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Information Sharing to Promote the Sustainability of Outer Space Activity: Towards Development of a Model Agreement

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SECURE WORLD FOUNDATION

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The Secure World Foundation strives to be a trusted and objective source of leadership and information on space security, sustainability, and the use of space for the benefit of Earth. We use a global and pragmatic lens to study and evaluate proposed solutions to improve the governance of outer space. While recognizing the complexities of the international political environment, SWF works to encourage and build relationships with all willing stakeholders in space activities, including government, commercial, military, civil society, and academic actors. Central to this approach is increasing knowledge about the space environment and the need to maintain its stability, promoting international cooperation and dialogue, and helping all space actors realize the benefits that space technologies and capabilities can provide.

About Deborah Housen-Couriel

Deborah Housen-Couriel is an expert legal practitioner, consultant and researcher in the fields of outer space law, cybersecurity, and data privacy. She was a Core Expert in the drafting of the Manual on International Law Applicable to Military Uses of Outer Space (MILAMOS); and is a member of the Editorial Board of the Encyclopedia of International Space Law (MEISL) at McGill University. She also served as a Core Expert for the Tallinn 2.0 Manual on the International Law Applicable to Cyber Operations. Deborah teaches International Space Law at the Law Faculty of Hebrew University, where she is on the Advisory Board of the Cyber Security Research Center; and Information Policy and Regulation at Reichman University's Data, Government and Democracy program. She is the founder and principal of Housen-Couriel Law Offices, a practice focusing on tailored compliance solutions for clients in Israel and internationally. Her most recent areas of academic research include best practices for information sharing between the private and public sectors.

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Executive Summary

OBJECTIVE OF THE RESEARCH

This Report reviews a selection of information sharing (IS) platforms for the sustainability of space activities which are currently in use by diverse space actors and analyzes their modes of operation in order to elicit the key elements of IS and to identify incentivization challenges for sharers, best practices, and trends. The analysis is carried out based on the twenty platforms studied, drawing out aspects that reflect these current examples of IS. As the context of outer space activity develops rapidly and widens to include a diversity of space actors and activities, determination of the modes and parameters of IS regarding those activities will evolve: it is an ongoing endeavor. A list of principles for developing a model agreement for space activity information sharing is appended to the Report, incorporating the basic elements identified for optimal IS. Finally, the aim of the Report is to support a more precise understanding of what such information sharing platforms can optimally provide for their sharing entities and what is needed to incentivize space actors to utilize them most productively in order to ensure the sustainability of space activities.

SCOPE

The selected platforms are drawn from five categories of space activity: (1) overall space domain awareness (OSDA);[1] (2) space traffic coordination; (3) post-mission disposal of space objects and space debris; (4) lunar activity and safety; and (5) atmospheric and environmental Earth observation. There is some overlapping across these categories, as elaborated upon in the Report. Also, while information sharing

1 The use of this term indicates the broad and inclusive scope of the IS platforms included in this category, and is not intended to imply military domain awareness, nor to include military information sharing modalities.

can be strategic or tactical (or a combination of both), we have focused on actionable information that IS participants can utilize in the immediate and short term, the parameters of which are defined herein.

MAIN FINDINGS AND CONCLUSIONS

Based on analysis of these twenty IS platforms, the Report offers observations on the current state of IS for the sustainability and governance of space activities and highlights how platforms are currently deploying innovations for broadening overall situational awareness and mitigating space risks. The innovations identified include tailored user interfaces that are interactive and map-based, supporting ease of use; near-real-time aggregation of critical information; real-time alerts on space-based risks that may be calibrated to the requirements of specific platform tiers and sharers; direct communications between space actors and the platform, in addition to “pushed” data supplied by the platform; robust integration of space- and Earth-based data sources; deployment of dedicated AI tools; and—in one case—direct, online connect with space debris removal services.

Any arrangement for space IS requires the exchange of both generic data such as identification of launching and participating states, orbital details, and activity descriptions, as well as additional parameters tailored to each shared activity. However, the Report’s findings show that current formatting efforts are fragmented. For instance, the COPUOS Working Group on the Status and Application of the Five United Nations Treaties on Outer Space (the “COPUOS Working Group”) is developing a format for Outer Space Treaty (OST) Article XI notifications that may not align with the formats of other IS platforms, such as Spacetalk’s proprietary communication standards or EU Space Information Sharing Analysis Centre (ISAC) formats. Broader recognition and adoption of ISO/TC 20/SC 13 and 14 documentation also remains an ongoing process, highlighting the need for stronger incentives for their *de facto* implementation. One useful model for the adaptation of standards and formats may be the Common Vulnerabilities and Exposures (CVE) system used for the U.S. Cybersecurity and Infrastructure Security Agency (CISA) cyber alerts, which is already applied with respect to such alerts for some satellite systems and is detailed herein.

Incentives for using space IS platforms are also shifting, brought about by two separate developments. The first development stems from the increased privatization of space activities, as private companies like ICEYE, LeoLabs, NorthStar, and Privateer operate for-profit portals that integrate commercial tools, including platform marketing and—as mentioned above—debris-removal pricing by a third party. These innovations raise new concerns about the economic models for information sharing, as well as the protection of intellectual property (IP) created in the context of space activities, including privately produced catalogues of space objects and vulnerabilities. While multilateral agreements such as the Artemis Accords and the Space Station Agreement explicitly address IP issues, this remains an open and challenging issue. The second development stems from the nascent regulatory projects for space governance, especially in the European Union. There, the NIS2 Directive and the proposed Space Act require the 27 EU countries to ensure that space actors institute IS practices that are subject to regulatory sanction if not utilized. Enforcement of these requirements is expected to come into play in the next few years. Another critical issue that impacts the incentivization of space actors to use space IS platforms is that of the underlying information security of platforms. This is a difficult topic to study, as information security controls are not consistently transparent to sharers and external researchers. The most protected platforms are likely to intentionally refrain from transparency regarding protection of digital data, its transmission and its storage. Measures that have been undertaken to standardize such protections include the ISO/TS 20517:2024 on cybersecurity for space systems, the National Institute of Standards and Technology (NIST) Communications Technology Laboratory's projects on the safety of space communications, and standards developed by the American Institute for Aeronautics and Astronautics and the Space Infrastructure Foundation.

While the Report has mapped and analyzed the incentives for IS with respect to outer space activities, the implications of actors in space ***refraining*** from participation, and the resultant risks to overall space sustainability, should also be considered. The proposed principles of a model agreement in Annex A of the Report address incentivization issues, such as the setting of clear thresholds and rules for IS, transparency of information security measures supporting the platform, and data exchange formats. Additional points that emerged from the research conducted for this Report, and which are expanded upon in the Summary and Conclusion, include: (a) the unidirectional nature of many of the 20 platforms studied (i.e., the export of information to participants), with less emphasis on their inputs; (b) the advantages of tiered-access portals; and (c) the challenges of collecting potentially critical information from confidential sources such as the military and the space insurance sector that do not transparently participate in the IS platforms reviewed here. Through measures such as improved mapping of space IS resources and ongoing research into the effectiveness of specific platforms, the present fragmentation of information sharing for sustainable space activities may be reduced.

TOPICS FOR FUTURE RESEARCH

Topics for future research that will impact the issues raised in this Report include: (a) an analysis of robust data sharing protocols for critical space IS that can be deployed rapidly and serve as a common format for state and non-state actors, such as the formats included in the 2025 Article XI Implementation Document; (b) development of a space risk assessment matrix that would be similarly standardized and integrated into IS platforms; and (c) a study of the actual, *de facto* use of these platforms by diverse space actors. The increasingly ubiquitous deployment of AI tools for more efficient IS will inevitably be part of such future research.

Acronyms and Abbreviations

Artemis Accords
*The Artemis Accords: Principles for a Safe, Peaceful, and Prosperous Future in Spac*e, 13 October 2020.

Article XI First Ideas Document
First Ideas for a Template on Article XI Outer Space Treaty Non Paper Submitted by the Chair of the Working Group on the Status and Application of the Five United Nations Outer Space Treaties of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, 12 May 2025

Article XI Implementation Document
Implementation of Article XI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and Article IV of the Convention on Registration of Objects Launched into Outer Space, A AC 105 C 2 L 338, 12 March 2025.

CISA
Cybersecurity and Infrastructure Security Agency of the United States Department of Homeland Security.

COPUOS 2025 Report
UN A 80 20, *Report of the Committee on the Peaceful Uses of Outer Space*, Sixty eighth session (25 June–2 July 2025), 7 July 2025.

COPUOS Working Group
Committee on the Peaceful Uses of Outer Space Working Group on the Status and Application of the Five United Nations Treaties on Outer Space.

Draft Code of Conduct
Draft International Code of Conduct for Outer Space Activities, Council of the European Union, 31 March 2014.

EU Space Act
2025 0335(COD), Proposal for a regulation on the safety, resilience and sustainability of space activities in the Union COM(2025) 335, 25 June 2025 and its Annexes 1 10.

ITU
International Telecommunication Union.

LTS Guidelines
Guidelines for the Long term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, Report of the Committee on the Peaceful Uses of Outer Space, A 74 20, 20 August 2019.

NIST
The US National Institute of Standards and Technology.

OSDA or Outer Space Domain Awareness
the broadest and most inclusive category of information sharing platforms, which does not explicitly include military domain awareness.

OST
United Nations, *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205.

Radio Regulations
International Telecommunication Union, Radio Regulations, Edition of 2020, Geneva, 2020.

Registration Convention
Convention on Registration of Objects Launched into Outer Space, 12 November 1974, 672 UNTS 9574.

Space Station Agreement
The Agreement Concerning Cooperation on the Civil International Space Station, January 29, 1998.

Part 1: Introduction

BACKGROUND

The rapid acceleration of human activity in outer space is unlocking transformative opportunities in science, technology, exploration, and economics—both in space and on Earth. Technological developments such as reusable launch vehicles, lunar mining, space-based 3D printing, orbital and lunar data centers, and Mars rovers exemplify this innovative wave of "New Space" initiatives. These efforts are driven by an expanding ecosystem of actors, which extend beyond the original participants in outer space initiatives—nation-states—to a broader range of space actors. The entry into outer space of private companies, nation–state–corporate hybrid partnerships, academic institutions, and even individuals[2] is currently characterizing the new nature of space missions and activities. Yet alongside these advances, critical vulnerabilities and risks arise that threaten the sustainability of space activities. Thus, information sharing (IS) among space actors has become increasingly critical for both overall situational awareness in space, and for the mitigation of threats and risks associated with space activities. It is no longer only a best practice, but rather a critical aspect of the feasibility and functionality of space activities.

> "Information sharing is no longer only a best practice, but rather a critical aspect of the feasibility and functionality of space activities.

RESEARCH OBJECTIVES

This Report examines how IS serves to promote the long-term sustainability of the use of the outer space environment. While international and national space law—including the 1967 Outer Space Treaty (OST) Articles VIII through XI, the 1974 Registration Convention, the 1998 International Space Station Agreement,[3] and the Artemis Accords[4]—provides a framework for cooperation and public notification of space activities, international space law currently lacks a dedicated, permanent mechanism for risk-focused IS. The voluntary Guidelines for the Long-term Sustainability of Outer Space Activities ("LTS Guidelines") have addressed this concern explicitly in Guideline C.2, entitled "Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange."[5]

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2 In 2005, Gregory Nemitz sued NASA, seeking a declaratory judgment regarding his alleged private property on the asteroid 433, "EROS." Nemitz' suit was unsuccessful but marked an interesting development in the standing of individuals with respect to outer space activities (Nemitz v. NASA, United States Court of Appeals, Ninth Circuit, 10 February 2005). For a more recent instance of individuals' interface with space activities, see Joe Hernandez, *A Florida family is suing NASA after a piece of space debris crashed through their home*, NPR, 24 June 2024.

3 See Article 19 on "Exchange of Data and Goods" and Article 20 on "Treatment of Data and Goods in Transit."

4 See Section 4 entitled "Transparency," Section 5 on "Interoperability," Section 8 on "Release of Scientific Data," and Section 11 on "Deconfliction of Activities."

5 The LTS Guidelines, C2. Other multilateral support for IS for space activities is supported by UN Space GGE's transparency and confidence building measures (*Report of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities*, A/68/189, 29 July 2013); the UNGA 2023 *Resolution on responsible behaviors in space (Reducing space threats through norms, rules and principles of responsible behaviours*, A/RES/78/20, 6 December 2023); the EU Space Act; the European Draft Code of Conduct; and the *Open-ended working group on reducing space threats through norms, rules and principles of responsible behaviours* (Recap Report, 15 March 2024 (https://unidir.org/publication/oewg-on-reducing-space-threats-recap-report/).

Such information exchange should facilitate the compilation and dissemination of information on the enhancement of long-term sustainability of space activities and should include measures for IS with nongovernmental entities. Guideline C.2 embodies this approach, continuing with a recommendation that states and international organizations "…take note of existing data-sharing practices used by non-governmental entities." Likewise, the COPUOS 2025 Report notes the need to "…accelerate the development of frameworks or information sharing and coordination to ensure space safety and sustainability,"[6] both reiterating earlier COPUOS reports' underlining of this priority and providing an impetus for the present study.

Continuing these developments, The Working Group on the Status and Application of the Five United Nations Treaties on Outer Space has begun to draft specific information sharing mechanisms and measures in accordance with OST Article XI, emphasizing that IS constitutes:

> …a key means of promoting and facilitating international cooperation among member States, and that article XI of the Outer Space Treaty had the potential to further enhance such cooperation and further contribute to capacity-building, access to space and space activities for the benefit of all countries. The Working Group also noted the importance of information exchange for transparency and confidence-building, as well as for coordination and the avoidance of harmful interference.[7]

This Working Group is also developing dedicated tools for space IS, including a proposed template for participants' sharing of data.[8] Several of the examples studied herein already provide such templates (e.g., the EU Space Surveillance and Tracking portal, the UNOOSA Long-Term Sustainability of Outer Space Activities Information Repository, Space Data Association, the Lunar Ledger), and these have been used in developing the principles for the model agreement in Annex A.[9]

Other multilateral and national instruments and initiatives have addressed IS to promote and support sustainable space activities, either explicitly or generally. These include the International Telecommunication Union Radiocommunication's (ITU-R) Working Party 7b on space radiocommunication applications, which is developing dedicated processes to facilitate information sharing between satellite operators and radio astronomy services;[10] CISA's Recommendations for Space System Operators for Improving Cybersecurity;[11] and the Building Blocks for the Development of an International Framework for the Governance of Space Resource Activities.[12] Such

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6 The COPUOS 2025 Report and the Committee's 2023 Report, pp. 15 and 34, and Annex II (UN A/AC.105/1279, *Report of the Scientific and Technical Subcommittee on its sixtieth session*, Committee on the Peaceful Uses of Outer Space Sixty-sixth session Vienna, 31 May–9 June 2023, 27 February 2023).

