceanic and Atmospheric Administration's (NOAA, Part of Department of Commerce) space weather prediction center and space weather observations provide data and information to support improved accuracy of orbital data - US DoD, through the US Space Command (USSPACECOM), publishes an up-to-date catalog of space objects online and provides spaceflight safety services - US DoS furnishes US space object registration information to UNOOSA for translation and public release, this information includes orbital elements - The FCC adopted a requirement that applicants must disclose the extent to which the satellite operator plans to share information regarding initial deployment, ephemeris, and/or planned manoeuvres with the 18th Space Defense Squadron or successor entity, or other entities that engage in space situational awareness or space traffic management functions, and/or other operators. - NASA's Heliophysics Division Space Weather Program, through its space weather research-to-operations and operations-to-research solicitation, funds investigations to improve the understanding of the dynamic nature of the neutral density in Earth's thermosphere that impacts orbits of space objects in this region, in order to enable better accuracy of orbital forecasting data. - For more detailed information on the efforts of specific government agencies and the private sector see the report



THE COLOGNE MANUAL ON SPACE TRAFFIC MANAGEMENT

ANNEX



Country	Report Document(s)	<p style="text-align: center;">B.3</p> <p style="text-align: center;">Promote the collection, sharing and dissemination of space debris monitoring information</p>
Germany	<p>A/A.C. 105/C. 1/2023/CRP.9 (6 February 2023)</p>	<ul style="list-style-type: none"> - A national object and orbit data catalogue is to be set up at the GSSAC (into which the detected objects are to be inserted and regularly updated) - GESTRA measurement data will also be made available to German universities and research institutions for scientific purposes - The provision of orbital data in the context of bilateral / multilateral cooperation is intended - Within EU SST, Germany will build and maintain the EU SST object and orbital data catalogue under the leadership of the German Space Agency. For this purpose, data of the sensors Page 7 contributed by the Member States are processed centrally and the EU SST object and the orbit data catalogue generated in this way is made available to the Member States. - AT DLR, Institute of Software Technology in close cooperation with GSOC, the software Backbone Catalogue of Relational Debris Information (BACARDI) is being developed (intended to display orbital data for up to 100,000 objects in space in real time) -> this software currently receives measurement data primarily from the SMARTnet network, but also from sensors of the DLR, Institute of Technical Physics and external databases -> primarily intended to support GSOC in mission operations, however, data products can also be exported and can therefore be used in other software programs, e.g. for sensor tasking. Additionally, these data can also be made available for other entities
Japan	<p>A/A.C. 105/C. 1/2023/CRP.28 (8 February 2023)</p>	<ul style="list-style-type: none"> - The Government of Japan is developing an SSA system for public and private satellite operating organizations, which will be operational in 2033. For the development of this SSA system, the Ministry of Defense and JAXA are currently acquiring SSA sensors - JAXA carries out research and development of technology related to space debris under the plan of the Government of Japan
United Kingdom	<p>A/A.C. 105/C. 1/2021/CRP.16 (19 April 2021)</p> <p>A/A.C. 105/C. 1/2022/CRP.22 (14 February 2022)</p> <p>A/A.C. 105/C. 1/2024/CRP.21 (1 February 2024)</p>	X
USA	<p>A/A.C. 105/C. 1/2023/CRP.22 (6 February 2023)</p>	<ul style="list-style-type: none"> - US is committed to continuing its practices of developing and sharing derived data products and methodologies in support of research and international scientific cooperation on the evolution of orbital debris. A key example is NASA's release and regular updates of orbital debris modeling and mission compliance assessment tools based on debris monitoring data, which are used by hundreds of satellite operators, academia, and research groups around the world - The USC also currently promotes the sharing and dissemination of derived data products about the characterization and location of orbital debris through the DoD's space-track.org, which will be captured in the continued development of the Department of Commerce's Open Data Platform - NOAA provides orbital positioning information to the Joint Space Operations Center (JSPOC) and Space Data Association which is used for conjunction assessments and collision avoidance - The DOC is charged with developing a civilian open data platform to share SSA information and provide basic spaceflight safety services to civil and commercial space operators - NASA continues to monitor and characterize debris too small to be tracked, but large enough to threaten human spaceflight and robotic missions. Efforts include collecting radar and optical debris measurement data, processing laboratory experiment data, and developing and maturing in-situ small debris measurement technologies. NASA shares the orbital debris monitoring data from these activities with the international community via a publicly available website (orbitaldebris.jsc.nasa.gov), technical publications (NASA Orbital Debris Quarterly News, etc.), and presentations at international events - NASA also releases and regularly updates orbital debris modeling and mission compliance assessment tools based on debris monitoring data. Such modeling tools are used by hundreds of satellite operators, academia, and research groups around the world - For more detailed information on the efforts of specific government agencies and the private sector see the report.



