Legal aspects of Active Debris Removal (ADR): regulation of ADR under international space law and the way forward for legal development

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4 Relevance of the Soft Law Pillar to Space Debris and ADR

The previous chapter assessed the application of the hard law pillar of international space law to debris removal and identified gaps that need to be remediated in further legal development. This chapter will examine the soft law pillar of space law and assess whether and how the gaps in the UN space treaties and general international law for the governance of space debris and ADR are addressed in this pillar. "Soft law" is a term used for non-binding instruments such as resolutions adopted by the UN General Assembly and sets of guidelines produced by other bodies, including the subsidiary organs of the UN such as COPUOS.[1]

It is noteworthy that "the first chapter in the book of space law" is written in the form of UN General Assembly resolutions, which are soft law instruments because they do not have legally binding force.[2] Before the conclusion of the Outer Space Treaty, the UN General Assembly adopted several resolutions for the governance of space activities. Among these resolutions, Resolution 1962(XVIII) of 1963 is "the first significant document formulating legal principles for the conduct of outer space activities".[3] The nine basic principles enshrined in the 1963 Declaration of Legal Principles were, with only relatively minor amendments, incorporated into the Outer Space Treaty four years later. In addition, it is generally understood that these nine basic principles express customary international law, binding all States of

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1 Byers, M., & Boley, A. (2023). *Who Owns Outer Space? International Law, Astrophysics, and the Sustainable Development of Space.* Cambridge University Press, p. 278.

2 Cheng, B. (1997). United Nations Resolutions on Outer Space: "Instant" International Customary Law?. In *Studies in International Space Law*. Oxford University Press, p. 125. For a general introduction to the UN General Assembly resolutions see UN. How Decisions are Made at the UN. <https://www.un.org/en/model-united-nations/how-decisions-are-made-un>. One may also say that the book of space law has a "preface", as several scholars and practitioners contributed their thoughts and considerations regarding space law even before the launch of Sputnik 1. For a historical outline of the development of space law see Masson-Zwaan, T. L. & Hofmann, M. (2019). *Introduction to Space Law*. Wolters Kluwer, pp. 1-4.

3 Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space. UNGA Res. 1962(XVIII) of 13 December 1963 ("Declaration of Legal Principles"). Traunmüller, K. (2012). The 'Declaration of Legal Principles Governing the Activities of States in the Exploration of Outer Space': The Starting Point for the United Nations' Law of Outer Space. In Marboe, I. (Ed.), *Soft Law in Outer Space: The Function of Non-Binding Norms in International Space Law*. Böhlau Verlag, p. 145.

the international community.[4] This illustrates that soft law and hard law are not isolated but intimately connected, as the establishment of the former may contribute to the development of the latter.

After the "golden age" of space law treaty-making between the 1960s and 1970s, no new space treaties were adopted within the UN. Instead, the development of space law took again the form of soft law. This started from the four UN General Assembly resolutions addressing certain special and technical categories of space activities,[5] namely satellite direct television broadcasting,[6] remote sensing of the Earth from space,[7] the use of nuclear power sources in outer space,[8] and international cooperation in the exploration and use of outer space.[9] These resolutions, together with the aforementioned 1963 Declaration of Legal Principles, are collectively referred to as the five sets of principles on space-related activities. Following the adoption of these five "Principles resolutions", the UN General Assembly adopted other space-related "Practice resolutions" that address certain concepts contained in the UN space treaties.[10] These resolutions provide recommendations on issues relating to the application of the concept of "launching State",[11] the enhancement of registration practices,[12] and the development of national legislation for space activities.[13]

4 Frigoli, M. (2019). Between Active Debris Removal and Space-Based Weapons: A Comprehensive Legal Approach. In Froehlich, A. (Ed.). *Space Security and Legal Aspects of Active Debris Removal*, Cham: Springer, p. 53. See also Lee, R. J., & Freeland, S. R. (2004). The Crystallisation of General Assembly Space Declarations into Customary International Law. *Proceedings of the Forty-Sixth Colloquium on the Law of Outer Space 2003*, American Institute of Aeronautics and Astronautics, p. 126. Gabrynowicz, J. I. (2006). The Outer Space Treaty and Enhancing Space Security. In *Building the Architecture for Sustainable Space Security: UNIDIR Conference Report*, 30-31 March 2006, p. 113. It is also noted that the incorporation of the principles contained in the Declaration of Legal Principles into the Outer Space Treaty "by and large marginalized any discussion on whether" the Declaration reflected customary international law. See von der Dunk, F. G. (2015). International Space Law. In von der Dunk, F. G. (Ed.), *Handbook of space law*. Edward Elgar Publishing, p. 38.

5 Jankowitsch, P. (2018). The Outer Space Treaty: Its First Fifty Years. *Proceedings of the International Institute of Space Law 2017*, *60*, pp. 7-8.

6 UNGA Resolution 37/92 of 10 December 1982.

7 UNGA Resolution 41/65 of 3 December 1986.

8 UNGA Resolution 47/68 of 14 December 1992.

9 UNGA Resolution 51/122 of 13 December 1996.

10 Tapio, J. & Soucek, A. (2019). National Implementation of Non-Legally Binding Instruments: Managing Uncertainty in Space Law?. *Air and Space Law*, *44*(6), pp. 567-568.

11 Application of the concept of the "launching State", adopted by the General Assembly in its resolution 59/115 of 10 December 2004.

12 Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects, adopted by the General Assembly in its resolution 62/101 of 17 December 2007.