7 A/AC.105/L.338/Add.2, *Report of the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space*, 21 June 2024, at §11.

8 See, for instance, *Background paper by the Secretariat, Implementation of article XI of the OST*, A/AC.105/C.2/L.338. 12 March 2025; and A/AC.105/C.2/2023/CRP.40, *Dedicated Tools and Practices for Enhanced Information Sharing*, 27 March 2023.

9 For a review of current COPUOS activities to develop information sharing activities, see Michael Friedl and Christopher Johnson, The COPUOS Briefing Book, 2nd ed., Secure World Foundation, 2025, at iv, 31, 61, and 86.

10 Resolution 681, World Radiocommunication Conference, Dubai 2023.

11 CISA, Recommendations for Space System Operators for Improving Cybersecurity, April 2024.

12 A/AC.105/C.2/2022/CRP.23, Building Blocks for the Development of an International Framework for the Governance of Space Resource Activities, 2022 (in its Article 14 on "Registration and Sharing of Information", and Article 18 on the establishment of a shared database for space resource activities).

documents will be referred to as relevant, but a comprehensive review of the IS-relevant provisions across all relevant multilateral, bilateral, and national outer space regulatory documents awaits further study.[13]

It is notable that across other developing domains of human activity, IS has emerged and proved itself as a key tool for situational awareness and threat mitigation. Three leading examples include the maritime domain, where a comprehensive Global Integrated Shipping Information System (GISIS) is administered by the International Maritime Organization;[14] the Antarctic Treaty Electronic Information Exchange System (EIES) maintained by the treaty Secretariat to support parties' compliance with Antarctic Treaty IS requirements;[15] and the U.S. Cybersecurity and Infrastructure Security Agency (CISA) platform for global cybersecurity IS.[16] These platforms have developed sector-specific modes of information sharing in the short, medium, and long terms and underline the criticality of sectoral-based situational awareness for the sustainability of each domain, as well as the potential for intersectoral IS as interdependencies deepen.[17]

Two underlying core issues are present throughout the Report and the analysis of the IS platforms analyzed: the importance in each instance of identifying the aim of IS for participating entities, whether they are countries, international organizations, or private sector actors (the "why" of the IS); and the means of incentivizing IS for these actors, despite barriers such as the reluctance to share information that may have commercial and business implications; legal constraints with respect to intellectual property, data privacy and national security; the time spent to train personnel; administrative costs; and information security for the IS platform itself (the "how" of IS). These issues are addressed specifically in Parts 3 and 4 below. It is important to underscore that they both engage with the most critical aspect of information sharing, which at its essence is an exercise in trust-building among sharers. The information shared by outer space actors is likely, in the best case, to answer their operational needs, provide added value for situational assessment, and allow them to quickly process real-time alerts that endanger their space systems. Yet without trust in the reliability of the information provided, the credibility of other sharers, and the security of the IS platform, incentivization will continue to pose a challenge.

The platforms reviewed in this Report are at varying stages of establishing the necessary, robust levels of trust among sharers, which is also a function of the period over which they have been operating. At the extremes of the scale, the UNOOSA-managed Index of Submissions by States under Article XI includes a 1967 U.S. notification of "Preliminary Scientific Results from Surveyor V" on the lunar surface,

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13 For a review and analysis of current IS developments at the multilateral level under OST Article XI, see Franzeska Knur, *Article XI OST – Information sharing and international cooperation: Current developments at the multilateral level*, in Stephan Hobe (ed.), *Liber Amicorum ON THE OCCASION OF THE CENTENARY OF THE COLOGNE INSTITUTE OF AIR LAW, SPACE LAW AND CYBER LAW*, Carl Heymanns 2025, 377-389.

14 Information exchange for aspects of maritime security is required under of contracting States in accordance with the International Convention for the Safety of Life at Sea, Regulation XI-2/13. See https://gisis.imo.org/public/default.aspx/

15 See Secretariat of the Antarctic Treaty, Electronic Information Exchange System, https://eies.ats.aq/Login?ReturnUrl=%2F.

16 See https://www.cisa.gov/. CISA uses a globally recognized format for cyber vulnerabilities, the Common Vulnerability Scoring System (CVSS).

17 See, for example, Deborah Housen-Couriel, *Information sharing for the mitigation of outer space–related cybersecurity threats*, ACTA ASTRONAUTICA, Vol. 203, February 2023, pp. 546-550.

while the recent Lunar Ledger is in the initial stages of developing a public registry for future lunar exploration activities. Differences in levels of trust are also evident in the specificity of technical data provided to sharers (LeoLabs and other platforms reviewed provide a near-real-time map of Low Earth Orbit [LEO] satellites); whether the IS platform is publicly accessible (such as Privateer's "Wayfinder" site), fee-based (Space ISAC charges for access), or limited by regulation (the EU Space ISAC); and whether the data shared provides tiered access according to intentionally graded trust levels (the EU-supported Global Earth Observation System of Systems Platform Plus specifically promotes tailored IS for self-defined sharing communities).

It is important to note that none of the platforms studied are designated exclusively for military use, and while overlap with military IS or its incorporation into certain platforms may, in fact, occur, it is not completely transparent. Optimal information sharing would encompass military data as well as civilian and commercial information, yet this is not a realistic possibility at present.[18]

> Optimal information sharing would encompass military data as well as civilian and commercial information, yet this is not a realistic possibility at present.

METHODOLOGY

Over fifty platforms for space activity information sharing have been identified in the literature review conducted in the preparation of this Report. The analysis herein focuses on a total of twenty selected space IS platforms out of the broader list, in the following five categories. The first four categories were selected based on their criticality for the sustainability of space activities, and the fifth, relating to Earth observation, for the insights it provides into information sharing using advanced satellite observation capabilities. It is also important to note that some of the platforms studied have overlapping functions and thus may be classified in more than one category.[19]

1. Overall space domain awareness (OSDA)

- *UNOOSA Long-term Sustainability of Outer Space Activities (LTS) Repository*
- *ITU Space Sustainability Gateway*
- *Space ISAC*
- *NATO Alliance Persistent Surveillance from Space (APSS)*
- *EU Space ISAC*

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18 See the references to the importance of military IS in, for example, Joint Publication 3-14, Space Operations, updated to 26 October 2020. One example of military IS can be seen in the Air Force Research Laboratory's Oracle-M system: see Oracle-M Hot Fire Test: A major milestone in Cislunar Space Situational Awareness and National Security, 6 May 2025, https://www.afrl.af.mil/News/Article-Display/Article/4176820/oracle-m-hot-fire-test-a-major-milestone-in-cislunar-space-situational-awarenes/.

19 For instance, the NorthStar and Privateer platforms provide overall space domain awareness, as well as specific space debris tracking.

2. Space traffic coordination

- *LeoLabs Space Traffic Management*
- *Space Data Association portal*
- *Office of Space Commerce (OSC) TraCSS*
- *Spacetalk*
- *European Union Space Surveillance and Tracking (EU SST)*

3. Post-mission disposal of space objects and space debris

- *NorthStar Earth & Space*
- *Privateer Space "Wayfinder"*
- *Aerospace Corporation Center for Orbital and Reentry Debris Studies (CORDS)*

4. Lunar activity and safety

- *UNOOSA Article XI Registry*
- *Lunar Ledger*
- *International Lunar Research Station Cooperation Organization (ILRSCO)*

5. Atmospheric and environmental observation from space

- *ICEYE*
- *COSPAR's Global Earth Observation System of Systems Platform Plus (GEOSS-PP)*
- *Polish Space Agency Sat4Envi Operating System*
- *NASA Fire Information for Resource Management (FIRMS)*

Each platform is briefly summarized in Part 5 below, following an accompanying comparative table which presents a schematic comparison of the twenty platforms. In cases where the data sharing formats used on the platform were transparent, they are likewise documented.

STRUCTURE

Following this Introduction, the Report begins by defining a working definition of information sharing for sustainable space governance (Part 2) and proceeds to the identification of key challenges of IS for space activities (Part 3). Part 4 discusses measures for incentivizing space actors to share information despite these barriers. Part 5 consists of the survey of the platforms in the five categories of space IS reviewed in this Report, with a brief introduction to each category. Part 6 includes the Report's Summary and Conclusion, with reference to some areas for future research to incorporate ongoing technological developments and innovations in outer space which will impact both the modes of IS and its content. Annexes A and B include, respectively, principles for a draft model agreement on IS for space activities, and a List of Interviews conducted in preparation of the Report.

Part 2: Defining Information Sharing and Its Contribution to Space Sustainability and Governance

INFORMATION SHARING FOR OPERATIONAL DATA EXCHANGE

Information sharing is a measure employed for the exchange of data deemed relevant by the sharing entities in a given domain of activity that is relevant to the resolution of a collective action problem. The types of information shared include identification of entities' activities that have been predetermined as of common interest, as well as potential vulnerabilities and risks to the sustainability of those activities.[20] The current academic and professional literature analysis of IS reflects a broad consensus that a critical level of trust is built over time when sharers exchange information that reliably brings them each some added value.[21]

A key underlying assumption of this generic definition, which is the starting point for our analysis, is that in the outer space context, IS contributes significantly to the mitigation of risks to outer space activities and their vulnerabilities when carried out effectively. It does so by putting in place a triangulation of common and overlapping interests on the part of participants, as follows:

- **The participation itself signals an interest in the common effort and commitment to governance and sustainability in outer space**, with respect to the area of space activity for which information is being shared (e.g., situational awareness, traffic coordination, environmental impacts, post-mission debris, lunar activity);
- IS supports **coordination of space activities** that can serve to reduce duplication of efforts and resources; and
- Sharers benefit from **improved overall situational awareness, despite inherent information asymmetries regarding risks and threats**. This is a critical advantage regarding, for example, space object conjunction and collision data, ephemeris (orbital) screening, and identification of abnormal space object behavior.

20 This Report uses the term "information" to include more specific terms such as "data," "specifications," and "input;" and these latter terms may be used interchangeably with "information" herein.

21 See Martin Gill and Stephen Crane, *The role and importance of trust: A study of the conditions that generate and undermine sensitive information sharing*, Security Journal 30 (2017), pp. 734–748; and Daniel Levin, Rob Cross, Lisa Abrams, and Eric Lesser, *Trust and Knowledge Sharing: A Critical Combination*, IBM Institute for Knowledge-based Organizations 19, no. 10 (2002), pp.1-11.

This triangulation is shown in **Figure 2.1** below, where the core shared value of "trusted information" can be characterized as information that is "attributed, available, has known pedigree and provenance, and is not controlled by any individual stakeholder or subset of stakeholders, and cannot be maliciously altered."[22] The optimal outcome of the interactions among sharers via a successful outer space IS platform will be the establishment and maintenance of informational trust over time.

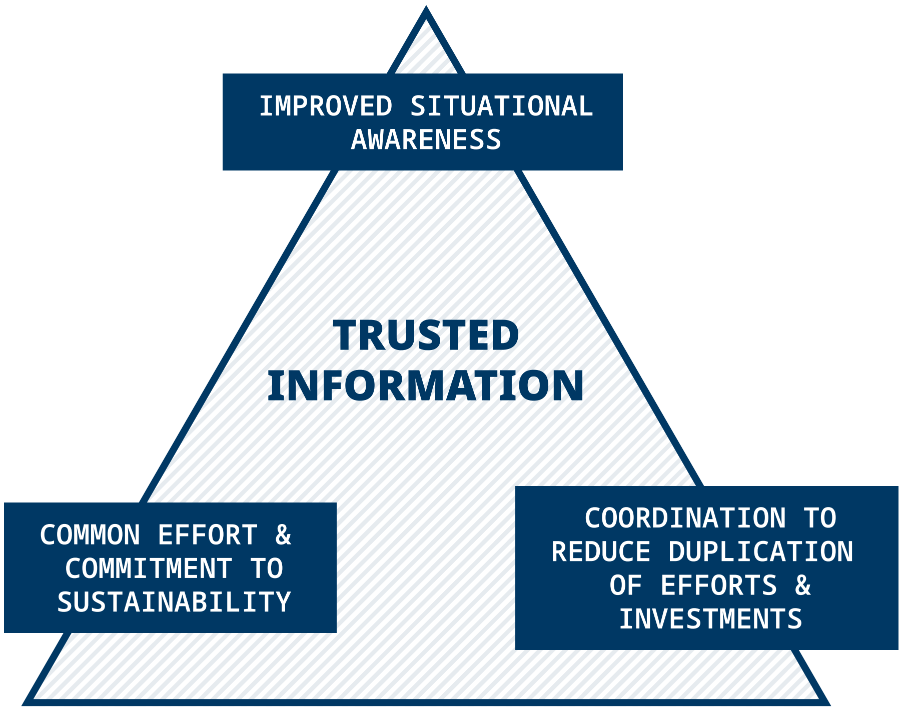

Figure 2.1 | *Core general interests supporting information sharing on outer space activities (Source: Author).*

For the purposes of this Report, we have analyzed space IS platforms that provide trusted information that can be characterized as ***actionable***, that is, relevant for sharers immediately—within a time span of 72 hours—or in the short-to-medium term of a few weeks. This focus may also be characterized as tactical IS (when data is shared about specific space activities, risks, and threats in near-real time), as opposed to strategic IS (when shared information includes intelligence, long-term assessments and reports, and business continuity planning). The emphasis on actionable and tactical IS significantly narrows the focus of the platforms reviewed and analyzed, and sets aside the wide array of more generalized, strategically oriented information sharing portals. Examples include the Consultative Committee for Space Data Systems (CCSDS) forum for the development of space-related communications and data systems, the Asia-Pacific Regional Space Agency Forum (APRSAF),[23] the Compendium of Space Debris Mitigation Standards under UNOOSA auspices,[24] and UNOOSA's

22 Harvey Reed, Nathaniel Dailey, Ruth Stilwell and Brian Weeden, *SISE (Space Information Sharing Ecosystems): Decentralized Space Information Sharing as a Key Enabler of Trust and the Preservation of Space*, AEROSPACE RESEARCH JOURNAL, 3 November 2021, at 1 (https://arc.aiaa.org/doi/abs/10.2514/6.2021-4078).

23 The Asia-Pacific Regional Space Agency Forum was established in 1993 to support IS for space activities in the Asia-Pacific region. More than forty space agencies, private companies, universities, and research institutes participate (https://www.aprsaf.org/about/).

24 See https://www.unoosa.org/oosa/de/ourwork/topics/space-debris/compendium.html

Online Index of Objects Launched into Outer Space.[25] Think tanks and academic institutes such as the European Space Policy Institute, the Secure World Foundation, and the British Interplanetary Society are some examples of nongovernmental entities that share information on space activities at the strategic level.