Country	Report Document(s)	<p style="text-align: center;">B.4 Perform conjunction assessment during all orbital phases of controlled flight</p>
<p style="text-align: center;">Germany</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.9 (6 February 2023)</p>	<ul style="list-style-type: none"> - Germany participates in EU SST, which also carries out conjunction analyses for EU Member States, EU organisations and European satellite operators - Germany contributes data to the collision avoidance (CA) service of EU SST and operates the EU SST database at GSSAC for the exchange of data within the EU SST partnership - In March 2022, over 140 registered users (i.e. satellite operators, EU organisations or civil protection authorities) from 22 EU Member States that have registered 270 satellites for the CA service (service is freely available to all European operators and in the future also to non-European users under the new EU Space Regulation) - The CA service of EU SST comprises clearly defined methods and processes for categorising approaches and dealing with high-risk events. Registered users receive further information in such cases. Individual cases also receive advice on possible actions (e.g. evasive manoeuvres). These services may also be provided to German operators who are not users of EU SST services - GSSAC maintains a database with satellite and mission-specific contact information from German satellite operators. Dedicated contact persons are known for various satellite missions - GSOC started to develop and operate a software system for conjunction assessment in 2009 and, ever since, is continuously developing, maintaining and operating the system. Besides conjunction assessment, the GSOC CA system also features CA maneuver planning and generation of CA products. GSOC supports other entities in conjunction assessment and collision avoidance. GSOC shares satellite ephemeris data with conjunction service providers and actively contacts other satellite operators in order to harmonize CA measures where needed
<p style="text-align: center;">Japan</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.28 (8 February 2023)</p>	<ul style="list-style-type: none"> - The Government of Japan requires in its Space Activities Act that all satellites capable of doing so should conduct orbital maneuvering in order to avoid collision if the possibility of collision with another satellite is identified and it is deemed appropriate - As for our space agency's activities, JAXA performs conjunction assessment and collision avoidance for its spacecraft in accordance with its collision risk management standard JIMR-016 - The challenge remains to establish international rules for conjunction analysis and collision avoidance.
<p style="text-align: center;">United Kingdom</p>	<p style="text-align: center;">A/AC.105/C.1/2021/CRP.16 (19 April 2021)</p> <p style="text-align: center;">A/AC.105/C.1/2022/CRP.22 (14 February 2022)</p> <p style="text-align: center;">A/AC.105/C.1/2024/CRP.21 (1 February 2024)</p>	<ul style="list-style-type: none"> - UK continues to implement this guideline through its SST programme and the National Space Operations Centre (NSPOC), and alongside the CAA - United Kingdom licensing processes require operators to have the capability to perform conjunction assessments during all phases of a mission and enact collision avoidance manoeuvres on platforms capable of adjusting their trajectories. The ability for a licensee to execute their responsibilities as spacecraft operator is assessed by the United Kingdom licensing authority as part of the licensing process, including processes for conjunction assessment and collision avoidance, as well as sources of information and criteria for actions. - NSPOC is currently running an Observe Strategy project which will define the future plan for sovereign sensor plans. - UKSA provides the Monitor Your Satellite service, a collision assessment alert service for United Kingdom licensed operators. In 2024 this will include Manoeuvre Trade Space Plots: enabling better decisions on manoeuvres by operators. This means all United Kingdom licensed satellite operators will have the information required to perform good conjunction assessment. - There are significant benefits to a shared civil-military approach to conjunction management and SST more widely
<p style="text-align: center;">USA</p>	<p style="text-align: center;">A/AC.105/C.1/2023/CRP.22 (6 February 2023)</p>	<ul style="list-style-type: none"> - The United States Government performs conjunction assessments for all spacecraft, regardless of capability to maneuver, and provides conjunction assessments to non-USG space operators. - The USG has made publicly available two complementary handbooks detailing USG experience and practices regarding collision avoidance information to help clarify USG approaches and methods: (1) NASA's "Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook" and (2) DoD's "Spaceflight Safety Handbook for Satellite Operations" - In addition, the FCC has adopted a regulatory rule requiring applicant NGSOs to certify that they will take all possible steps to assess and, if necessary, to mitigate collision risk, upon the receipt of a conjunction warning. - DoD performs around-the-clock conjunction assessment for all active satellites on-orbit. USSPACECOM provides basic conjunction analysis without cost for all operators and disseminates emergency and routine conjunction assessments to operators worldwide. USSPACECOM also provides advanced conjunction assessment prediction (screening) information to operators with Space Situational Awareness sharing agreements. - FCC adopted a rule requiring applicants for NGSO satellites to certify that, upon receipt of a conjunction warning, the operator of the satellite will take all possible steps to assess and, if necessary, to mitigate collision risk. - NASA defines a 3-step process for conjunction assessment: Conjunction assessment prediction (screening), conjunction risk assessment, and conjunction mitigation (for details see report) - For more detailed information on the efforts of specific government agencies and the private sector see the report.