13 Recommendations on national legislation relevant to the peaceful exploration and use of outer space, adopted by the General Assembly in its resolution 68/74 of 11 December 2013.

In addition to the UN General Assembly resolutions, there are other non-binding instruments governing space-related issues produced within the framework of the UN and other international bodies such as the IADC and the International Organization for Standardization (ISO). Among these instruments, some address topics that are of direct relevance to space debris including the mitigation of space debris and the preservation of long-term space sustainability, which merit more detailed discussion in this chapter. Also deserving specific attention is the 2013 *Report of the Group of Governmental Experts on Transparency and Confidence-building Measures in Outer Space Activities* ("GGE Report of 2013"),[14] which provides measures that can assist in building confidence and reducing misperceptions among States regarding space activities, and could thus be useful to address the dual-use concerns of ADR.

Alongside the legal developments made by States and international bodies, the commercial space industry is playing an increasingly active role in developing voluntary, consensus-based guidelines and best practices through industry associations and working groups.[15] These industry-developed documents usually embody the commitments of the endorsing entities to make their best efforts to achieve compliance. In view of the ever-growing trend of privatisation and commercialisation of space activities, the endorsement of private space actors can have important practical implications even though the documents are not formally adopted by governmental entities. Moreover, the documents produced by the commercial industry can serve as a basis for further legal development at the international level. A prominent example in this regard can be found in the documents published by the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS) regarding commercial RPO and on-orbit servicing.[16] These documents provide guidance for the design and execution of missions involving RPO and they informed the development of the ISO Standard 24330:2022 which addresses the same area.[17] Therefore, the picture of the international legal regime governing space activities would be incomplete without including the contributions of the commercial space industry.

The aim of this chapter is to examine whether and how the soft law pillar of international space law contributes to filling the regulatory gaps in the

14 The text of the GGE Report of 2013 is contained in UN Doc. A/68/189 (29 July 2013).

15 FCC. (24 April 2020). Mitigation of Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking. FCC 20-54, para. 11. <https://docs.fcc.gov/public/attachments/FCC-22-66A1.pdf>.

16 The publications of CONFERS are available at: <https://satelliteconfers.org/publications/>.

17 ISO 24330:2022 "*Space systems — Rendezvous and Proximity Operations (RPO) and On Orbit Servicing (OOS) — Programmatic principles and practices*", published on 1 July 2022. <https://www.iso.org/standard/78463.html>.

hard law pillar for the governance of the four issues relating to ADR and whether there are any remaining gaps. These four issues will be addressed respectively in Sections 4.1 to 4.4. Section 4.1 will focus on several sets of international guidelines and standards relevant to the protection of the outer space environment, and discuss how these instruments are relevant to the prevention and reaction against space debris. Section 4.2 will assess how soft law instruments could contribute to the clarification of the notion of "fault" for the attribution of liability for damage caused in outer space, and discuss the initiatives taken by the commercial space industry for the development of technical and safety standards and best practices applicable to ADR operations. Section 4.3 will discuss the recommendations regarding the registration of space objects and highlight the need for further legal development to facilitate the requesting and granting of approval for the consensual removal of space debris. Section 4.4 will assess the relevance of TCBMs in addressing potential security concerns related to ADR activities. Section 4.5 will conclude this chapter and assess the role of soft law for the future development of space law to govern ADR activities.

4.1 *Issue 1*: International Guidelines and Standards Relevant to the Control of Space Debris

Chapter 3 points out that the hard law pillar of international space law does not impose a clear obligation upon States to mitigate or remediate space debris. As noted by Popova and Schaus, the lacunae in the binding law regarding effective mechanisms for the protection of the outer space environment from the hazard posed by space debris have not remained completely unaddressed by the international community.[18] Rather, States and international organisations have engaged in cooperative regimes to tackle the space debris problem through the development of non-legally binding instruments.[19] This section will discuss several soft law instruments that provide useful guidance to address the space debris problem. Section 4.1.1 will discuss several international mechanisms on space debris mitigation, with emphasis placed on two major sets of space debris mitigation guidelines that have gained wide acceptance within the international community, namely those adopted by the IADC and COPUOS. After assessing the substance of these international instruments, the section will discuss their application to ADR activities and their implementation in practice. Section 4.1.2 will examine the LTS Guidelines adopted by COPUOS in 2019, including the development of this instrument, its relevance to space debris

18 Popova, R., & Schaus, V. (2018). The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space. *Aerospace*, *5*(2), p. 10.

19 Blount P. J. (2019). On-Orbit Servicing and Active Debris Removal: Legal Aspects. In Nakarada Pecujlic, A., & Tugnoli, M. (Eds.). (2019). *Promoting Productive Cooperation Between Space Lawyers and Engineers*. IGI Global, p.184.

and ADR, and the implementation of the LTS Guidelines. Section 4.1.3 will conclude this section.

4.1.1 International Space Debris Mitigation Guidelines and Standards

This Section will discuss a series of international non-binding instruments on space debris mitigation and will be divided into five sub-sections. Section 4.1.1.1 will discuss the IADC Space Debris Mitigation Guidelines, which is the first international document that is specialised in the field of space debris mitigation.[20] The IADC Space Debris Mitigation Guidelines were used as a foundation for the development of the COPUOS Space Debris Mitigation Guidelines, which will be addressed in Section 4.1.1.2. Section 4.1.1.3 will introduce other space debris mitigation guidelines and standards developed at the international level, which are the ISO Standard 24113,[21] the International Telecommunication Union (ITU) Recommendation ITU-R S.1003.2,[22] and the European Code of Conduct for Space Debris Mitigation (ECoC).[23] Section 4.1.1.4 will assess the application of the space debris mitigation guidelines to ADR operations. Section 4.1.1.5 will discuss whether the international space debris mitigation guidelines have been sufficiently complied with in practice to limit the growth of space debris.