Moreover, there are several categories of space IS platforms which provide actionable data that are explicitly beyond the scope of this Report. These include military and national security platforms, which are not public, and thus not subject to credible external analysis;[26] the space insurance sector's common assessment mechanisms;[27] and the ITU-R's comprehensive space plan assignments and related databases under the Radio Regulations, which constitute a unique and technically detailed IS resource for outer space actors.[28]

Sharing entities on space IS platforms analyzed in this Report include government actors, private companies, international organizations, NGOs, and even individuals. Each platform reviewed defines eligible entities specifically. In past years, such platforms were overwhelmingly managed by governmental agencies or intergovernmental actors, such as the Space-Track portal that has been operated since 1957 by the U.S. Department of Defense (DoD) at Space-Track.org,[29] and the European Union's Space Surveillance and Tracking platform (EU SST). Yet the new role of commercial entities in outer space activity[30] is evidenced not only by their participation in space IS as sharers; but also, significantly, in their standing up of independent IS platforms on their own initiative. Examples of these include the paid-access, commercial portals operated by NorthStar Earth & Space, Space ISAC, LeoLabs, and ICEYE, detailed in Part 5 below.[31]

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25 See https://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=

26 Yet see the interesting approach to improving deterrence through "strategic disclosure" of space assets and activities Wendy Cobb, *Costly Signals in Space: Increasing Credibility via Strategic Disclosure*, SPACE AND DEFENCE, Vol. 16: No. 2, Article 5.

27 One example is the Space Risks Study Group (SRSG), under the auspices of the International Union of Aerospace Insurers (IUAI). See https://www.iuai.org/page/spacestudy

28 The notification procedure under Article 11 of the Radio Regulations requires administrations to submit for ITU-R confirmation detailed technical data about space objects, including orbital parameters, antenna beams, frequency use, etc. See the ITU-R description of these resources at *Space Plan Assignments Recorded in the Master Register*, https://www.itu.int/en/ITU-R/space/plans/Pages/MIFR.aspx.

29 Space-Track is about to be incorporated into the Traffic Coordination System for Space (TraCSS) IS portal under the auspices of the U.S. National Oceanic and Atmospheric Administration's Office of Space Commerce.

30 Hongxi Wang, *Commercial Space Companies: Lawmakers of 21st Century New Space*, 46 JOURNAL OF SPACE LAW. 221 (2022).

31 Note that this is a partial listing of commercial portals or platforms related to IS, which are continuing to expand.

THE KEY PURPOSES OF IS FOR PROMOTING SPACE SUSTAINABILITY

The aims of tactical IS in the context of space sustainability and governance extend throughout the lifecycle of the space object and have critical relevance for both technical aspects of space operations and the actual saving of human life in space.[32] Following this holistic approach, Reed et al. have proposed four categories of IS events: initial lifecycle benchmarks (launch, orbit insertion, maneuvers); orbit or trajectory tracking; intention-to-maneuver data and possible conjunctions; and terminal lifecycle events (collision detection, decommission).[33] The critical data for governance of these four categories is both massive in quantity and technically detailed. And because of the unique nature of the outer space environment—such as distance from human control centers, extreme weather conditions, high-energy radiation, and microgravity effects—they may be impacted by unpredictability, distortions, and incomplete specifications. Human misperception and error, technical malfunctions, operational entanglement, and bad actors also contribute to data distortions and incompleteness. IS platforms enable actors and other stakeholders to collect more pieces of the overall outer space situational awareness "puzzle," to assemble a completer and more accurate picture of risks and potential risks, and to decide on a course of action, which may or may not include mitigation measures. Moreover, successful IS, in the best case, constitutes a positive externality: not only do the sharers benefit from a more reliable outer space environment, but also other space actors gain advantage from the improved governance of the sharers' space activities.[34]

Finally, it is important to underscore the obvious point that space information sharing is deeply embedded in the international legal regime for outer space activities as set out in the OST and its four companion treaties. Specifically, Chernykh and Volodin emphasize that IS constitutes a concrete application of the treaties' principle of international cooperation for space activities:

> It cannot be denied that the most accurate, complete, and up-to-date information on the activities of States in outer space is the highest guarantee for ensuring the implementation of the basic principles of international space law, such as freedom of access to and use of outer space, non-appropriation of outer space, [and] respect for international law....[35]

As such, information sharing not only contributes to space sustainability as a practical tool but also serves as a best practice for ensuring ongoing safety of space operations. It is a critical means of promoting optimal governance of the OS environment within the framework of space law.

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32 Brett Tingley, *Chinese astronauts 'stuck' on space station to get a new spacecraft after debris strike leaves them without a ride home*, 17 November 2025, https://www.space.com/space-exploration/launches-spacecraft/chinese-astronauts-to-get-replacement-spacecraft-after-debris-strike-leaves-them-without-a-ride-home.

33 Reed et al., *supra* note 22 at 3.

34 Ross Anderson et al., in Noam Nisan et al. (eds.), Incentives and Information Security, Algorithmic Game Theory 633 (2007).

35 Irina Chernykh and Daniil Volodin, *The Principle of International Cooperation and Sharing of Information Principle under International Space Law: Towards Synergy*, 67 SPACE POLICY (2024), at 101593. The quotation is at their footnote 2 (J.-F. Mayence, T. Reuter, Article XI, paras 92–94, in: S. Hobe, B. Schmidt-Tedd, K.U. Schrogl (eds.), COLOGNE COMMENTARY ON SPACE LAW, vol. 1, Carl Heymanns, Cologne, 2009).

Part 3: What's the Problem? Key Challenges of Information Sharing for Space Activities

GENERAL CHALLENGES OF INFORMATION SHARING

As noted above, the sharing of organizational data of any kind is an exercise in trust. When entities—whether countries, international organizations, non-state actors, or companies—are not compelled to share information by legal requirements or by other measures that entail sanctions for non-sharing, there is often a need to establish a specific operational or business benefit that can only be met through such an exchange. For instance, in the context of trade and commerce entities may easily share data that present their economic positioning in a positive light, thus attracting potential customers and investors, but may be less likely to volunteer information on debts and legal claims against them. In the latter case, mechanisms such as confidentiality and nondisclosure agreements can serve to boost trust levels when they are relevant or feasible.

Yet there are also some clear disincentives for IS outside of the organization. First, if clear and robust safeguards to protect sensitive information such as intellectual property, proprietary business processes, and protected personal data are not explicit elements of the IS platform, there will likely be a disincentive to share. Moreover, there may be legal prohibitions on sharing such data, including national security restrictions. Second, even when such safeguards are in place, potential exposure of protected data may occur through the "bottoming out" of trusted platforms, as evidenced by the repeated breaches of high-security hubs such as the U.S. National Security Agency's cyber weapons cache, the German federal parliament, and the UK Electoral Commission.[36] Given these and other cases of government databases having been hacked and sensitive data having been publicly exposed, the IS platform itself must also be carefully vetted for its own information security levels as part of the incentivization of sharers.[37] Thirdly, administrative costs and personnel training needed for a given platform may be prohibitive.[38] Finally, there may be concerns about IS "free riders"—entities that ostensibly participate in the sharing process but in fact do not contribute to it. All of these disincentives may serve to erode trust in a given IS platform, even before the sharing organization can evaluate whether there are actual benefits that accrue to it by *de facto* utilization. Some specific challenges to space IS are discussed in the following section.

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36 Swati Khandelwal, *Shadow Brokers Leaks Another Windows Hacking Tool Stolen from NSA's Arsenal*, THE HACKER News (7 September 2017), https://thehackernews.com/2017/09/shadowbrokers-unitedrake-hacking.html.

37 Housen-Couriel, *supra* note 17.

38 See Lawrence Gordon, Martin Loeb & William Lucyshyn, *Sharing Information on Computer Systems Security: An Economic Analysis*, 22 JOURNAL OF ACCOUNTING & PUBLIC POLICY (2003), pp. 461-85. The implementation of the recent Executive Order of 18 December 2025 (*Ensuring American Space Superiority*, Section 4) might entail user fees or other charges associated with formerly free-of-charge SSA and STM data, as it currently stands.

SPECIFIC CHALLENGES FOR OUTER SPACE ACTIVITY IS

The harsh physical environment of outer space, its distance from terrestrial decision and control centers, technical complexity, and other aspects of space activities all pose challenges for information sharing. These include:

- **The dynamic operational environment:** The OS environment is subject to unpredictable anomalies (e.g., space weather, high-energy particles, solar activity) which are difficult to model and test at scale prior to launch. Despite the distance from decision and control centers, IS often demands real-time detection and communication of space anomalies.
- **Space object malfunction:** Malfunctions may be difficult to detect and notify to other sharers with sufficient lead time for response, or may result in false positives.
- **Intended illegitimate activities that introduce a threat vector:** Intentional malfeasance also has the “space object malfunction” characteristics.
- **Harmful interference to radio frequency communications:** Interference with frequency use may impact both data collection and its transmission.
- **Space debris impacts:** Tiny fragments travelling at high speeds (~7–8 km/s) pose impact risks that are challenging to detect and share in a short time frame, and the full effects of their impact may be unpredictable.
- **Less-than-optimal aspects of the platform itself:** These aspects include an incomplete or insufficient view of the relevant space environment due to orbital constraints or a low number or participants, data exchange protocols that do not transmit complete data sets for the needs of participants, insufficient sharing speed (either in gathering data or in its distribution), false positives, and defective information security along the data transmission pipeline.
- **Costs of IS:** The costs of commercially supplied information sharing may be prohibitive (or provide a strong disincentive) for small and medium enterprises in particular; IS platforms that have in the past refrained from imposing financial costs may discontinue this economic model, as indicated in the December 2025 Executive Order on *Ensuring American Space Superiority* referred to above.

Some of the general IS challenges with respect to the potential exposure of sensitive organizational information that are noted in the previous section are also applicable to space IS (i.e., exposure of intellectual property, proprietary business processes, and protected personal data; legal prohibitions on sharing such data, including national security restrictions for military and dual-use space objects; administrative costs; and free riders).

All of the above considerations may impinge upon the establishment of trust among sharing entities, some of whom may be commercial competitors. Nonetheless, space actors’ participation in a given space IS platform may increasingly less of a voluntary “opting-in;” and more of a required measure determined by regulatory requirements (for instance, if the space object that they operate has been designated critical infrastructure by national law), by the terms of its national operating license, or even by commercial contract. Beyond these growing constraints that may change the nature of space IS in coming years, current incentives to overcoming sharing barriers are reviewed in the following Part 4.

Part 4: Incentivizing Space Actors to Share Information Despite Barriers

Where space actors are not required by regulation, license, or contract to share information on their space activities (beyond the general requirements that devolve on state parties under the OST and the Registration Convention), it is important to provide explicitly positive incentives with respect to the following issues: national security concerns, regulatory restrictions, business and commercial concerns, costs and training, and the reliability and security of the platform itself.

NATIONAL SECURITY CONCERNS

These concerns are best met with an explicit exemption from sharing data for which there is such a concern, as the likelihood that sharers are in any event prohibited from sharing by law, license, or contract is high.[39] Current unresolved issues in the context relate to dual-use space objects, which may not be fully exempt from, for example, OST Article IX consultation requirements and Article XI notification requirements. The latter are subject to the notifying state's considerations of notifications that are "feasible and practicable," which allows flexibility with regard to space objects that raise national security concerns.

REGULATORY RESTRICTIONS

National regulations may likewise restrict IS, whether for security reasons, financial secrecy and antitrust prohibitions, criminal investigation needs, personal data privacy protections, and the like. Similarly to national security concerns, such restrictions should be accommodated on IS platforms with explicit exemptions.

BUSINESS AND COMMERCIAL CONCERNS

Protection of intellectual property, proprietary business processes, and other commercially sensitive content is a significant disincentive to IS, even (perhaps especially) in situations where urgent organizational action may be required to mitigate risks stemming from an anomaly. The use of anonymization and pseudonymization as a clear, tested, and secure option can support IS in this context.

39 See Chernykh et al., *supra* note 35 at 6.

COSTS AND TRAINING

Organizations may be reluctant to devote resources to IS platforms, whether financial or human. Incentives include availability of training programs that are low cost and easily accessible on the platform, mentoring by organizations already using the platform, and tiered trial periods for onboarding new sharers.

RELIABILITY AND INFORMATION SECURITY OF THE IS PLATFORM

As discussed above, space actors will have difficulty sharing data at several levels if the IS platform's information security has not been thoroughly vetted in accordance with the standards which their organization applies internally or are required to apply by national cybersecurity laws and regulations. The platform's security level and protocols should be available to participants as part of their onboarding process, at the latest.

Part 5: Five Categories of Information Sharing Platforms for Space Activities

Twenty IS platforms for overall OSDA, space traffic coordination, atmospheric and environmental observation from space, post-mission disposal of space objects and space debris, and lunar safety are reviewed below. They are listed under five categories of IS which stem from the motivation of space actors to understand their specific environment of operations as broadly and as deeply as possible, given the available data and the data that can be extrapolated from it. Overall space ecosystem awareness encompasses these processes.[40] Space actors can curate their own situational awareness independently, of course, but it is an axiom of the research conducted in the context of this Report that the optimal acquisition of a full catalogue of space objects of interest—their capabilities and characteristics, transit through orbit and out-of-orbit, and any anomalies—is implemented through IS with other parties.

The concept of space situational awareness overarches all five types of platforms reviewed in this Report,[41] and is defined as "...the ability to accurately characterize the space environment and activities in space."[42] Space situational awareness is supported by orbital and trajectory data on space objects, their characteristics and capabilities, space weather data, and information on space anomalies, including malfunctioning of space objects. It also includes assessment of potential threats to space objects from nation-states or non-state actors. The data collected on an ongoing basis for constructing situational awareness for space activities is drawn from both Earth-based resources (such as radar and optical telescopes) and, increasingly, space-based resources (such as satellite imaging and radio frequency monitoring). One of the key outputs of data collection are space object catalogues, which may contain tens of thousands of space objects when space debris is included. The inherently cooperative and international nature of this curation is described by Christensen and Samson as follows:

> [SSA] requires a network of globally distributed sensors as well as data sharing between satellite owner-operators and sensor networks. [It] also forms the foundation of space sustainability as it enables safe and efficient space operations and promotes stability by reducing mishaps, misperceptions, and mistrust.[43]

Four of the categories were selected based on their criticality for the sustainability of space activities, and the fifth, relating to Earth observation, for the insights it provides into information sharing using advanced satellite observation capabilities. It is also important to note that some of the IS platforms analyzed herein have overlapping functions and thus may belong to more than one category.

This Part begins with a comparative table, **Table 5.1**, of the platforms studied, briefly reviews the platforms themselves, and concludes with a summary of the characteristics and trends identified. Detailed explanations of the five categories and each IS platform follow the table.

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40 Christopher Newman and Matthew Zellner, 'Heavens Open' - The Need for Increased Data from Space and Creating a Duty to Share that Data, in Legal Aspects of Space: NATO Perspectives, NATO Legal Gazette Issue 42, December 2021, 194-207 at 196.

41 Albeit narrowed to the terrestrial context within the Earth observation category.

42 Ian Christensen and Victoria Samson, *Space Situational Awareness Fact Sheet*, Secure World Foundation, July 2024, at 2 (https://www.swfound.org/publications-and-reports/space-situational-awareness-fact-sheet).