Country	Report Document(s)	<p style="text-align: center;">B.5 Develop practical approaches for pre-launch conjunction assessment</p>
<p style="text-align: center;">Germany</p>	<p>A/AC.105/C.1/2023/CRP.9 (6 February 2023)</p>	<ul style="list-style-type: none"> - No governmental development or production of national space launch vehicles - Germany does not possess any launch sites for launch vehicles but participates in launch vehicle programmes of ESA - The Government is currently supporting the commercial development of small launch vehicles ("microlaunchers") - GSOC is currently developing a software system for the assessment of the safety of launch trajectories in terms of probability of collision with resident objects in space. The system will support future launch segment operators in the assessment of safe launch windows and decision making (i.e. launch go / no-go).
<p style="text-align: center;">Japan</p>	<p>A/AC.105/C.1/2023/CRP.28 (8 February 2023)</p>	<ul style="list-style-type: none"> - Through the guidelines of the Space Activities Act, Japan encourages domestic launch and transportation service providers to introduce and use tools to assess third-party injury risk (people, property, public health, environment) associated with launch, in-orbit operation and re-entry of space objects - The review criteria requires that, at the time of launch, the project team shall establish communication procedures with relevant agencies to ensure the safety of aircraft and vessels during the launch operations. - Japan will participate and respond accordingly in any future discussions on the information to be provided for pre-launch conjunction assessment through a dedicated consultative process within COPUOS. - For activities in space agencies, JAXA performs pre-launch conjunction assessment of Japanese flagship rockets with manned spacecraft, in accordance with national regulation and JAXA's standard. - Challenges that remain: to establish international rules for pre-launch conjunction assessment, to create an international database for trajectories and their errors of space objects, and to establish an international scheme of sharing launch/re-entry schedule and trajectories.
<p style="text-align: center;">United Kingdom</p>	<p>A/AC.105/C.1/2022/CRP.22 (14 February 2022)</p> <p>A/AC.105/C.1/2021/CRP.16 (19 April 2021)</p> <p>A/AC.105/C.1/2024/CRP.21 (1 February 2024)</p>	<ul style="list-style-type: none"> - The United Kingdom is in the process of developing an increasingly robust methodology to implement this guideline through our Space Surveillance and Tracking (SST) programme and the NSpOC, and alongside the CAA. - There is a need to develop common international standards on this topic, but it is unclear in which forum this should be undertaken. As the population grows, the risk will increase leading to greater closures in the launch window. A need to share screening criteria, catalogues and common assumptions on future populations is evident. The potential challenge of sharing the latter two pieces of information may be due to national security and commercial sensitivities - As part of its regulatory responsibilities the CAA examines of pre-launch conjunction assessments as part of the flight safety analysis conducted by applicants before launch. In addition, the United Kingdom continues to look at international best practice for launch, including pre-launch conjunction assessments. The ongoing research is considering the risk to space objects from launch and whether screenings should be performed exclusively for manned objects or for a larger catalogue. The research will be used to guide the development of future regulations that will be followed by future United Kingdom launch operators. - The United Kingdom's LCOLA (Launch Collision Avoidance Analysis) is currently carried out by US Space Command (USSPACECOM) under an arrangement between United Kingdom and United States Government.
<p style="text-align: center;">USA</p>	<p>A/AC.105/C.1/2023/CRP.22 (6 February 2023)</p>	<ul style="list-style-type: none"> - U.S. law requires FAA-licensed launch service providers to conduct pre-launch conjunction assessment for space objects to be launched, per 14 CFR § 450.169 – launch and reentry collision avoidance analysis requirements - The USG will continue to build on its existing mechanisms for providing pre-launch conjunction assessments. This is a multifaceted approach that involves multiple departments and agencies to ensure safe operations and address emerging challenges of pre-launch coordination. - NOAA uses NASA's Conjunction Assessment Risk Analysis (CARA) to provide pre-launch conjunction assessments for NOAA missions. - DoD conducts pre-launch conjunction assessment for all U.S. Government space objects to be launched, as well as for those operators that request assistance and have a written SSA sharing arrangement with DoD, and provides multiple public resources regarding conjunction assessment (for examples see the report) - For more detailed information on the efforts of specific government agencies and the private sector see the report