4.1.1.1 IADC Space Debris Mitigation Guidelines

The IADC is an international forum for the coordination of activities related to the issues of man-made and natural debris in space.[24] It was formed in 1993 by its four founding members, namely NASA, ESA, the Russian Space Agency (RSA, now Roscosmos), and the National Space Development Agency of Japan (NASDA, now JAXA).[25] The IADC has currently thirteen member agencies, including twelve national space agencies and ESA, which represents virtually all major spacefaring nations.[26]

The primary purpose of the IADC is "to exchange information on space debris research activities between members, to facilitate opportunities for

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20 Yakovlev, M. (2005). The "IADC Space Debris Mitigation Guidelines" and Supporting Documents. *Proceedings of the 4th European Conference on Space Debris*, p. 1.

21 ISO Standard 24113 "*Space systems — Space debris mitigation requirements*", last updated in May 2023. <https://www.iso.org/standard/83494.html>.

22 ITU Recommendation ITU-R S.1003.2 (12/2010) "*Environmental protection of the geostationary-satellite orbit*". <https://www.unoosa.org/documents/pdf/spacelaw/sd/R-REC-S1003-2-201012-IPDF-E.pdf>.

23 *European Code of Conduct for Space Debris Mitigation* ("ECoC"), Issue 1.0, adopted on 28 June 2004. <https://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf>.

24 IADC. About. <https://www.iadc-home.org/what_iadc>.

25 Johnson, N. (2012). Origin of the Inter-Agency Space Debris Coordination Committee. In *Orbital Debris Quarterly News*, *16*(4), pp. 3-4.

26 For the IADC membership see IADC website: <https://www.iadc-home.org/what_iadc>.

cooperation in space debris research, to review the progress of ongoing cooperative activities and to identify debris mitigation options".[27] The IADC consists of a Steering Group and four specified Working Groups (WGs) covering measurements (WG1), environment and database (WG2), protection (WG3) and mitigation (WG4).[28] At the 17th meeting of the IADC in October 1999, a new Action Item (AI 17.2) was adopted to develop a set of consensus-based space debris mitigation guidelines.[29] WG4, together with the Steering Group, developed and refined a draft set of mitigation guidelines during 2001-2002.[30] In 2002, The IADC member agencies adopted the IADC Space Debris Mitigation Guidelines by consensus, which were subsequently updated in 2007, 2020 and 2021, with clarifications and target values added to the guidelines in these updates.[31] The IADC also publishes and updates the *Support to the IADC Space Debris Mitigation Guidelines*, which provides specifications on "the purpose, feasibility, practices, and tailoring guide for each recommendation" contained in the IADC Space Debris Mitigation Guidelines.[32]

The IADC Space Debris Mitigation Guidelines describe existing practices that have been identified and evaluated for limiting the generation of space debris in space activities.[33] The guidelines are applicable to mission planning and the design and operation of spacecraft and launch vehicle orbital stages, with a focus on the following four areas:[34]

Area (1): Limitation of debris released during normal operations;
Area (2): Minimisation of the potential for on-orbit break-ups;
Area (3): Post-mission disposal;
Area (4): Prevention of on-orbit collision.

With regard to *Area (1)*, the IADC Space Debris Mitigation Guidelines recommend that spacecraft and launch vehicle orbital stages should be designed not to intentionally release debris during normal space opera-

27 Art. 1, Terms of Reference (ToR) for the IADC. IADC-93-01 (Rev. 11.6), initially adopted 25 October 1993, last updated 3 October 2018.

28 IADC, *supra* note 24.

29 Johnson, N. L. (2006). Recent Developments in Space Debris Mitigation Policy and Practices. In *NASA Technical Reports Server*, p. 1. <https://ntrs.nasa.gov/citations/20060052514>.

30 See Compendium of Space Debris Mitigation Standards Adopted by States and International Organizations (15 May 2023) ("Space Debris Compendium"), p. 94. The Compendium has been developed as a contribution of Canada, the Czech Republic and Germany to COPUOS in 2014. ESA provided support in compiling and finalizing the Compendium. The Compendium is available on a dedicated UNOOSA webpage: <https://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html>.

31 IADC Space Debris Mitigation Guidelines (2021), p. 2.

32 IADC. Support to the IADC Space Debris Mitigation Guidelines. IADC-04-06 Rev. 5.8, June 2021, Foreword.

33 Sec. 1, IADC Space Debris Mitigation Guidelines (2021).

34 Secs. 1&2, ibid.

tions, or at least to minimise the adverse impact of the released debris on the orbital environment.[35] In addition, the risk of the intentionally released debris must be properly assessed to ensure that their hazard to other space objects is "acceptably low in the long-term".[36]