43 *Ibid.*

Table 5.1 | *Schematic Comparison of Selected Information Sharing Platforms*

#	Type and Name	Description	IS Formats Specified	Participation (Countries, Private Sector, Public)	Registration and/or Agreement	Actionability
	OVERALL SPACE DOMAIN AWARENESS (OSDA)					
1	UNOOSA Long-Term Sustainability of Outer Space Activities Information Repository	An open-source repository of information developed by the UN to build transparency, confidence, and capacity for long-term sustainability of OS activities. Registration of participants is required.	No	Countries, Private Sector, Public	No	Immediate, Short-to-Medium Term, Long-Term
2	ITU Space Sustainability Gateway	A comprehensive, diverse platform for space-related information, regularly updated by the ITU and its Radiocommunication Bureau. Information is also shared by Member States and other space stakeholders. Some access is restricted to Member States.	No	Countries, Private Sector	Yes	Short-to-Medium Term, Long-Term
3	Space ISAC	This industry-led platform focuses on space industry threats by monitoring and analyzing data about supply chain intrusions, space weather events, cyber threats, and other risks based on industry-to-industry intelligence, as well as IS with U.S. government. Participation is fee-based.	No	Private Sector	Yes	Immediate, Short-to-Medium Term
4	NATO Alliance Persistent Surveillance from Space (APSS)	APSS is notable for its creation of the Aquila "virtual constellation" of both national and commercial satellites from which a diverse range of information flows into a single IS platform. Currently, 17 NATO countries have signed the APSS MoU, and since 2025, NATO has been considering the inclusion of vetted private companies[TT3] . The nature of data shared on the APSS platform is not publicly available.	No	Countries	Yes	Not Specified
5	EU Space ISAC	This Information Sharing and Analysis Centre was established to provide the required IS in the space sector under EU regulation, specifically the Network and Information Security Directive (NIS2) under which the ground segment of the space sector is a designated critical infrastructure ("Sector of high criticality"). The proposed EU Space Act also refers to it as part of organizations' compliance with EU space law. Participation is limited to EU entities at present, but may require non-EU space providers' participation under the eventual Space Act.	Yes	Countries, Private Sector	Yes	Immediate, Short-to-Medium Term, Long-Term
	SPACE TRAFFIC COORDINATION					
6	LeoLabs Space Traffic Management	A private-sector global provider of space traffic management services in the LEO orbit to both government entities and commercial entities. Services include real-time conjunction data messaging, ephemeris (orbital) screening, identification of abnormal space object behavior, and space situational awareness using AI capabilities. Tracking support is provided using the proprietary Global Radar Network. Its satellite tracking catalogue contains 25,000 LEO space objects.	Yes	Countries, Private Sector	Yes	Immediate, Short-to-Medium Term
7	Space Data Association (SDA)	This platform supports entity-to-entity IS by collating vetted operator data in its Space Data Center that utilizes a secure machine-to-machine interface to share operational data between IS participants and redistribute it. SDA also maintains vetted contact data for specific space objects, including authoritative "points of contact" for each satellite operator to simplify coordination for collision-avoidance or radio frequency interference (RFI) mitigation.	Yes	Private Sector	Yes	Not Specified
8	TraCSS	Through the U.S. Office of Space Commerce, TraCSS has been mandated to provide space traffic safety data and services to support spaceflight safety to commercial and other private-sector space operators (both U.S. and other nations). This data will include real-time potential conjunction alerts, launch collision avoidance analysis, re-entry information, space weather data, and modeling and simulation (M&S) functionality.	Yes	Countries, Private Sector	Yes	Immediate, Short-to-Medium Term
9	Spacetalk	This collaborative communication platform serves as a hub for vetted space actors to transparently share their orbital data, space debris data, trajectory information, space object status, and maneuvering intentions. The platform itself does not provide independent assessments of collision or other space risks, leaving that aspect to the sharing entities themselves. Sharers communicate directly on the platform and may respond with direct communications to the platform as a whole or to a single user, and data is actionable in real time. Membership is open to nation-states, international organizations, and private companies.	Yes	Countries, Private Sector, Public	Yes	Immediate, Short-to-Medium Term
10	European Union Space Surveillance and Tracking	The EU SST Service Provision Portal is operated by EUSPA and 15 EU countries providing IS for approximately 500 space objects to assess the risk of in-orbit collisions and fragmentation, uncontrolled re-entry of space debris, space weather emergencies, and asteroid and comet Earth-approaches. Real-time collision avoidance support is provided to participants. The platform is open to EU-based sharers only at present.	Yes	Countries	Yes	Immediate, Short-to-Medium Term

LEGEND: Yes · No · Countries Participation · Private Sector Participation · Public Participation · Immediate · Short-to-Medium Term · Long-Term · NS Not Specified

#	Type and Name	Description	IS Formats Specified	Participation (Countries, Private Sector, Public)	Registration and/or Agreement	Actionability
POST-MISSION DISPOSAL OF SPACE OBJECTS AND SPACE DEBRIS						
11	NorthStar Earth & Space	This private Canadian corporation's data sharing platform is available to participants on a commercial basis, on either a subscription basis or a pay-for-use model. It utilizes a dedicated satellite platform, Skylark for comprehensive near-Earth orbits (LEO, MEO, and GEO), providing de-orbit support and identification of potential space debris events based on tracking of a catalogue of what the company claims includes "hundreds of thousands" of space objects including at resolution levels of 5 cm objects in LEO and 40 cm objects in GEO.	No	Private Sector	Yes	Immediate, Short-to-Medium Term
12	Aerospace Corporation Center for Orbital and Reentry Debris Studies (CORDS)	The CORDS Reentry Database is supported by Aerospace, an early private-sector player in the U.S. space sector. The database is publicly accessible, documenting objects that have reentered the atmosphere since 2000 using a selection of filters (e.g., rocket body, payload, debris) and sortable by launch date, mission name, reentry type, and predicted reentry time.	Yes	Countries, Private Sector, Public	No	Short-to-Medium Term
13	Privateer's Wayfinder portal	Privateer is a U.S.-based company that supports the public-facing information sharing platform Wayfinder to track space debris (as well as operational spacecraft) in near-real time. There is no fee or registration for the portal use, and it is searchable by space object type, constellation, country, and orbit (LEO, MEO, HEO, GEO). Portal users have an option to receive access to estimated space debris removal costs.	Yes	Private Sector, Public	No	Immediate, Short-to-Medium Term
LUNAR ACTIVITY						
14	UNOOSA Index of Article XI Submissions	UNOOSA's Index of Submissions by States under OST Article XI does not register lunar activities exclusively: it includes all Article XI national submissions. Out of 74 submissions, 8 currently address lunar activities. A specific format for lunar IS is also being developed by COPUOS.	Yes	Countries	No	Short-to-Medium Term, Long-Term
15	Lunar Ledger	A centralized, reliable, public registry for lunar exploration activities such as landing locations, mission objectives, and operative timelines; IS among a wide range of lunar stakeholders. Information shared is vetted internally prior to publication on the platform, in accordance with data points (database in development). The Project is supported by the nonprofit Open Lunar Foundation.	Yes	Countries, Private Sector, Public	No	Not Specified
16	International Lunar Research Station Cooperation Organization	The founding ILRSCO agreement between China and Russia on 25 November 2022 is not available for review of IS mechanisms. There are presumably IS mechanisms within the Partnership Agreements that are concluded with participating nations (currently 13); and for the entities participating in China's "555 Project" to invite 50 other countries, 500 scientific research institutions, and 5,000 overseas researchers to join the ILRS.	No	Countries	Yes	Not Specified
ATMOSPHERIC AND ENVIRONMENTAL OBSERVATION FROM SPACE						
17	ICEYE	A commercial platform providing persistent monitoring, management, and mitigation of the impacts of climate change. Participants (data resellers and commercial partners that include national authorities) have API-enabled access to data on wildfires, floods, hurricanes, and other climate events, including both forecast and real-time data.	Yes	Countries, Private Sector	Yes	Immediate, Short-to-Medium Term
18	Global Earth Observation System of Systems Platform Plus (GEOSS-PP)	GEOSS-PP provides a central portal for participants to access diverse climate change data including crop mapping, terrestrial land degradation, nutrient pollution, climate change impact on pandemic risk, assessment of targeted parameters of ecosystem health, and forest biomass. The interface is map-based, allowing access to Earth observation data from satellites, airplanes, drones, and in-situ sensors at global, regional, and local scales, directly connecting users to vetted providers.	Yes	Private Sector, Public	Yes	Immediate, Short-to-Medium Term, Long-Term
19	Polish Space Agency Sat4Envi Operating System	Poland's national information sharing system for the sharing of digital satellite information relating to the environment throughout the territory of Poland uses data processed through Copernicus (Sentinel-1, -2, -3) and other meteorological satellites. The project is implemented by Polish national institutions in the framework of the National Space Strategy and is largely unidirectional for the benefit of commercial and private users.	No	Private Sector, Public	No	Not Specified
20	NASA Fire Information for Resource Management System	FIRMS is a map-based global portal for sharing near-real-time actionable fire data with emergency responders; municipal, regional, and national authorities; and the public. It allows for minimal IS from users.	Yes	Public	No	Immediate, Short-to-Medium Term

LEGEND: Yes; No; Countries Participation; Private Sector Participation; Public Participation; Immediate; Short-to-Medium Term; Long-Term; NS Not Specified

Below is the detailed survey of the space IS platforms studied.

OVERALL SPACE DOMAIN AWARENESS (OSDA)

As the outer space environment becomes increasingly congested, collision risks and other anomalies constitute a growing threat to space safety and security. These threat vectors endanger space exploration, innovation, and investment; they also deepen concerns around the misuse of space by bad actors. OSDA aims to reduce risk by narrowing informational asymmetries and improving transparency regarding activities in the space environment. Evolving technologies are supporting IS platforms with more precise data gathering techniques and facilitating their distribution for improved OSDA, as seen in the portals reviewed below.[44] Commercial space actors are also beginning to provide OSDA capabilities to space actors at military-grade levels.[45]

UNOOSA Long-term Sustainability of Outer Space Activities Information Repository

The 2025 COPUOS Report recommended establishing a unified information sharing platform for overall SSA under UN auspices, emphasizing that such a mechanism was in accordance with international space treaty law; and could significantly advance international cooperation, increase transparency in space activities, and build trust among users.[46] The current Repository invites participation from UN Member States, COPUOS permanent observers, and private entities approved by their national authorities. It hosts documentation submitted by vetted contributors, totaling 103 entries at the time of writing. These inputs are categorized by type of participant, relevance to the LTS Guidelines, and thematic area, including collision avoidance, space weather, and capacity building. The actionability of the information varies considerably due to differences in detail, scope, and purpose, though most submissions apply to short- and medium-term operational concerns. One example of clearly actionable material is the extensive Technical Annex included in the 2024 conference room paper on the protection of lunar astronomy and science.[47]

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44 Beicho Wang et al., *Research advancements in key technologies for space-based situational awareness*, SPACE: SCIENCE AND TECHNOLOGY, 18 June 2022, Article ID 9802793.

45 Victoria Samson, SSA and Space Security: An Update (presentation), 8 October 2025, https://www.swfound.org/publications-and-reports/ssa-and-space-security-an-update.

46 The COPUOS 2025 Report, at p. 11. This recommendation draws in part on a 2022 working paper by the Chair of the COPUOS Working Group on the Long-Term Sustainability of Outer Space Activities (A/AC.105/C.1/L.404, *Ideas for an information repository and for the agenda of the workshop to be held in 2024*, 6 December 2022).

47 A/AC.105/C.1/2024/CRP.14, Protection of Astronomy and Science on the Moon, 29 January 2024 (jointly submitted by the International Astronomical Union, Square Kilometre Array Observatory, European Organisation for Astronomical Research in the Southern Hemisphere, European Astronomical Society, Open Lunar Foundation, For All Moonkind, and the Secure World Foundation).

ITU Space Sustainability Gateway (SSG)

The ITU's SSG is a comprehensive, vetted collection of space-related information maintained and regularly updated by the ITU and its Radiocommunication Bureau, which oversees orbital assignments and frequency allocations for outer space use.[48] Contributions also come from Member States and other, broadly defined, space stakeholders. As a result, the range of material available through the SSG is notably diverse. It includes national space laws and policy documents, such as the FCC's list of approved space stations; private-sector codes of conduct, including Satellite Orbital Safety Best Practices; the ITU Space Networks Systems Database; national post-mission disposal strategies; and commercial satellite catalogs, such as those provided by LeoLabs. The portal also maintains an updated listing of space agencies and satellite operators. While many datasets are freely accessible, some external databases linked through the SSG require paid commercial accounts, and certain internal ITU-R resources—particularly those produced by Study Group 4 on satellite services and Study Group 7 on scientific services and space systems—require an authenticated ITU account. Overall, the information offered through this platform is actionable for both short-to-medium-term operational needs and longer-term policy and planning considerations.

Space ISAC

This industry-led platform supports the Space Information Sharing and Analysis Center, which focuses on helping the space sector prepare for and respond to vulnerabilities, incidents, and threats by disseminating timely, actionable information among its members. Established in 2019, Space ISAC enables global commercial space service providers to share intelligence on supply chain intrusions, space weather events, cyber threats, and other operational risks. Information also flows between industry members and U.S. government authorities which provide alerts and classified or sensitive-but-shareable insights through the Space ISAC Watch Center.[49] Participating agencies include NASA, the National Security Agency, the National Reconnaissance Office, the National Oceanic and Atmospheric Administration (NOAA), the Department of State, the Missile Defense Agency, the Office of the Director of National Intelligence, U.S. Space Command, and the U.S. Space Force. The platform also organizes communities of interest tailored to specific risk environments, such as the LEO satellite operators' group created in 2024.[50] Its Working Groups, including the Information Sharing Working Group, develop best practices and standardized templates for participants. Access to the platform is restricted to vetted, fee-paying industry members who sign an IS agreement, and sharers' level of access is tiered according to membership category.[51] See **Figure 5.1** below for a graphic depiction of IS participants via Space ISAC.

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48 The SSG operates on the basis of ITU Plenipotentiary Resolution 219 (Bucharest 2022) *Sustainability of the radio-frequency spectrum and associated satellite-orbit resources used by space services*; and ITU-R Resolution 74 (RA 2023) *Activities related to the sustainable use of radio-frequency spectrum and associated satellite-orbit resources used by space services*. See, respectively, https://www.itu.int/en/action/internet/Pages/resolutions.aspx and https://www.itu.int/dms_pub/itu-r/opb/res/R-RES-R.74-2023-PDF-E.pdf.