Country	Report Document(s)	B.1 Provide updated contact information and share information on space objects and orbital events	B.2 Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects	B.3 Promote the collection, sharing and dissemination of space debris monitoring information	B.4 Perform conjunction assessment during all orbital phases of controlled flight	B.5 Develop practical approaches for pre-launch conjunction assessment
Canada	<p>A/IAC 105/C 1/2023/CRP 8 (6 February 2023)</p> <p>A/IAC 105/C 1/2024/CRP 4 (29 January 2024)</p>	<p>Canada is sharing information on space object and orbital events with the National Defence Centre of Operations as well as regularly updating orbital data on its operational missions (with propulsion) by uploading it multiple times per day on the US-led free service www.space-track.org. Canada will continue to operate available Canadian sensors to contribute to improving the accuracy of orbital data on space objects and will maintain the Collision Risk Assessment and Mitigation on Systems (CRAMS) services to evaluate the status of orbital data.</p> <p>- Canada's civilian Satellite Operations Centre also works closely with National Defence partners at the Canadian Space Operations Centre to collaborate and share information with international partners on space debris and active space assets</p> <p>- Canada is conducting outreach with industry and academia to promote the development and use of techniques and methods to improve the accuracy of orbital data. This includes participating in conferences, workshops, and exercises to promote the importance of space situational awareness, and the tools and measurements used to capture it</p> <p>To date, this has included participating in the Commercial Sprint Advanced Concept Training (SACT) international exercises, which bring together government representatives and commercial partners to test operational tools for space surveillance.</p> <p>- Licence holders under the Radiocommunication Act and the Remote Sensing Space Systems Act (RSSSA) are required to provide contact information of the individuals involved in operation of the satellite communication and remote sensing space system. Licence holders under the Radiocommunication Act also provide specific orbital parameter information and system capabilities (altitude and propulsion control systems, navigation and control capabilities, etc.)</p> <p>- In addition, Canada has two space-based SSA assets that collect observational data that is shared with international partners. Civil experts work alongside their military counterparts in the Canadian Space Operations Centre, liaising with industry and international partners to enable timely notifications in case of potential risks to their space operations. Research and innovation is ongoing to improve SSA data accuracy. For example, research is ongoing with ThothX ARO, a 46m Inverse Synthetic Aperture Radar antenna located in central Canada to track SSA satellites in GEO.</p> <p>- There is a benefit to collaboration between civilian and military stakeholders for conjunction analysis and space situational awareness. In addition, the ability to analyze SSA data from multiple sources, independently verify and collaborate with international partners is important.</p>	<p>Update provided on B.2 - B.3</p> <p>- Canada operates two space-based space situational awareness (SSA) assets, which collect observational data that is shared with international partners. In addition, SSA experts conduct outreach with industry and academia to enable timely notifications in case of potential risks to their space operations and promote the development and use of techniques and methods to improve the accuracy of orbital data</p> <p>- CSA's Satellite Operations Centre has been in continuous operation since 1995 and monitors and mitigates space debris issues on 24/7 basis</p> <p>- Status of orbital data is evaluated through the CSA's Collision Risk Assessment and Mitigation System (CRAMS) -> provides value added analyses for approx. 11 satellites from CAN government, industry and academia as well as international partners</p> <p>- CAN is reviewing its regulatory framework for space activities (as committed to in the 2019 Space Strategy). SSA and STM are being considered as one aspect of this broader review</p>	<p>- Accurate, timely and actionable SSA information, combined with clear, global, space traffic "rules of the road", is of growing interest and importance</p> <p>- Two major challenges that would benefit from further elaboration in the Subcommittee:</p> <p>1) A growing number of data sources are available for space surveillance and tracking but inconsistency between these data sources can lead to more confusion and greater risk to space operations</p> <p>2) Regarding STM, while the relevant legal aspects are being addressed by the Legal Subcommittee (LSC) there is no similar thematic area within the STSC to discuss the technical and scientific elements of STM, which would complement their consideration at the LSC and inform deliberations at COPUOS</p>	<p>Canada has provided joint information on the implementation of B.1 - B.5:</p> <p>- Canada is sharing information on space object and orbital events with the National Defence Centre of Operations as well as regularly updating orbital data on its operational missions (with propulsion) by uploading it multiple times per day on the US-led free service www.space-track.org. Canada will continue to operate available Canadian sensors to contribute to improving the accuracy of orbital data on space objects and will maintain the Collision Risk Assessment and Mitigation on Systems (CRAMS) services to evaluate the status of orbital data.</p> <p>- Canada's civilian Satellite Operations Centre also works closely with National Defence partners at the Canadian Space Operations Centre to collaborate and share information with international partners on space debris and active space assets</p> <p>- Canada is conducting outreach with industry and academia to promote the development and use of techniques and methods to improve the accuracy of orbital data. This includes participating in conferences, workshops, and exercises to promote the importance of space situational awareness, and the tools and measurements used to capture it</p> <p>To date, this has included participating in the Commercial Sprint Advanced Concept Training (SACT) international exercises, which bring together government representatives and commercial partners to test operational tools for space surveillance.</p> <p>- Licence holders under the Radiocommunication Act and the Remote Sensing Space Systems Act (RSSSA) are required to provide contact information of the individuals involved in operation of the satellite communication and remote sensing space system. 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Annex 5:
International STM Authority (ISA)