As to *Area (2)*, the IADC Space Debris Mitigation Guidelines provide recommendations on the avoidance of accidental break-ups and intentional destructions.[37] According to the Guidelines, the potential of accidental explosive break-ups should be minimised both during and after mission operations. As to the former, spacecraft and orbital stages should be designed in such a way to prevent or minimise the risk of failure that could lead to accidental explosive break-ups during operational phases.[38] The probability of occurrence of such break-ups should be at least below 10^{-3} in order.[39] For the minimisation of accidental break-ups after the completion of mission phases, the spacecraft and orbital stages should be duly passivated, i.e., all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal.[40] Besides accidental break-ups, the IADC Space Debris Mitigation Guidelines also recommend the avoidance of intentional destruction of space objects and other harmful activities that may significantly increase on-orbit collision risk.[41] If intentional break-ups cannot be avoided, they should be conducted at sufficiently low altitudes to reduce the adverse environmental impacts.[42]

With regard to *Area (3)*, the IADC Space Debris Mitigation Guidelines provide detailed recommendations for two protected regions, namely the GEO Protected Region and the LEO Protected Region. The IADC Guidelines define GEO as "Earth orbit having zero inclination and zero eccentricity, whose orbital period is equal to the Earth's sidereal period".[43] The altitude of GEO is around 35,786 km above the Earth's surface.[44] The GEO Protected Region is defined as a segment of the spherical shell that is ± 200km GEO altitude with ±15 degrees latitude.[45] For the post-mission disposal of GEO objects, the IADC Guidelines recommend the re-orbiting of these objects to a higher orbit that remains outside the GEO Protected Region for at least

35 Sec. 5.1, ibid.
36 Ibid.
37 Sec. 5.2, ibid.
38 Sec. 5.2.2., ibid.
39 Ibid.
40 Sec. 5.2.1, ibid.
41 Sec. 5.2.3, ibid.
42 Ibid.
43 Sec. 3.3.3, ibid.
44 Ibid.
45 Sec. 3.3.2(2), ibid.

100 years.[46] To fulfil this objective, the IADC Guidelines provide a formula describing the minimum increase in perigee altitude with an eccentricity less than or equal to 0.003.[47] According to this formula, the perigee altitude of end-of-mission spacecraft and launch vehicle orbital stages should be increased by at least 235 km above GEO.[48]

The LEO Protected Region is defined as the "spherical region that extends from the Earth's surface up to an altitude of 2,000 km".[49] For the post-mission disposal of LEO objects, the IADC Space Debris Mitigation Guidelines recommend that these objects should be de-orbited, preferably through direct re-entry, or where appropriate be manoeuvred into an orbit with an expected residual orbital lifetime of 25 years or shorter.[50] This guideline is often referred to as the "25-year rule". The success rate of post-mission disposal is recommended to be at least 90%, which is set to limit the adverse impact of space activities on the long-term sustainability of the orbital environment.[51] For spacecraft and orbital stages that are to be disposed of by re-entry into the atmosphere, the IADC Space Debris Mitigation Guidelines recommend that "debris that survives to reach the surface of the Earth should not pose an undue risk to people or property".[52] More specifically, the IADC Guidelines recommend using the threshold of 10^{-4} for limiting casualty risk per single re-entry event.[53] This Casualty Expectation (E_c) threshold is also reflected in the space debris mitigation guidelines and standards of several space agencies,[54] such as NASA Standard 8719.14,[55] the ESA Re-entry Safety Requirement,[56] and the JAXA Space Debris Mitigation Standard.[57]

Finally, as to *Area (4)*, space operators are recommended to estimate and limit the probability of accidental collision with known objects when developing the design and mission profile of their spacecraft and orbital stages.[58] If reliable orbital data and conjunction assessments are available, operators should consider the coordination of launch windows for launch vehicle orbital stages and the implementation of CAMs for spacecraft in

46 Sec. 5.3.1, ibid.
47 Ibid.
48 Ibid.
49 Sec. 3.3.2(1), ibid.
50 Sec. 5.3.2, ibid.
51 Ibid.
52 Ibid.
53 Ibid.
54 Support to the IADC Space Debris Mitigation Guidelines, *supra* note 32, p. 33.
55 NASA Standard 8719.14C "*Process for Limiting Orbital Debris*", approved 5 November 2021.
56 *ESA Re-entry Safety Requirements*, issue 1, revision 0, ESSB-ST-U-004, issued on 4 December 2017.
57 *JAXA Space Debris Mitigation Standard*, JMR-003B, revised in 2011.
58 Sec. 5.4, IADC Space Debris Mitigation Guidelines.

orbit.[59] Besides the collision avoidance with known objects, the IADC Space Debris Mitigation Guidelines also recommend designing spacecraft to limit the impact of collisions with small debris that could cause a loss of control, which is usually achieved through the use of shielding structures.[60]

The IADC Space Debris Mitigation Guidelines, as the first international instrument on space debris mitigation, has been explicitly referred to and implemented in many national and international mechanisms on space debris mitigation. The Guidelines were also used as a foundation for the development of other sets of international space debris mitigation guidelines and standards including the COPUOS Space Debris Mitigation Guidelines,[61] which will be discussed in the next section.