49 Sandra Erwin, *Space industry group warns of escalating cyber threats, outmatched defenses*, SpaceNews, 18 June 2024.

50 Jeff Foust, *Space ISAC establishes LEO satellite operators' group*, SpaceNews, 17 April 2024.

51 See Space ISAC Member Benefits, https://spaceisac.org/wp-content/uploads/2025/03/Member-Benefits_2-4-25-1.pdf

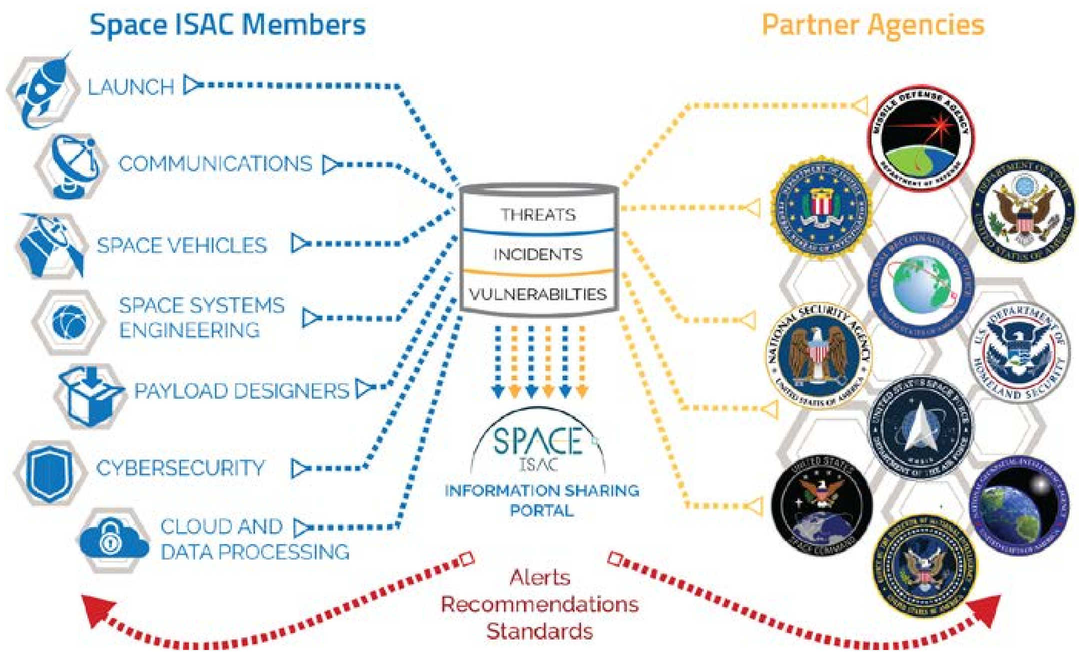

Figure 5.1 | *Information Sharing Ecosystem. Credit: Space ISAC*

NATO Alliance Persistent Surveillance from Space (APSS)

NATO's initiative to provide alliance countries with "persistent, real-time intelligence, surveillance, and reconnaissance capabilities" in outer space was launched in 2023, following the organization's December 2019 declaration that it considers space to be an operational domain for the alliance.[52] APSS is notable for its creation of the virtual Aquila constellation of both national and commercial satellites, from which a diverse range of information flows into a single IS platform. Currently, 17 NATO countries have signed the APSS Memorandum of Understanding.[53] Moreover, in 2025, NATO issued a formal RFI to private companies to gather information on space industry capabilities to support NATO information sharing for overall space situational awareness on the APSS platform. This initiative has raised concerns about hybrid IS between military, commercial, and other space actors.[54] No details are publicly available about the data currently provided through the APSS platform.

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52 NATO, *Overarching Space Policy*, 27 June 2019.

53 NATO, *Washington Summit: 17 Allies take further steps to boost NATO space capabilities*, 10 July 2024, https://www.ncia.nato.int/about-us/newsroom/washington-summit-17-allies-take-further-steps-to-boost-nato-space-capabilities.

54 Marianna Sata, *The Privatisation of Persistent Surveillance: Risks and Opportunities for NATO's Space Strategy*, Atlas Institute of International Affairs, 13 September 2025 (https://atlasinstitute.org/the-privatisation-of-persistent-surveillance-risks-and-opportunities-for-natos-space-strategy/).

EU Space ISAC

This Information Sharing and Analysis Centre was established to provide the required IS in the space sector under EU regulation, specifically the Network and Information Security Directive (NIS2) under which the ground segment of the space sector is a designated critical infrastructure ("Sector of high criticality").[55] Information sharing is among the NIS2 regulatory requirements for such high criticality sectors. This portal is also referenced in the proposed EU Space Act as a compliance mechanism for some of the Space Act's IS provisions.[56] The EU Space ISAC portal is hosted by the European Union Agency for the Space Programme, and includes a detailed Terms of Reference document that describes the sharing mechanism.[57]

SPACE TRAFFIC COORDINATION

Space traffic coordination (STC) refers to systems and processes—encompassing space situational awareness information sharing as well as operational guidelines or practices—that seek to reduce the potential for collisions and other incidents in space that could create debris or other safety risks for space activities. STC is an enabler of increased safety and sustainability in space activities,[58] and relies in its essence on information sharing by using conjunction data messaging (CDM) and other specifications to alert operators to potential collisions and allow them to carry out avoidance maneuvers in accordance with their own risk assessments and internal collision avoidance policies—both of which are increasingly employing dedicated AI tools.[59]

Traffic Coordination System for Space (TraCSS)

TraCSS operates under the auspices of NOAA's Office of Space Commerce. It is scheduled to begin full information sharing operations in early 2026, with registered users for the pilot program including Amazon LEO, Iridium, Eutelsat OneWeb, SpaceX, Vantor (formerly Maxar), Planet, and Intelsat, and pre-launch coverage of spaceflight safety screening services for more than 8,000 spacecraft. TraCSS has been mandated to provide space traffic coordination to support spaceflight safety of commercial space operators (both the United States and other nations), as set out in 2018 White House Directive-3 on space traffic management,[60] the OSC's April 2024 Global Space Situational Awareness Coordination policy document, [61] and the December 2025 Executive Order Ensuring American Space Superiority.[62] This data will include potential conjunction alerts, launch collision avoidance analysis, re-entry information, space

55 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 (NIS 2 Directive) *OJ L* 333, 27.12.2022, pp. 80–152.

56 EU Space Act, article 95 (4).

57 EU Space ISAC, *Terms of Reference*, version 3.0, 16 April 2024. https://www.euspa.europa.eu/sites/default/files/documents/eu_space_isac_terms_of_reference.pdf.

58 This definition of STC is based on Ian Christensen's recent working definition provided here: https://www.swfound.org/events/workshop-on-space-traffic-coordination-at-2025-thai-space-expo.

59 Chiara Manfletti, Marta Guimares, and Claudia Soares, *AI for space traffic management*, Journal of Space Safety Engineering, Vol.10 (4), December 2023, pp. 495-504.

60 Space Policy Directive-3, *National Space Traffic Management Policy*, 18 June 2018.

61 Office of Space Commerce, *Global Space Situational Awareness Coordination*, https://www.space.commerce.gov/wp-content/uploads/Global-Space-Situational-Awareness-Coordination-Vision-March-2024.pdf

62 *Supra* note 38.

weather data, and M&S functionality. Information sharing within TraCSS leverages relevant CCSDS and ISO standards for data exchange. It is currently integrating the existing space traffic management public portal that has been operated since 1957 by the U.S. DoD at space-track.org. Interestingly, the platform's webpage includes a disclaimer for any U.S. government responsibility for the reliability of TraCCS information.[63]

LeoLabs Space Traffic Management services

LeoLabs is one of several private-sector providers of space traffic management services in the LEO orbit for government entities, military forces, and commercial entities worldwide.[64] Operating on the basis of commercial contracts with clients which are not publicly available, its services are tailored to client specifications and can include real-time dashboards of aspects of LEO situational awareness and traffic management. Capabilities include real-time conjunction data messaging, ephemeris (orbital) screening, identification of abnormal space object behavior, and space situational awareness using AI capabilities. LeoLabs also provides tracking support throughout launch of the mission using its proprietary Global Radar Network. Its satellite tracking catalogue currently contains 25,000 LEO space objects.[65]

Space Data Association (SDA)

The SDA is a nonprofit international association of satellite operators, including major satellite companies such as Iridium, Intelsat, SAS, NASA, Arabsat, Boeing, and AsiaSat. This platform supports entity-to-entity information sharing of data critical to the safety and integrity of the space environment in order to mitigate risks, and the organization collates operator data, vets it, and redistributes it to provide conjunction assessments. SDA also maintains vetted contact data for specific space objects, including authoritative "points of contact" for each satellite operator to simplify coordination for collision avoidance or RFI mitigation. SDA operates a Space Data Center that utilizes a secure machine-to-machine interface to share operational data among IS participants.

Spacetalk

This collaborative communication platform serves as a hub for space actors to transparently share their orbital data, space debris data, trajectory information, space object status, and maneuvering intentions.[66] The platform itself does not provide independent assessments of collision or other space risks, leaving that aspect to the

63 The disclaimer text reads: "OSC provides TraCSS 'as is' and without any warranties, including, for example, that data and information from TraCSS will be error free or that access will be uninterrupted. The United States Government is immune from any suit arising from the provision or receipt of SSA data or information." (https://space.commerce.gov/traffic-coordination-system-for-space-tracss/).

64 Examples of other providers include Slingshot, ExoAnalytic Solutions, COMSPOC, Kayhan, Aldoria, Look Up Space, and Digantara.

65 In late 2025, LeoLabs concluded a contract with the U.S. Space Force and Department of Commerce to license its space object catalogue for their use, a notable cross-sector instance of strategic information sharing for space sustainability (Douglas Gorman, *LeoLabs Lands Cross-Government Licensing Contract*, Payload, 9 December 2025).

66 Another example of such a collaborative platform is that being developed by SPACEMAP. See Shawn Choi et al., *Real-time Conjunction Assessment and Collision Avoidance of Satellites for Concurrent Avoidance Negotiation with Comparative Analysis of Passive Ranging Method and Traditional Sources*, Advanced Maui Optical and Space Surveillance Technologies Conference (AMOS), 2024.

sharing entities themselves. The sharers communicate directly on the platform and may respond with direct communications to the platform as a whole or to a single user (see the sample messaging in **Figure 5.2** below). The administration of this IS platform is conducted by a private Swiss company, and membership is open to nation-states, international organizations, and private companies. The information shared is actionable in real time.[67]

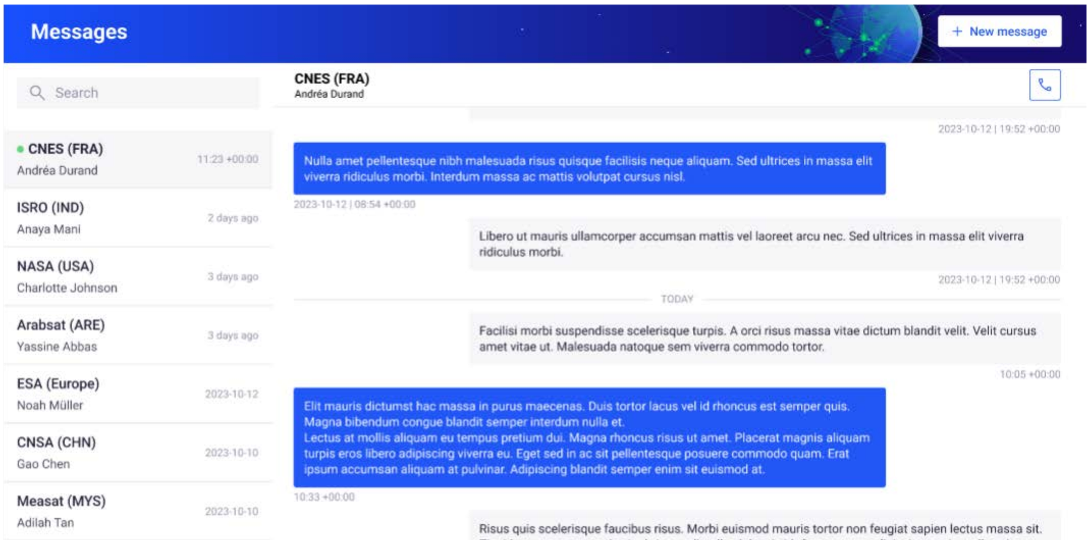

Figure 5.2 | *Sample of messaging on the Spacetalk platform (2025).*

European Union Space Surveillance and Tracking (EU SST) – This is a key IS platform within the Space Situational Awareness pillar of the EU's 2021 Space Programme.[68] Operated by EUSPA and 15 EU Member States through their national space agencies,[69] the SST Service Provision Portal supports the exchange of data for assessing risks of in-orbit collisions, fragmentation events, and uncontrolled re-entries. The system relies on a distributed network of ground- and space-based sensors that track more than 500 orbital objects, and it has recently incorporated commercial entities. Germany hosts the SST Database, the IS hub that links all national operations centers and enables the upload and download of actionable data, including conjunction assessments, and re-entry predictions. Access to EU SST is restricted to EU Member States and other European-based, vetted users who accept its Terms of Use, with tiered levels of information availability.[70] Its detailed Service Portfolio allows participants to configure IS requirements through a Service Configuration Document, covering collision-risk analyses, recommended avoidance maneuvers, conjunction data, and support during extreme events. Crucially, EU SST "pushes" real-time collision avoidance notifications, enabling users to coordinate responsive actions directly by applying the portal's operational tools.

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67 Participants in the first test of the platform in October 2025 included sharers from Europe (ESA, Okapi Orbits [DEU], EPFL [CHE], Swiss Armed Forces), China (Debris-X), and India (OrbitArch).

68 "Space Situational Awareness," EU Space Program, EU Agency for the Space Programme, https://www.euspa.europa.eu/eu-space-programme/ssa.

69 Austria, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Latvia, the Netherlands, Poland, Portugal, Romania, Spain, and Sweden.

70 See Terms and Conditions of Use of the SST Service Provision Portal and SST Services, https://portal.eusst.eu/portalng/terms-use.

POST-MISSION DISPOSAL OF SPACE OBJECTS AND SPACE DEBRIS

With the growing numbers of space objects in Earth orbit—LEO, MEO, GEO, and their subcategories—the issue of post-mission disposal of these objects and their debris is critical. Accurate measurement of the quantity of space debris is a challenge: there are some estimates of approximately 1 million pieces of space debris larger than 1 cm that are orbiting the Earth.[71] Debris collisions, resulting from anti-satellite tests, failed satellite remnants and "dead" satellites, and other space object fragments pose serious operational risks, including risks to human life.[72]

The OST requires information sharing regarding space debris as a violation of the "due regard," "harmful contamination," and "harmful interference" principles under Article IX, as well as, arguably, under the Article XI space activities' locations-and-results notifications. Other multilateral agreements have addressed the problem of space debris more specifically, such as the COPUOS Space Debris Mitigation Guidelines that were first endorsed by the UN General Assembly in 2007,[73] inviting Member States to implement them using relevant mechanisms of their choice. Some of these are highlighted below. Another example of multilateral engagement with this problem is the Inter-Agency Space Debris Coordination Committee (IADC), which first convened in 1993 to coordinate information sharing at the policy level for the mitigation of space debris and its effects.[74] The IADC published its own Space Debris Mitigation Guidelines in 2020 (updated in 2021), reflecting existing mitigation practices such as limitation of debris released by space objects during normal operations, minimization of orbital disintegration and collision, and post-mission disposal and re-entry.[75] In the February 2025 IADC Report on the Status of the Space Debris Environment, which tracked levels of global compliance with existing space debris mitigation guidelines, the Committee concluded: "Even in case of no further launches into orbit, it is expected that collisions among the space debris objects already present will lead to a further growth in space debris population."[76]

Thus, the space debris problem continues to endanger space sustainability. In the information sharing platforms reviewed below, it is interesting to note that in this context as well, commercially owned and operated (COCO) solutions are coming into play for both governmental and nongovernmental space actors.[77]

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71 *IADC Report on the Status of the Space Debris Environment*, A/AC.105/C.1/2025/CRP.10, 6 February 2025, at 4.