Idea: A system obliging States to plan and pursue the trajectory of a space object in orbit in a way that makes accidents improbable.

Rule 1: All participants oblige themselves to observe these guidelines.

Rule 2: Before a launch into orbit any potential launcher needs to be clear on and communicate the following information:

- The time and location of entry into orbit, e.g. location and date of launch and approximate time and location of orbital insertion
- The parking orbit of the space object
- The time and location of the re-entry into the Earth atmosphere (if applicable)

Rule 3: In case of an envisaged launch the launcher (governmental or non-governmental launcher) is obliged to transfer the information required according to rule 2 to the International STM Authority (ISA).

Rule 4: The STM Authority gives the permission for the launch, according to the following conditions:

- envisaged course of the space object does not endanger other objects on ground, in airspace or in outer space
- the launcher has observed all precautionary measures for the envisaged mission
- the space object is space worthy

Rule 5: The space object is launched under the supervision of the STM Authority.

Rule 6: The launcher is obliged to pursue the travel (e.g. trajectory) through the orbit with regard and under the supervision of the STM Authority.

Rule 7: When the Operation re-enters the Earth's atmosphere the operator requests a permission of the STM Authority. This permission is granted according to the following criteria:

- Envisaged course of the space object does not endanger other objects
- A contingency plan for un-controlled re-entry is presented



- Air Traffic Management has been informed

Rule 8: Should problems arise during the stay in orbit the operator will immediately inform the national space authority and the STM Authority and try to resolve the problem with the assistance of the STM Authority.

Rule 9: (a) The operator is obliged to avoid any generation of space debris during normal operations in accordance with international standards on space debris mitigation.

(b) The operator will report to the STM Authority any observed pieces of space debris.

Rule 10:

a) There is an International Space Traffic Management Authority (STM Authority or ISA)

b) It will be established in

c) The task of the STM Authority is the authorisation and supervision of space objects in the process of being launched into outer space, of traveling through outer space and by returning back to the Earth.

d) The STM Authority is entitled to continuously monitor the space-worthiness of the spacecraft.



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