4.1.1.2 COPUOS Space Debris Mitigation Guidelines

The COPUOS Space Debris Mitigation Guidelines are the result of many years of work by COPUOS and its Scientific and Technical Subcommittee (STSC).[62] COPUOS started to address the issue of space debris in the late 1970s and early 1980s with some studies concerning the factual information of space debris conducted by then.[63] However, these early initiatives did not create significant waves but only small ripples in COPUOS.[64] It was not until 1994 that a new item "space debris" was added to the agenda of the COPUOS STSC.[65] On the basis of the research conducted according to a multi-year work plan in furthering the understanding of space debris, the COPUOS STSC adopted a technical report on space debris in 1999 and agreed to have it widely distributed for further deliberations.[66]

In 2001, the Subcommittee agreed to establish a work plan for expediting the international adoption of voluntary space debris mitigation measures.[67] In 2003, the IADC presented its space debris mitigation guidelines to the COPUOS STSC, and the Subcommittee began its review of the IADC guidelines according to its work plan.[68] This bridged the work between the IADC

59 Ibid.
60 Ibid.
61 Space Debris Compendium (2023), *supra* note 30, p. 94.
62 Preface of the COPUOS Space Debris Mitigation Guidelines. The text of this instrument is available at: <https://www.unoosa.org/pdf/publications/st_space_49E.pdf>.
63 Perek, L. (2002). Space Debris at the United Nations. *Space Debris*, *2*(2), p. 124.
64 Ibid, p. 125.
65 UN Doc. A/AC.105/571 (10 March 1994), Report of the Scientific and Technical Subcommittee on the Work of its thirty-first Session, para. 64.
66 Ibid, para. 35. The text of the technical report is contained in UN Doc. A/AC.105/720 (1999).
67 UN Doc. A/AC.105/761 (2 March 2001), Report of the COPUOS Scientific and Technical Subcommittee on its thirty-eighth session, para. 130.
68 UN Doc. A/AC.105/804 (5 March 2003), Report of the COPUOS Scientific and Technical Subcommittee on its fortieth session, para. 121.

and COPUOS with regard to the development of space debris mitigation guidelines.[69] In 2007, the COPUOS STSC adopted its space debris mitigation guidelines at its forty-fourth session,[70] which were then endorsed by the Committee at its fiftieth session[71] and later by the UN General Assembly in its Resolution 62/217 of 2007.[72]

The development of space debris mitigation guidelines from the IADC to COPUOS indicates the acceptance by the global space community of a set of debris mitigation measures initially developed by a smaller "club" of leading spacefaring nations.[73] In fact, while the membership of the IADC represents leading space agencies in the world, COPUOS has currently over a hundred member States with a wide range of diverging space capabilities.[74] In addition, the members of the IADC are agencies while those of COPUOS and the UN General Assembly are States. Therefore, the adoption of the COPUOS Space Debris Mitigation Guidelines can be seen as embodying a stronger political commitment at a broader scale to limit the generation of space debris.

Like the IADC Guidelines, the COPUOS Space Debris Mitigation Guidelines are not legally binding under international law.[75] States and international organisations are encouraged to voluntarily take measures to ensure that these guidelines are implemented to the greatest extent feasible, through space debris mitigation practices and procedures.[76] The COPUOS Space Debris Mitigation Guidelines contain seven guidelines developed on the basis of the technical content and basic definitions of the IADC Space Debris Mitigation Guidelines.[77] As such, the substance of the COPUOS Guidelines reflects that of the IADC Guidelines.[78] As mentioned earlier, the IADC Space Debris Mitigation Guidelines focus on four areas. COPUOS Guideline 1 reflects the first area and provides that space systems should be designed to avoid or minimise the intentional release of objects during normal operations. COPUOS Guidelines 2, 4 and 5 correspond to the second

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69 Soucek, A. (2015). Historical Background and Context of COPUOS SMD Guidelines. In Hobe S., Schmidt-Tedd, B., & Schrogl K.-U. (Eds.). In *CoCoSL Vol. 3*, p. 614.

70 UN Doc. A/AC.105/890 (6 March 2007), Report of the COPUOS Scientific and Technical Subcommittee on its forty-fourth session, para. 99 & Annex IV.

71 UN Doc. A/62/20 (2007), Report of the COPUOS on its fiftieth session, para. 118.

72 UN Doc. A/RES/62/217 (2007), Resolution adopted by the General Assembly on 22 December 2007, para. 26.

73 Stubbe, P. (2015). SDM Rationale. In *CoCoSL Vol. 3*, p. 624.

74 For COPUOS membership see: <https://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html>.

75 Sec. 3, COPUOS Space Debris Mitigation Guidelines.

76 Ibid.

77 Sec. 2, ibid.

78 For the correspondence between the IADC Space Debris Mitigation Guidelines and the COPUOS Space Debris Mitigation Guidelines see Space Debris Compendium, *supra* note 30, pp. 98-99.

area and they address the minimisation of accidental break-ups during and after operational phases as well as the avoidance of intentional destruction of on-orbit objects and other harmful activities. COPUOS Guidelines 6 and 7 correspond to the third area and address the post-mission disposal of objects in the LEO and GEO regions to limit their long-term inference with these regions. COPUOS Guideline 3 reflects the fourth area and recommends operators to limit the probability of accidental collision in orbit.

The main difference between the space debris mitigation guidelines of the IADC and those of COPUOS is that the former contain more specific technical details while the latter represent "a set of high-level qualitative guidelines".[79] For instance, the IADC Guidelines provide for the 25-year residual lifetime rule and the 90% success rate for the post-mission disposal of LEO objects.[80] In comparison, the COPUOS Guidelines provide only that LEO objects that have terminated their operational phases "should be removed from orbit in a controlled fashion" or at least "be disposed of in orbits that avoid their long-term presence in the LEO region".[81] While the COPUOS guidelines do not provide numerical limitations, the Reference section of the instrument expressly states that "[f]or more in-depth descriptions and recommendations pertaining to space debris mitigation measures, Member States and international organizations may refer to the latest version of the IADC space debris mitigation guidelines and other supporting documents".[82] Therefore, the lack of quantitative measures in the COPUOS Guidelines could be remedied by referring to the IADC Guidelines. Hence, the update of the IADC Guidelines can have practical implications for the implementation of the COPUOS Guidelines.[83]