72 Tingley, *supra* note 32.

73 A/RES/62/217 (2007). COPUOS' most recent version of the Guidelines was published in 2010 (Space Debris Mitigation Guidelines, Vienna, 2010).

74 See https://www.iadc-home.org/what_iadc.

75 IADC *Space Debris Mitigation Guidelines*, 2021.

76 *IADC Report, supra* note 71.

77 See also the Space Safety Coalition's *Best Practices for the Sustainability of Space Operations*, 2024, https://spacesafety.org/best-practices/. As of this writing, 45 private sector space actors have endorsed these best practices for space safety.

Aerospace Corporation Center for Orbital and Reentry Debris Studies (CORDS)

The CORDS Reentry Database is supported by Aerospace, an early private-sector player in the U.S. space sector. The database is publicly accessible, documenting objects that have reentered the atmosphere since 2000 using a selection of filters (e.g., rocket body, payload, debris) and sortable by launch date, mission name, reentry type, and predicted reentry time. See an example of the information shared on the CORDS database in **Figure 5.3**.

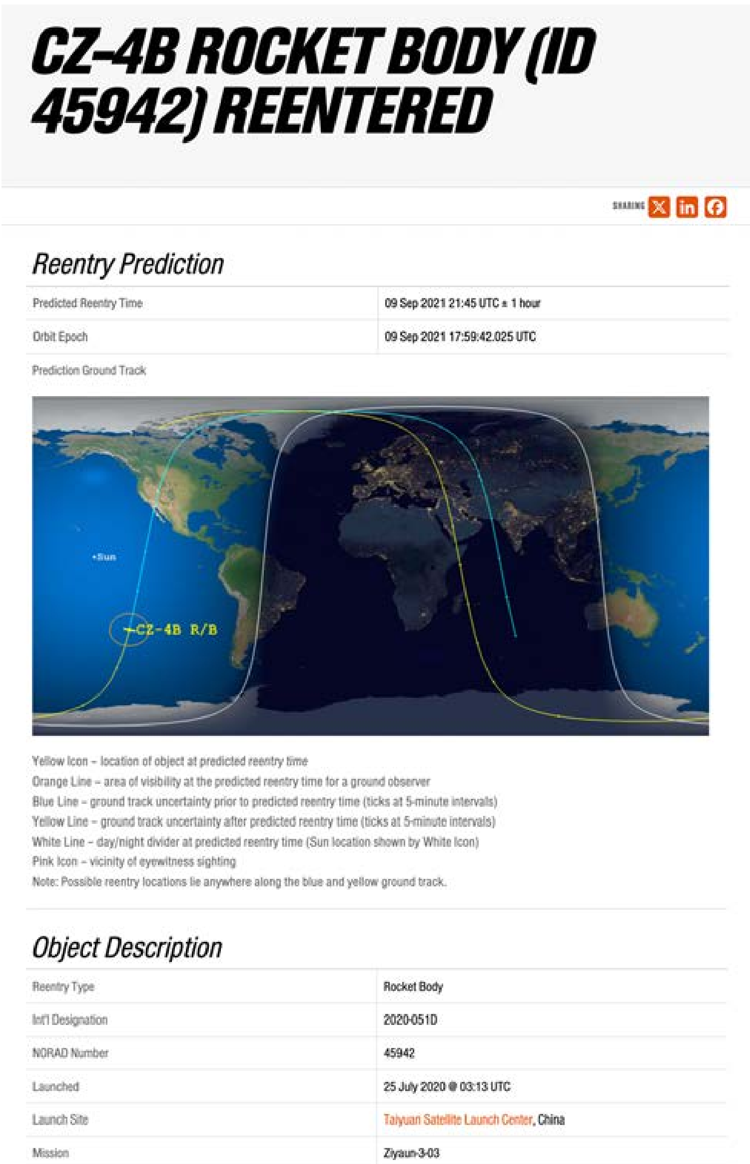

Figure 5.3 | *Sample from the CORDS Reentry Database*

NorthStar Earth & Space

This private Canadian corporation's data sharing platform is available to participants on a commercial basis, on either a subscription basis or a pay-for-use model. It utilizes a dedicated satellite platform, Skylark, for comprehensive near-Earth orbits (LEO, MEO, and GEO). Besides providing near-real-time tracking and high-precision collision warnings, space object identification, and other event detection; NorthStar provides de-orbit support and identification of potential space debris events based on tracking of a company catalogue of "hundreds of thousands" of space objects including at resolution levels of 5 cm objects in LEO and 40 cm objects in GEO.[78] Information sharing is provided to governmental, military, commercial, and space insurance sector clients.

Privateer Space "Wayfinder"

Privateer is a U.S.-based company that supports the public-facing information sharing platform Wayfinder to track space debris, as well as operational spacecraft, in near-real time. There is no fee or registration for the initial portal use, but commercial entities may acquire specific deployments of Wayfarer IS. The platform provides a sophisticated interface, and is searchable by space object type, constellation, country, and orbit (LEO, MEO, HEO, GEO). Wayfinder provides an interesting innovation: for each space object, including space debris, portal users have an option to receive access to estimated removal costs.[79] Cost estimates are provided by a third party, KMI, which is linked to the Wayfinder site and provides commercial services for debris removal through a separate, proprietary portal.[80] An additional innovation is the "Crow's Nest" function, which is a listing for the upcoming 48-hour window of the 100 most likely conjunction risks.[81]

LUNAR ACTIVITY AND SAFETY

Lunar activity has in recent years intensified with the development of lunar projects by several countries new to lunar activity, as well as private sector actors. The intensification of activities—both current and planned, with 100 lunar payloads anticipated by 2030—will require modes of cooperation and coordination beyond those envisioned by the Moon Agreement in its Articles 4, 5, 7, 9, and 11.[82] Moreover, neither the LTS Guidelines, nor the Artemis Accords, nor the Building Blocks specifically address information sharing for lunar activities.

However, in the 2025 workplan of the COPUOS Action Team on Lunar Activities Consultation (ATLAC), one of the priority topics set out is consideration for "...an international mechanism that includes but is not limited to information sharing on

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78 Gunter Krebs, *Skylark 1-12*, Gunter's Space Page, https://space.skyrocket.de/doc_sdat/skylark-1.htm.

79 Estimated removal costs are provided by a third party that has access to the Wayfinder site. And that provides commercial services for debris removal through a separate , proprietary portal.

80 KML, *End-of-life Services*, https://www.kallmorris.com/end-of-life-services.

81 Privateer, *More than dots: Wayfinder and the data*, https://www.privateer.com/blog/more-than-dots-wayfinder-and-the-data.

82 Seventeen countries are currently party to the Moon Agreement. See UN Treaty Collection, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXIV-2&chapter=24&clang=_en.

lunar exploration missions, with a view to fostering international cooperation, as well as capacity-building, and avoiding harmful interference in the interest of peaceful, safe and sustainable lunar activities for the benefit of all humankind." The work of ATLAC is currently underway, and its report on progress made is due to be presented to COPUOS in 2027.

One recent nongovernmental initiative to cull out the priorities of stakeholders for IS in lunar activities, Lunar Information Sharing 101, identified four main aims on the basis of interviews with 70 representatives of 36 governmental and nongovernmental space stakeholders.[83] These aims were: (a) operational safety and lunar situational awareness; (b) fostering exclusively peaceful uses of the Moon through transparency; (c) promotion of sustainability of lunar activities through enhanced stakeholder cooperation, mission interoperability, and enhanced efficiency; and (d) sharing scientific data and mission results for benefit sharing, capacity building, and inclusion of lunar stakeholders regardless of their degree of socioeconomic development. The document noted that there was consensus among interviewees regarding the criticality of IS for lunar safety, which is viewed as an urgent priority.[84] On the other hand, they were more reserved regarding IS for capacity building and benefit sharing:

> While most actors agreed on the importance of these purposes, there is a diversity of views on how they can be achieved through information sharing. Some actors noted that a basic level of information sharing would provide benefits and help build capacity. Others indicated that these purposes require specific data sharing on scientific results, lessons learnt, as well as critical technologies and practices.[85]

These insights will be important to encompass in lunar IS platforms as they develop. Aspects of lunar IS that will be immediately relevant to stakeholders include: (a) the purpose, timeframe and technical aspects of the mission; (b) expected outcomes, subject to commercial, intellectual property, and national security derogations; (c) designation of entities participating (nations, private companies, academic institutions); and (d) safety measures. In the abovementioned Lunar Information Sharing 101 policy document, a template for lunar IS has been proposed.[86]

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83 Antonino Salmeri and Samuel Jardine, Policy Release: Lunar Information Sharing 101, Lunar Policy Platform. August 2025, at p. 7 (https://lunarpolicyplatform.org/news/2024-lunar-policy-snapshot-hzk6w).

84 *Ibid*. The document summarized the views of interviewees, which were in consensus around "…a multi-layer approach whereby different kinds of actors get access to different kinds of information: basic information on nature, location, and duration of activities should be publicly accessible. Information on conduct and envisaged impact should be visible only to States or licensed lunar operators. Technical and operational information should be disclosed only if there is a risk of accidents and would be best furnished on a bilateral basis. A small minority of actors preferred a fully transparent approach where all shared information should be publicly available." (p. 13).

85 *Ibid*, p. 11.

86 *Ibid*, Annex.

In this section, two information sharing platforms for lunar activities are reviewed, both in their initial stages. The third IS mechanism is that planned within the framework of China's lunar activities, although details the specific IS platform is not publicly available.

The Lunar Ledger

The Lunar Ledger Project, launched in 2022, aims to create a centralized, trustworthy, and publicly accessible registry for lunar exploration activities, including landing sites, mission objectives, and operational timelines. Its broader purpose is to facilitate IS among the diverse communities involved in lunar activities. Supported by the nonprofit Open Lunar Foundation, the initiative is designed to enable governments, commercial operators, scientific and academic institutions, civil society groups, and financial entities to establish a common baseline of information, improve understanding of planned and ongoing missions, and enhance coordination to reduce operational risks.[87] Although still under development, the project's preparatory materials are publicly available. A 2024 white paper detailing the platform's technical design outlines key information sharing needs such as risk mitigation, identification of data discrepancies and gaps, and standardization of mission contact information.[88] It also describes incentives for participation, a phased development plan, and results from early prototype testing. The Ledger is conceived as a public utility that integrates both open-source data and voluntary contributions from states, industry, academia, think tanks, and other organizations, all subject to an internal verification process. The white paper explains this verification workflow (see **Figure 5.4**). As the platform remains at an early stage, the degree to which its shared data will be actionable has yet to be determined.

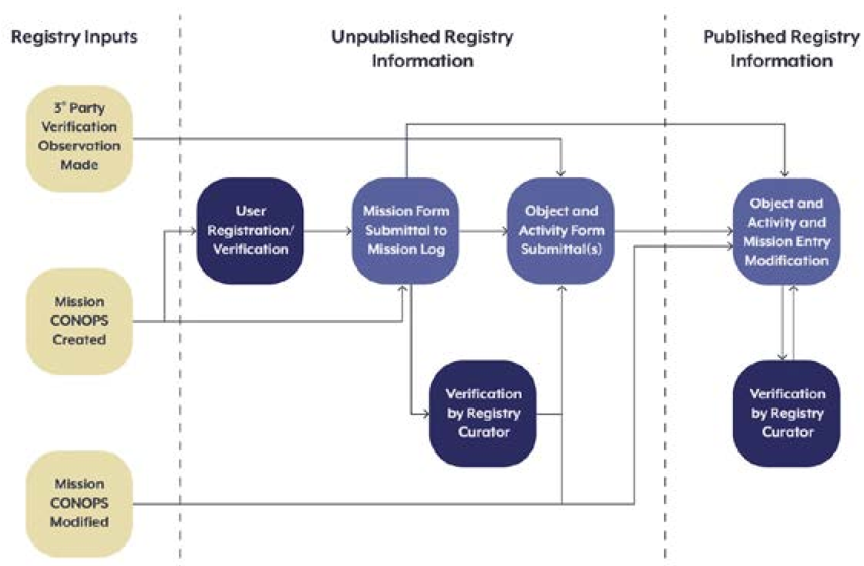

Figure 5.4 | *Process of data verification for information sharing inputs, E. Cremer (2024) at 17.*

87 Eric Cremer, Prototyping a Lunar Registry of Missions, Objects, and Activities, 5 March 2024, p. 3, https://www.openlunar.org/publications/prototyping-a-lunar-registry-of-missions-objects-and-activities.

88 *Ibid.*

OST Article XI Submissions

In the context of the work of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space that operates in the framework of UNOOSA, a format for IS regarding lunar activities is being developed and countries have already begun registration on UNOOSA's Index of Submissions by States under Article XI.[89] To clarify, the Index does not register lunar activities exclusively: it includes all Article XI national submissions as well as those under Principle IX of the Principles Relating to Remote Sensing of the Earth from Outer Space and Principle IV(3) or Principle V of the Principles Relevant to the Use of Nuclear Power Sources In Outer Space). Yet of the 74 submissions, at least 9 address aspects of "…the nature, conduct, locations and results…" of national lunar activities, beginning with the U.S. notification of the first Moon landing in 1969. Examples include notifications of lunar missions on the part of Japan, Luxembourg, and the United States; and Russia's notification of nuclear power sources on board the Luna-Glob lander. The information shared is likely to be relevant in the short-to-medium range, as well as the long range.

The International Lunar Research Station Cooperation Organization (ILRSCO)

The Station is a planned lunar base developed jointly by the China National Space Administration (CNSA) and Russia's Roscosmos. Envisioned as a long-term scientific outpost on the lunar surface, it is intended to support extensive research activities and autonomous operations. The ILRSCO agreement was signed on 25 November 2022,[90] and its Article 10 sets out the general provisions on the exchange of information between the parties, with no specific mechanism being established. However, in June 2021, CNSA and Roscosmos released the ILRS Guide for Partnership,[91] describing mission plans and identifying five categories for international cooperation: the south pole mission itself, supporting space systems, subsystems, equipment, and ground and application cooperation. Within these categories, and presumably once formal cooperation agreements are concluded, the Guide calls for "data analysis and sharing" among mission partners, though no broader system for external information sharing has been announced. Public reporting has referenced China's "555 Project," which aims to involve 50 countries, 500 institutions, and 5,000 researchers in the ILRS and may lead to a dedicated information sharing platform. [92] Notably, in 2023, China issued its Rules for Management of International Cooperation in Lunar Samples and Scientific Data, governing international requests for sample loans. [93] These Rules, including standardized forms and a loan agreement, were implemented at least once in 2025.[94]

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89 See https://www.unoosa.org/oosa/en/treatyimplementation/ost-art-xi/index.html.