4.1.1.3 Other International Guidelines and Standards regarding Debris Mitigation

In addition to the space debris mitigation guidelines adopted by the IADC and COPUOS, other international bodies have also developed their guidelines and standards to limit the creation of space debris. Like the COPUOS Space Debris Mitigation Guidelines, the ISO 24113 was also developed on the basis of the IADC Space Debris Mitigation Guidelines. The ISO is an independent, non-governmental international organisation with a membership of 169 national standards bodies.[84] Through its members, the

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79 Sec. 2, COPUOS Space Debris Mitigation Guidelines.
80 Sec. 5.3.2, IADC Space Debris Mitigation Guidelines.
81 Guideline 6, ibid.
82 Sec. 6, ibid.
83 Like the IADC Space Debris Mitigation Guidelines, the COPUOS Space Debris Mitigation Guidelines are also intended as a living document which "will be reviewed and may be revised, as warranted, in the light of new findings", though the instrument has thus far not yet been updated. See Sec. 5 "Updates", COPUOS Space Debris Mitigation Guidelines.
84 ISO. About us. <https://www.iso.org/about-us.html>.

ISO brings together experts to share knowledge and develop voluntary, consensus-based, market-relevant international standards that support innovation and provide solutions to global challenges.[85] Space debris is one of the global challenges that the ISO is dealing with through the publication of international standards and technical reports addressing this matter.

The development of standards typically takes place within the ISO's Technical Committees (TCs) and Sub-Committees (SCs).[86] TC20 "Aircraft and space vehicles" is responsible for the development of internationally accepted standards for aircraft and space vehicles.[87] Its Subcommittee 14 (SC 14) "Space Systems and Operations" is tasked with developing international standards that reflect best practices for space systems and operations.[88] It has developed a family of standards addressing space debris mitigation, which are organised in a hierarchical structure.[89] At the top of the hierarchy is ISO Standard 24113 which was first published in 2010 and updated in 2011, 2019 and 2023. The latest version ISO 24113:2023 "defines the primary space debris mitigation requirements applicable to all elements of unmanned systems launched into, or passing through, near-Earth space".[90] It contains a set of high-level debris mitigation requirements that are intended to reduce the growth of space debris and to minimise casualty risks associated with the atmospheric re-entry of space debris.[91] Detailed processes and implementation measures associated with these requirements are provided in a series of lower-level standards.[92]

The ISO standards serve to "formulate the recommendations contained in the IADC and UN guidelines in such a way that they can be readily applied" from an engineering perspective.[93] As noted by Kato *et al.*, while the international space debris mitigation guidelines "provide a common understanding for the adoption of mitigation measures, they are not necessarily written in a style that is suitable for application in the commercial

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85 Ibid.

86 Ibid.

87 ISO/TC 20 "Aircraft and Space Vehicles". <https://www.iso.org/committee/46484.html>.

88 Stokes, H., Akahoshi, Y., Bonnal, C., Destefanis, R., Gu, Y., Kato, A., Kutomanov, A., LaCroix, A., Lemmens, S., Lohvynenko, A., Oltrogge, D., Omaly, P., Opiela, J., Quan, H., Sato, K., Sorge, M. & Tang, M. (2020). Evolution of ISO's Space Debris Mitigation Standards. *Journal of Space Safety Engineering*, *7*(3), p. 325.

89 Ibid.

90 Sec. 1 "Scope", ISO 24113:2023, *supra* note 21.

91 Foreword, ibid.

92 Ibid.

93 Ibid, p. 2. See also Stokes *et al.* (2020), *supra* note 88, p. 326. Similarly, Oltrogge summarises that ISO standards "exist to codify, in an implementable and verifiable way, what international guidelines seek to accomplish". See Oltrogge, D. (2019). Space Standards at the ISO Level. *ESA-ECSL Space Debris Workshop: Regulation, Standards and Tools*, p. 13. <https://conference.sdo.esoc.esa.int/proceedings/ecsl19/paper/5>.

world", which "can lead to differences in interpretation".[94] To enhance the standardisation of implementation, these guidelines need to be translated "into a set of measurable and verifiable requirements to minimise the creation of debris during the launch, operation, and disposal of space systems".[95] This challenge is addressed by the ISO, which has developed standards that can be applied in a variety of ways, including voluntary implementation by space operators, introduction in commercial contracts, and incorporation into the national and international mechanisms relating to space debris mitigation measures. Specifically, the European Coordination on Space Standardization (ECSS) adopted the ISO 24113:2011 as the ECSS-U-AS-10C standard in 2012.[96] Following the updates of the ISO 24113 in July 2019 and May 2023, the ECSS-U-AS-10C was also revised accordingly, first in December 2019 and later in February 2024, adopting the requirements of the updated ISO 24113 with a few modifications and additions to accommodate the needs of the ECSS members.[97]

Another international forum for the development of space debris mitigation measures is the ITU, which is the UN specialised agency for information and communication technologies.[98] Communication through radio links is essential for space operations, which are needed not only for the connection between a space object and its mission control centre for Telemetry, Tracking and Command (TT&C), but also for the execution of missions assigned to the space object such as navigation and Earth observation.[99] Hence, it is important for space operators to have "reliable and interference-free radio connection for their space assets and services".[100] In this regard, the ITU, through its Radiocommunication Sector (ITU-R), and its executive arm, the Radiocommunication Bureau (BR), is the global agency responsible for the management of radio-frequency spectrum and satellite orbit resources.[101]

In December 2010, the ITU-R published Recommendation ITU-R S.1003-2 (12/2010) "*Environmental protection of the geostationary-satellite orbit*", which

94 Kato, A., Lazare, B., Oltrogge, D., & Stokes, P. H. (2013). Standardization by ISO to ensure the sustainability of space activities. *Proceedings of the 6th European Conference on Space Debris*, p. 1.

95 Ibid.

96 Space Debris Compendium, *supra* note 30, p. 92.

97 ECSS-U-AS-10C Rev.2 – Adoption Notice of ISO 24113: Space systems – Space debris mitigation requirements (9 February 2024). See also Ventura, S. (21 September 2021). ESA Space Debris Mitigation and Re-entry Safety Framework – Status and Novelties. *Presentation at ESA Clean Space Industrial Days*, p. 2. <https://indico.esa.int/event/321/contributions/6330/attachments/4389/>.

98 ITU. About ITU. <https://www.itu.int/en/about/>.

99 Masson-Zwaan & Hofmann (2019), *supra* note 2, p. 133.

100 Ibid.

101 ITU. (Updated October 2021). ITU-R: Managing the Radio-Frequency Spectrum for the World. <https://www.itu.int/en/mediacentre/backgrounders/Pages/itu-r-managing-the-radio-frequency-spectrum-for-the-world.aspx>.

"provides guidance about disposal orbits for satellites in the geostationary-satellite orbit and comments on the increase in debris due to fragments resulting from increased numbers of satellites and their associated launches".[102] The document, which applies to the operation of satellites in the GEO, is addressed to ITU Member States.[103] As a recommendation of the ITU Radiocommunication Assembly, ITU-R S.1003.2 is not legally binding.[104] It describes the GEO as "a unique resource that offers significant benefits to operators" for its physical characteristics and associated usability and recognises that the proliferation of space debris in this orbit would increase collision risks, which may damage or degrade the telecommunications functions of satellites.[105] Focusing on the environmental protection of the GEO region, ITU-R S.1003-2 provides the following four recommendations to limit the accumulation of non-functional objects in GEO:

1. Minimise debris released into the GEO region during the placement of a satellite in orbit;
2. Strive to shorten the lifetime of debris in elliptical transfer orbits with the apogees at or near GEO altitude;
3. Remove decommissioned satellites above to a graveyard orbit;
4. Carry out the removal to graveyard orbit with particular caution in order to avoid radio frequency interference with active satellites.[106]

In addition to the international mechanisms regarding space debris mitigation with more or less a global outreach, efforts have also been taken at the regional level to limit the generation of space debris. On 28 June 2004, ESA and four major national space agencies in Europe, namely the Italian Space Agency (ASI), the British National Space Center (BNSC)[107], the French Space Agency (CNES) and the German Aerospace Agency (DLR), adopted the European Code of Conduct for Space Debris Mitigation.[108] The ECoC is consistent with the IADC Space Debris Mitigation Guidelines while providing greater technical detail and explanations.[109] The application of the ECoC "is voluntary and should be applied by the European Space Agency,

102 ITU-R S.1003.2 (12/2010), p. 1. This document was first adopted in 1993 as ITU-R S.1003-0 (04/93), revised in 2004 as S.1003-1 (01/2004), and later revised in 2010 as ITU-R S.1003.2 (12/2010). The text of the document is available at: <https://www.itu.int/rec/R-REC-S.1003/en>.

103 Space Debris Compendium, *supra* note 30, p. 101. The ITU has currently 193 member States, which is virtually universal membership. *See* ITU. List of ITU Member States. <https://www.itu.int/en/ITU-R/terrestrial/fmd/Pages/administrations_members.aspx>.

104 Ibid. ITU-R Recommendations are approved by ITU Member States. Their implementation is not mandatory; however, they enjoy a high reputation and are implemented worldwide. See ITU. ITU-R Recommendations. <https://www.itu.int/pub/R-REC>.

105 ITU-R S.1003.2 (12/2010), *supra* note 102, p. 1.

106 Ibid.

107 The BNSC was replaced on 1 April 2010 by the United Kingdom Space Agency (UKSA).

108 Space Debris Compendium, *supra* note 30, p. 103.

109 Ibid.

by national space agencies within Europe and their contractors".[110] The signing agencies also recommend the application of the ECoC "by any other space project conducted in Europe, or by a European entity acting outside Europe, including operators".[111]

In order to tailor the ECoC to the needs of ESA projects, ESA developed the "Requirements for Space Debris Mitigation for ESA Projects" (ESA/ADMIN/IPOL(2008)2), which came into force on 1 April 2008.[112] This 2008 document was superseded in 2014 by the administrative instruction "Space Debris Mitigation Policy for Agency Projects" of the ESA Director General.[113] In November 2023, as part of ESA's Zero Debris approach that sets out the Agency's goal to significantly limit the generation of space debris by 2030, ESA updated its Space Debris Mitigation Policy.[114] The objectives of the new Policy are to carry out space activities in an environmentally sustainable manner, preserve space for future generations and work towards "zero debris" by 2030.[115] To achieve these objectives, the 2023 Policy states that it is ESA's policy and commitment to, *inter alia*, mitigate space debris and implement the COPUOS Space Debris Mitigation Guidelines.[116]