90 Agreement between the Government of the Russian Federation and the Government of the People's Republic of China Regarding Cooperation for the Construction of the International Lunar Research Station, 25 November 2022 (author's copy). See also the *Joint Statement between CNSA And ROSCOSMOS Regarding Cooperation for the Construction of the International Lunar Research Station*, 04/29/2021, https://www.cnsa.gov.cn/english/n6465668/n6465670/c6811967/content.html.

91 *International Lunar Research Station Guide for Partnership*, 16 June 2021, https://www.cnsa.gov.cn/english/n6465652/n6465653/c6812150/content.html.

92 Fred Schwaller, *China and Russia plan to build nuclear power station on moon*, DW, 19 May 2025, https://www.dw.com/en/china-and-russia-plan-to-build-nuclear-power-station-on-moon/a-72565465.

93 China National Space Administration, *Rules for Management of International Cooperation in Lunar Samples and Scientific Data*, 2 August 2023, https://www.cnsa.gov.cn/english/n6465645/n6465648/c10086003/content.html

94 Jatan Mehta, *International researchers selected to study China's Chang'e Moon samples, including US ones but without NASA*

ATMOSPHERIC AND ENVIRONMENTAL OBSERVATION FROM SPACE

The international space community has devoted extensive efforts to using space technology to observe and understand the Earth's atmosphere and environment. Such activities include the overall influence of space activities on terrestrial and atmospheric climate change; land use and land cover monitoring; natural resource management; monitoring of forests and wildfires; detection of illegal fishing; monitoring of oil pipelines and illegal extraction; monitoring of protected marine areas and marine species; environmental monitoring; monitoring of the atmosphere, greenhouse gases, and air pollution; urban planning; disaster management support; telehealth and epidemiology; watershed monitoring and development planning; irrigation infrastructure assessment; agriculture, horticulture, and crop production forecasting; monitoring of desertification; snow and glacier monitoring; and monitoring of oceans, glacial lakes, and other water bodies.[95]

This category of IS platforms differs from the preceding categories in that the information shared primarily serves scientific, crisis management, and social benefit purposes on Earth, rather than operational aspects of activities that take place in outer space. It has been included because of the insights it provides into certain aspects of IS (e.g., protection of confidentiality), as well as the leveraging of advanced satellite observation capabilities. Similar capabilities will be critical for the eventual application of the aspects of OST Article XI detailed below.

Article IX of the OST imposes two requirements on states regarding the atmospheric and environmental impacts of space activities, which are supported by observation and data collection from space. These include the explicit requirement to avoid adverse changes in the environment of the Earth and the general "due regard" requirement. Multilateral policy documents also support the sharing of information on atmospheric and environmental observations. For instance, the 1986 Principles Relating to Remote Sensing of Earth from Outer Space define the scope of "remote sensing activities" and set out 15 principles for their implementation by states.[96] Principles IIX, X, XI, and XIII, in particular, encourage information sharing of remote sensing activities that promote the protection of the Earth's natural environment. The LTS Guidelines also recommend IS for space weather-related impacts and system anomalies, including terrestrial natural disasters or other catastrophes (Guidelines B7 and C3). The observation and analysis of such impacts of space activities themselves on the Earth's atmosphere and environment are in a nascent stage and are likely to emerge as such impacts become more measurable and quantifiable, including in the context of IS platforms.

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funding, MEDIUM, 29 April 2025.

95 See UN A/AC.105/1279, *Report of the Scientific and Technical Subcommittee on its sixtieth session*, Committee on the Peaceful Uses of Outer Space Sixty-sixth session Vienna, 31 May–9 June 2023, 27 February 2023, at p. 15.

96 UNGA 41/65 Principles relating to remote sensing of the Earth from outer space, Annex, 1986. Remote sensing is defined there as "...the activity of 'sensing of the Earth's surface from space by making use of the properties of electromagnetic waves emitted, reflected or diffracted by the sensed objects, for the purpose of improving natural resources management, land use and the protection of the environment.'"

In the wake of these and other recommendations, as well in response to private-sector and other nongovernmental needs, the four examples of IS platforms studied below show the potential for deeper implementation of Article XI. As noted, they do not distinguish in their remote sensing functions between observed impacts on the atmosphere and the environment that are caused by space activities and those that are of terrestrial origin—a distinction that is, in any event, becoming increasingly difficult to ascertain.[97]

ICEYE

This platform is operated on a commercial basis by a private Finnish company using synthetic aperture radar (SAR) satellites for persistent monitoring, management, and mitigation of the impacts of climate change. Participants have access to data on wildfires, floods, hurricanes, and other climate events, including both forecast and real-time data. The platform's Flood Rapid Impact Solution, for example, commits to providing initial data within 8 to 12 hours of a flood starting, followed by continuous updates. Use of the platform is directed towards emergency responders, insurance companies, the maritime and financial sectors, and governmental authorities. Participants access ICEYE through a dedicated API following the conclusion of a Partnership Agreement (contract models are available online), and they specify the types of notifications they require.[98]

Global Earth Observation System of Systems Platform Plus (GEOSS-PP)

The recently-upgraded GEOSS-PP serves as a central portal for accessing diverse climate-related datasets. These include information on crop mapping, land degradation, nutrient pollution, ecosystem health indicators, and forest biomass. The platform's map-based interface links users directly to vetted providers of satellite, airborne, drone, and in-situ sensor data at global, regional, and local scales. GEOSS-PP also offers tailored community portals, created through an internal vetting process, which allows groups to access curated datasets relevant to their needs. Voluntary providers may participate through the platform's Yellow Pages after authorization. Examples of community portals include AfriGEOSS—supporting data priorities identified by organizations such as African Association of Remote Sensing of the Environment, African Centre of Meteorological Application for Development, EIS-AFRICA, and the United Nations Economic Commission for Africa; and the GREEN portal, which monitors nutrient pollution in selected European aquatic ecosystems. The GPP User Agreement is publicly available,[99] and users can determine the actionability of the data they need through filtering tools. Illustrative datasets include space-monitored nitrogen and phosphorus concentrations in European inland waters and near-real-time satellite imagery of desertification.

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97 Elena Cirkovic and Danielle Wood, *Integrating planetary boundaries into sustainable space exploration: An earth-outer space system design framework*, ACTA ASTRONAUTICA, Vol. 228, March 2025, pp. 1088-1098.

98 See the sharing parameters available at https://docs.iceye.com/constellation/api/ and the contract options for joining the platform at https://docs.iceye.com/constellation/api/company/get-contract/.

99 See https://www.geoportal.org/contents/rest/document/116/content. The vetting process for data sharers is described on the GEOSS-PP site (https://www.geossplatformplus.com/).

Polish Space Agency Sat4Envi Operating System

Poland's national space IS portal provides centralized access to digital satellite data related to environmental conditions across the country. The platform processes imagery and measurements from Copernicus missions as well as other meteorological satellites and is implemented by national institutions as part of Poland's Space Strategy.[100] Key contributors include the Institute of Meteorology and Water Management, the Space Research Centre of the Polish Academy of Sciences, the Academic Computer Centre CYFRONET AGH, and the Polish Space Agency (POLSA). Their institutional databases—such as the Central Register of Nature Protection Forms—are integrated into the Sat4Envi system. The platform's goal is to offer free, open access to remote sensing resources for citizens, students, researchers, entrepreneurs, and public authorities, supporting environmental monitoring and decision-making. Sat4Envi provides several e-learning modules explaining data applications and analytical tools.[101] Its defined thematic areas include land analysis, forestry, agriculture, crisis response, and water management, with most information relevant at operational and planning scales. Registration for viewing the portal is open to the public, ensuring transparency, and users may also apply to contribute data or derived products through an online form reviewed by administrators at POLSA.[102]

NASA Fire Information for Resource Management System (FIRMS)

FIRMS is a global, map-based platform that provides near-real-time fire data to emergency responders, government authorities at all levels, and the public. Designed to deliver actionable information quickly, it processes satellite observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) operated by the U.S. Geological Survey, and the Visible Infrared Imaging Radiometer Suite (VIIRS), a weather instrument operated by NOAA. Although the platform includes an interactive feature that allows users to upload information through a feedback form, its primary value lies in its unidirectional, open and immediate access to satellite-derived fire detections without requiring registration. FIRMS enables users to track active fires, hotspots, and thermal anomalies, supporting rapid response and situational awareness. The system is managed by NASA's Health and Air Quality Applied Sciences Team (HAQAST), which operates a broader suite of information sharing platforms dedicated to applying space-based data to air quality and public health challenges. These include portals that monitor the ozone layer, measure atmospheric pollution, assess smoke dispersion, and analyze related chemical processes. FIRMS thus serves as a critical component of a larger NASA initiative aimed at translating Earth observation data into operational tools for risk mitigation and public safety.[103]

100 *Poland National Space Strategy* (2017). The Sat4Envi Operating System is implemented as part of "Task No. 2: Satellite applications development – contribution to digital economy."

101 See https://sat4envi.imgw.pl/elearning/.

102 See https://nsisplatforma.polsa.gov.pl/syp_en?lang=en.ly

103 See https://haqast.org/data-and-tools/#tools.

SECTION SUMMARY

The review of the twenty information sharing platforms above shows several notable characteristics and trends in the current state of IS for space sustainability in the five categories analyzed. Overall, the literature reviewed shows a clear awareness on the part of national authorities (the United States, Poland, China), and supra-national and international organizations (the EU and NATO) that information sharing is a critical element of their space activities. On the other hand, private sector space actors that are not compelled to share—by regulation, license, or contract—need to be otherwise incentivized. Although the research could not identify statistical data on the quantity or percentage of all space actors that currently engage actively in IS, this is an important issue for future study and analysis.

The diversity among IS platforms is also evident in the following aspects, which are noted in the comparative table (see **Table 5.1**):

- **The types of entities initiating and maintaining the IS platform:** nation-states, NATO, private companies, and nongovernmental organizations.
- **The level of actionability of the information shared, when these parameters are externally transparent:** real time and short-to-medium term (tactical IS), and long term (strategic IS).
- **The range of participants:** the full range of space actors (national authorities, nonprofit organizations, private companies, military entities), as well as academic institutions, think tanks, and members of the public.
- **Vetting mechanisms for participants** ranges from no vetting at all (the Polish Space Agency Sat4Envi Operating System is freely accessible on a public website), to a simple registration process (Spacetalk), to a full contractual arrangement (LeoLabs). The EU Space Surveillance and Tracking platform currently restricts access to European Union entities, subject to EU regulations.
- **Transparency of formats used for information sharing:** most of the platforms studied do not publicize the formats used, although some of the commercial platforms do note that they have developed proprietary formats.

The stages of development and use of the IS platforms studied fall on a spectrum that reflects two parameters. The first is the status of exploration and use of a given space sector. For example, IS for the safety of lunar activities, including their Article XI registry, has not been fully deployed: processes and templates are under development by COPUOS, and the Lunar Ledger is scheduled to begin its activities in 2026. On the other hand, information sharing for terrestrial atmospheric and environmental observation is at an advanced stage, and platforms such as NASA's Fire Information for Resource Management System provide high-resolution data that are publicly accessible and shared with first responders and the public at large.

The second parameter impacting the stage of development of IS platforms is the extent to which they successfully integrate existing databases that have aggregated data over the decades of space activities, such as the ITU-R's comprehensive data collections under the Radio Regulations and the U.S. DoD's Space-Track portal that has been operational since 1957 (and is now being incorporated into the OSC's TraCSS).

Of the private sector IS platforms studies, ICEYE has also prioritized the synthesis of a maximum number of vetted space data sources. Moreover, to the extent that IS platforms have been able to aggregate a maximum number of sources, participants benefit from enhanced, overall situational awareness for their space activities. A good example is NATO's Aquila-based portal, which is a "virtual constellation" of both national and commercial satellites.

Surprisingly, there is a lag in the development of IS platforms in areas for which the degree of risk that is associated with the space activity for which information is shared—specifically, platforms dedicated to space debris identification and removal. Despite the considerable efforts and initiatives of multistakeholder organizations that have been reviewed above to address the space debris problem, dedicated IS platforms for its detailed identification and subsequent removal measures are still developing or may be not publicly transparent. Two exceptions are the private sector's NorthStar Earth & Space platform and Privateer's Wayfinder. As noted above, the latter also links to a third-party provider of space debris removal services, including price estimates for removal of debris.

Finally, innovation in IS platforms of all five types studied is providing improved sharing capabilities for participants. These include:

- **Map-based and interactive user interfaces that allow for ease of use** (LeoLabs, ICEYE, Wayfinder);
- **Real-time aggregation of potential collision dat**a (Space Data Association, TraCSS, LeoLabs, EU Space Surveillance and Tracking);
- **Real-time alerts on space-based risks**, including mitigation recommendations pushed out to sharers;
- **Real-time, direct communication between space actors** about collision avoidance and other risks (Spacetalk, Space Data Association);
- **Robust integration** of space-based and terrestrial based data sources (GEOSS-PP);
- **Development and deployment of dedicated AI tools** for identification of space-based risks (NATO APSS, LeoLabs, EU SST, NorthStar).
- **Direct, online connect with space debris removal services** as described on the Wayfarer platform.

In the following Part 6, these aspects are included and assessed in the Report's Summary and Conclusion.

Part 6: Summary and Conclusion

This Report has reviewed and analyzed information sharing from the perspective of the ways in which it serves space actors not only as a best practice, but as an essential tool for a safe, sustainable, and collaborative future in outer space. Yet the final assessment on the part of most of these actors will be a practical one: IS must serve their operative needs, or it will not be used optimally by them.

MAIN FINDINGS AND CONCLUSIONS

Based on analysis of the five categories of information sharing reviewed, the Report offers observations on the current state of IS for the sustainability and governance of space activities, and highlights the means by which IS platforms are deploying innovations for broadening overall space situational awareness and mitigating space risks. The innovations identified in Part 5 include increasingly dynamic user interfaces that are map-based, interactive, and easy to navigate. They support real-time aggregation of potential collision; real-time alerts on space-based risks; direct communication between space actors about collision avoidance and other risks; robust integration of space-based and terrestrial based data sources; deployment of dedicated AI tools for identification of space-based risks; and direct, online connect with space debris removal services. As innovation in these capabilities continues, it is anticipated that IS will be increasingly tailored to the needs of operators and, potentially, the nation-states charged with supervising their space activities.

Furthermore, the IS platforms studied in this Report support the approach (and, in fact, the trend) that any arrangement for information sharing on space activities will require that different types of ***pre-defined information be shared***: both generic information about the participants and the characterization of their activity (e.g., launching state and participating states, orbital details(; and additional, specific parameters that describe aspects of their activities that sharers have agreed to communicate to one another. A leading example of this combination is the IS template currently under development included in the Article XI First Ideas Document of the COPUOS Legal Subcommittee, which requests parameters such as expected scientific, economic and social benefits of the shared space activity.

Nonetheless, with respect to the IS formats that would best serve rapid, standardized, and easily implemented preventive actions (if needed), there is currently a fragmentation of efforts. As discussed above, the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space is currently developing a common format for Article XI notifications,[104] yet these formats may not be compatible with legacy IS systems nor with proprietary commercial systems such as LeoLabs' space object catalogue or Spacetalk's orbital data standard.

Likewise, broader adoption of space data standards developed through the work of organizations such as ISO Subcommittee 13 for Space Data and Information Transfer (TC20/SC13) and ISO Subcommittee 14 for Space Systems and Operations (TC20/SC14) remains an ongoing process, highlighting the need for

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104 *Supra* note 7.

stronger incentives for their implementation. The adoption of standards for optimal IS needs to be better incentivized. One model that may be helpful in this context is that of the Common Vulnerabilities and Exposures (CVEs) used for distributed CISA cyber alerts, which is already applied with respect to such alerts that affect cyber risks to some satellite systems.[105] CVEs have been widely adopted by diverse cybersecurity stakeholders around the globe, as standardized vulnerability indicators based on publicly disclosed information.[106]

The incentivization measures for the use of IS platforms in general (analyzed in Part 4) are undergoing an interesting change, brought about by two separate developments. The first development stems from the increased privatization of space activities. While former space IS platforms may have relied solely upon treaty-based information sharing requirements (e.g., NATO APSS, EU Space ISAC, and OST Article XI requirements), the role of private sector actors as operators of IS platforms has brought a much more commercialized, contract-based approach to space IS. As shown in the Report, companies such as ICEYE, LeoLabs, NorthStar Earth & Space, and Privateer operate portals on a for-profit basis, leveraging private sector marketing know-how. For example, Privateer's Wayfinder portal, which includes mapping of space debris, links the user directly to a price estimate for debris removal; ICEYE's earth observation API allows for tactical, task-specific access on a pay-as-you-go basis. These innovations also raise new concerns about protecting intellectual property created in the context of space activities, including privately produced catalogues of space objects and their vulnerabilities.

In a point related to the innovations being introduced into such privatized platforms, incentives for IS on the part of private sector actors must also be able to encourage innovation while ensuring protection and confidentiality of intellectual property. The issue of privatized catalogues of space objects and their vulnerabilities, accessible only to paying customers, is one example of this issue. While multilateral agreements such as the Artemis Accords and the Space Station Agreement explicitly address IP issues, and a White Paper of the International Trademark Association proposes a Global Space IP Registry,[107] this is an open and challenging issue for IS platforms.

The second development regarding incentivization stems from the nascent regulatory projects for space governance, especially in the European Union. There, the NIS2 Directive and the proposed Space Act require the 27 EU countries to ensure that space actors establish information sharing platforms and practices that are subject to regulatory sanction if not utilized. Enforcement of these requirements has not yet been implemented but are expected to come into play over the next few years. It should be noted that, as in other EU regulations, there are significant enforcement issues for third-party space actors located outside of EU territory.[108]

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105 CISA does not provide specific CVE alerts for satellite systems or other space objects, but there are instances in which CVEs are relevant for ascertaining ground segment vulnerabilities. See, for example, CVE-2025-29909 relating to a vulnerability in CryptoLib software used for CCSDS Space Data Link Security Protocol – Telecommand processing (https://nvd.nist.gov/vuln/detail/cve-2025-29909).

106 See *CVE Numbering Authorities* (no date), https://www.cve.org/ProgramOrganization/CNAs; and Ioana Branescu, Grigorescu Octavian, and Dascalu Mihai, *Automated Mapping of Common Vulnerabilities and Exposures to MITRE ATT&CK Tactics*, INFORMATION 15 (4) 214 (2024).

107 International Trademark Association, *Intellectual Property in Space*, White Paper, 10 May 2023.

108 See the EU Space Act's Chapter 3, "Space Services Providers from Third Countries and International Organizations."

Another critical issue that impacts the incentivization of space actors to use space IS platforms is that of the information security of the platforms themselves. This is a challenging topic to study, as information security controls are not consistently transparent to potential sharers. The most protected platforms are likely to intentionally refrain from publicly sharing their protection of shared digital data, its transmission and its storage. Two examples of steps that have been undertaken to standardize these protections are the 2024 ISO standard on cybersecurity for space systems,[109] and the NIST Communications Technology Laboratory's projects on the safety of space communications.[110]

While the Report has mapped and analyzed the incentives for information sharing with respect to outer space activities, the implications of actors in space *refraining* from participation, and the resultant risks to overall space sustainability, should also be considered. As stated at the outset, IS no longer constitutes only a best practice for space actors, but is rather a critical aspect of the functionality and sustainability of space activities. The proposed principles for a model agreement in Appendix A address these issues through explicit provisions that, for example, information shared will be anonymized and the security measures supporting the platform itself will be transparent and verifiable to all participants prior to their joining.

Additional points that emerged from the research conducted for this Report include:

- **The unidirectional nature** of many of the twenty platforms studied (i.e., the "pushing out" of information to platform participants), with less emphasis on modes for its reception and integration into the platform. One initiative to counter this tendency is seen in Spacetalk, which explicitly emphasizes collaborative communication among participants.
- **The advantages of tiered-access portals**, such as Space ISAC, which ensure that information is shared with communities of participants where different levels of trust may be required, while information collection resources benefit all participants.
- The understanding that **information sharing for space activities is best characterized as a "system of systems,"** due to the diversity of space actors and their varied operational needs. The Aquila virtual satellite configuration used by NATO's APSS is a good example of this paradigm. Future coordination of IS platforms and systems may leverage innovations such as Distributed Ledger Technology (DLT) to provide a synchronized and trusted copy of an IS ledger.
- Following this point, the **non-inclusion (or non-transparent inclusion) of military catalogues** of space objects, databases, and anomaly alerts is an ongoing challenge for outer space IS. While some platforms such as Space ISAC may share outer space data collected by military entities (listed government partners include the DoD Missile Defense Agency, the U.S. Space Command, and the U.S. Space Force), other platforms are likely to fall short of military vetting requirements. This is an open issue without a clear solution, which is by no means limited to space sustainability IS, yet it should be made explicit.

109 ISO/TS 20517:2024, *Space systems – Cybersecurity management requirements and recommendations* (2024).

110 NIST, *Advancing Space Communications at NIST Communications Technology Laboratory*, 16 September 2025, https://www.nist.gov/news-events/news/2025/09/advancing-space-communications-nist-communications-technology-laboratory.

- Another relevant, non-transparent source for space IS, especially with respect to short-and-medium term risk assessment, is **the space insurance sector**. This is a second open issue without a clear solution because of confidentiality requirements, although occasional glimpses into the risk assessments for space activities conducted by insurers may be incorporated into platforms as relevant.[111]

Topics for future research that will impact the information sharing issues raised in this Report include: an analysis of data sharing protocols for critical space information sharing that can be implemented rapidly and serve as a common format for state and non-state space actors; development of a space risk assessment matrix that would be similarly standardized; and a coordination of information sharing obligations of countries at the international level with internal regulatory requirements for both governmental and private actors, via national licensing mechanisms for space activities. The increasingly ubiquitous deployment of AI tools for more efficient IS will inevitably be part of such future research initiatives. In addition, future research will benefit from access to sources on non-Western space IS platforms, such as the China–Russia ILRSCO.

In conclusion, an important next step for researching the effectiveness of IS for space sustainability and governance is a study of the actual, *de facto* use of IS platforms by space actors. In order to move ahead with the critical task of ensuring the sustainability of space activities, solutions should be tailored to the practical, real-time and short-to-medium term data needs of sharers. These needs are best met by a deeper understanding of the actual levels of participation in IS platforms, including platforms that do not publicly disclose numbers of users and the types of critical outer space data that they share. Through measures such as improved mapping of space IS resources and ongoing research into the effectiveness of specific platforms, the present fragmentation of information sharing for sustainable space activities may be reduced.

SOME PROPOSED WAYS FORWARD

This Report has surveyed several initiatives for promoting space IS on the part of both governmental and nongovernmental actors, with COPUOS taking the lead within the UN system on work for OST Article XI notifications. Several avenues for moving ahead stem from its findings and from the conclusions above.

The first proposal for moving ahead with space information platforms is to **convene a multilateral, multisector conference with the aim of coordinating data exchange formats and protocols for potential IS between platforms, including unified SOS alert protocols for space emergencies** and overall synchronization of efforts where relevant and feasible. The "Principles for a Draft Model Agreement for Information Sharing for Space Activities" included in Annex A may serve to support these coordination efforts. The convening entity will optimally be a neutral actor, either a nongovernmental organization (such as those referred to in Part 2)

111 See, for example, Research & Markets, SPACE INSURANCE MARKET REPORT 2025, September 2025; and Andrea Harrington, *Insurance as Governance for Outer Space Activities*, ASTROPOLITICS, 18(2), 99–121 (2025).

or an intergovernmental body that is prepared to include private sector actors as crucial participants in the process for developing broadly recognized formats and protocols.[112]

A second direction proposed is the standing up of **a task force focused on evolving solutions for IS of private sector, proprietary, or national security space object catalogues and risk assessment information**, potentially including the military and space insurers. Similarly to the previous proposal, the convener should be a neutral entity, with resources contributed by a broad base of stakeholders which would include governmental and nongovernmental actors, standardization bodies, think tanks, and academia. The methodological model might be the "sprint" model used by computer software developers, adopted to a concrete, agreed, and feasible timeline.[113]

A third and final proposal addresses the issue of **actual, *de facto* utilization of IS platforms on the part of space actors**, by conducting a broad-based survey of who shares, what they share, under what circumstances, and when they choose to refrain from IS. Results might be leveraged within the space IS initiatives that are currently underway. Such a project might be approached through similarly designed surveys of diverse outer space stakeholders, each within its professional context (e.g., the International Astronautical Federation, Space ISAC, EU Space ISAC, the American Institute of Aeronautics and Astronautics, the APRSAF, the Satellite Industry Association).

In summarizing these potential ways forward, it is emphasized that space IS will probably remain a system of systems, due to the increasing diversity of space actors and their varied operational needs. As human activity in space evolves, it will be critical for overall space sustainability to be managed with optimal information sharing between IS platforms around risks and vulnerabilities, and with credible and transparent modes of assessing how successfully informational gaps are, in fact, minimized. To that end, the technical and pragmatic work of IS coordination will need to be merged with a broader vision of space sustainability.

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112 On the crucial need for globally recognized emergency alert protocols, see, for example, Joe Hersey, *All stations-distress: Radio communications from the time of the Titanic*, USCG PROCEEDINGS, Summer 2012, pp. 54-58.

113 For an explanation of the "sprint" model, see Rahul Awati and Vicki-Lynn Brunskill, *What is a sprint (software development)*, TechTarget, 10 September 2024, https://www.techtarget.com/searchsoftwarequality/definition/Scrum-sprint.

Annex A: Principles for a Draft Model Agreement for Information Sharing for Space Activities

The Draft Model Agreement is envisaged as a two-part document, including a generic Terms of Use section which may be made publicly available,[114] and a Service Configuration section that is specific to each participant and is confidential. The following principles have been elicited from the research conducted for this Report, and their aim is to serve as a basis for both sections of the Draft Model Agreement which will be agreed between the IS platform facilitator and participants in IS platforms such as those analyzed in the Report. The principles are intended to apply to both public IS portals and restricted-access portals, including commercial IS platforms.

> An important next step for researching the effectiveness of IS for space sustainability and governance is a study of the actual, de facto use of IS platforms by space actors.

1. **It is critical that the IS platform facilitator provide clear rules and thresholds for sharing.**

   The specific situations in which participants transmit information to the platform, and in which they receive it from the platform facilitators and/or directly from other participants, should be carefully prescribed. In a tiered-access platform, there may be a range of thresholds and rules that provide insular sharing for each tier and a separate set of thresholds and rules in accordance with the level of community trust established at each tier.

2. **The types of information shared by participants joining the IS platform must be defined at the outset, including the anticipated uses for each type of data.**

   The Model Agreement should include a detailed typology of the information to be shared in both directions: from participants to the platform, and from the platform to participants. If peer-to-peer collaboration is supported by the platform, then that typology should also be included. In circumstances in which the platform itself shares certain data with other third-party IS platforms, an additional typology will be required. A standardized coding system for information types might be leveraged both within the platform and with third parties.

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114 See both the Terms of Reference document shared on the EU Space ISAC portal (https://www.euspa.europa.eu/sites/default/files/documents/eu_space_isac_terms_of_reference.pdf), and EU SST's *Terms and Conditions of Use of the SST Service Provision Portal and SST Services* (https://portal.eusst.eu/portalng/terms-use).

3. **Confidentiality and anonymization capabilities will incentivize reluctant participants.**

   Likewise, it will be advantageous for participants to have an option for confidential and/or anonymized sharing of data. This is important for protection of sensitive data that may otherwise inhibit participation in the IS platform (intellectual property, proprietary business processes, data limited by antitrust law, and protected personal data). With regard to information that has national security implications, legal constraints on both platform facilitators and participants will determine the parameters of sharing and confidentiality requirements.

4. **Vetting of participants should be undertaken by a trusted entity, whether it is the IS platform facilitator or a third party.**

   In order to establish the highest possible level of trust among participants, vetting criteria will be clear and periodically tested on participants. Misuse of the IS platform, or free riding, should be subject to sanctions that are graded according to severity of misuse.

5. **Information security on the platform should be transparent to participants and should comply with accepted standards.**

   Information security ensures reliable and secure digitized IS by focusing on the confidentiality, integrity, and availability of the shared data. Robust information security measures that comply with standards such as ISO 27001, ISO/TS 20517, and other space-related information security standards are necessary for participants' confidence in the platform's functionality, as well as for compliance with national cybersecurity regulation.

6. **Guidance, training, meetups, and tabletop exercises will promote use of the IS platform.**

   Guidance materials for participants, as well as onboarding, real-time e-training, and help desk functions constitute best practices for both onboarding and ongoing use. Periodic participant meetups, tabletop exercises, and refresher sessions can showcase platform upgrades and innovations, as well as build trust among participants.

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Annex B: Interviews

Interviews were held during the course of the research for the Report with the following individuals. Interviewees bear no responsibility for errors of fact or assessment of facts on the part of the author.

Dr. Franziska Knur, Chair of the Working Group on the Status and Application at the Five United Nations Treaties on Outer Space at the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space.

Mr. Daniel Oltrogge, Chief Scientist and Director of the Center for Space Safety Standards and Innovation at COMSPOC LLC and lead coordinator for the Space Safety Coalition.

Dr. Antonino Salmeri, Director, Lunar Policy Platform.

Dr. Yevgeny Tsodikovich, Economics Department, Ben-Gurion University of the Negev.

Mr. Fred Slane, Founder of Space Infrastructure Foundation and International Chair for the ISO Technical Committee on Space Systems and Operations (ISO TC 20).

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