The above discussion shows that the international instruments regarding space debris mitigation are closely connected, which is reflected in the fact that some instruments served as the basis for the development of others as well as the express cross-reference among these instruments. As Dupuy submits, "repetition" plays an influential role in the development of soft law, especially "in the international environmental 'soft' law-making process".[117] More specifically, "[c]ross-reference from one institution to another, the recalling of guidelines adopted by other apparently concurrent international authorities, recurrent invocation of the same rules formulated

110 Art. 2.2, the ECoC.

111 Ibid.

112 Klinkrad, H. & Bohlmann, U. (2009). Requirements on Space Debris Mitigation for ESA Projects. *Presentation to the 48th session of the Legal Subcommittee of the UN COPUOS*, p. 3. <https://www.unoosa.org/pdf/pres/lsc2009/pres-07.pdf>. See also ESA. Mitigating Space Debris Generation. <https://www.esa.int/Safety_Security/Space_Debris/Mitigating_space_debris_generation>.

113 ESA, Space Debris Mitigation Policy for Agency Projects, issued on 28 March 2014, ESA/ADMIN/IPOL(2014)2.

114 ESA. ESA Space Debris Mitigation Policy, issued on 3 November 2023, ESA/ADMIN/IPOL(2023)1. The text of the document is available at <https://technology.esa.int/upload/media/ESA-ADMIN-IPOL-2023-1-Space-Debris-Mitigation-Policy-Final.pdf>. See also ESA. New Space Debris Mitigation Policy and Requirements in effect. <https://esoc.esa.int/new-space-debris-mitigation-policy-and-requirements-effect>. ESA. ESA's Zero Debris Approach. <https://www.esa.int/Space_Safety/Clean_Space/ESA_s_Zero_Debris_approach>.

115 Sec. 2, ESA Space Debris Mitigation Policy (2023).

116 Ibid.

117 Dupuy, P.-M. (1991). Soft Law and the International Law of the Environment. *Michigan Journal of International Law*, *12*(2), p. 424.

in one way or another at the universal, regional and more restricted levels, all tend progressively to develop and establish a common international understanding".[118] Hence, while the international instruments on space debris mitigation have different addressees and focuses, their close connection and overall consistency enhance their power to steer the behaviour of States towards the limitation of debris creation.

4.1.1.4 Application of the Space Debris Mitigation Guidelines to ADR Activities

The space debris mitigation guidelines, as their titles suggest, focus on limiting the future generation of space debris. The mitigation of space debris is indispensable for controlling the growth of space debris, for the positive effects resulting from future ADR missions could be offset if space activities fail to effectively limit the creation of more debris. In the meantime, as mentioned in Chapter 2, debris mitigation measures alone are insufficient to halt the continued increase of space debris, for the debris population is projected to continue growing even without any new launches, because collisions among existing objects in orbit will generate additional debris according to the Kessler syndrome. Therefore, debris remediation is also necessary to stabilise the orbital environment, and international instruments regarding ADR need to be developed like the space debris mitigation guidelines.

While the current space debris mitigation guidelines do not expressly address ADR, they still bear some relevance to the issue. First, with regard to the post-mission disposal of objects passing through the LEO region, the IADC Space Debris Mitigation Guidelines provide that: "Retrieval is also a disposal option."[119] The *Support to the IADC Space Debris Mitigation Guidelines* sheds further light on the feasibility of this option.[120] This document explains that with the current technology, the option of on-orbit retrieval is not feasible for most spacecraft owners and/or operators.[121] Therefore, "until such time that direct retrieval is a more commonly available option (perhaps by robotic means), this is not a practical solution".[122] As noted by the US FCC, direct retrieval means "the use of one spacecraft to retrieve another from orbit", which includes ADR activities.[123] Therefore, while at the current stage, ADR technologies might not be sufficiently mature to be employed as a commonly accessible post-mission disposal strategy at a large scale, ADR may likely become an available option for the removal of end-of-mission spacecraft out of congested orbital areas with technological advances in the future. To support future direct retrieval operations, it

118 Ibid.
119 Sec. 5.3.2, IADC Space Debris Mitigation Guidelines.
120 Support to the IADC Space Debris Mitigation Guidelines, *supra* note 32.
121 Ibid, p. 32.
122 Ibid.
123 FCC 20-54 (2020), *supra* note 15, para. 106.

would be helpful if newly launched spacecraft and launch vehicle orbital stages could be more ADR-ready, e.g., to equip these objects with interfaces that may facilitate their removal from orbit after the termination of their operational phases.

In addition to the consideration of ADR as a potential post-mission disposal option for objects passing through the LEO region, the space debris mitigation guidelines are also relevant to ADR activities when it comes to the limitation of the generation of space debris as a result of ADR operations per se. As noted earlier, ADR is needed to control the growth of space debris because the current number of debris in Earth orbit is large enough to trigger the self-sustaining collisional cascading process of space debris. Therefore, it would run afoul of the purpose of ADR activities if these activities generate even more amount of space debris. Hence, ADR activities should also comply with the space debris mitigation guidelines like other space activities, and arguably even more so because ADR is intended to clean up rather than adding to the mess that has already been created in space. In fact, the FCC affirms expressly that its orbital debris mitigation rules apply to all spacecraft operators seeking licenses from the FCC, including operators of In-Space Servicing, Assembly, and Manufacturing (ISAM) systems such as ADR spacecraft.[124]

The application of the space debris mitigation guidelines to ADR activities can be assessed from all four categories of debris mitigation measures contained in the IADC Space Debris Mitigation Guidelines.[125] As to the limitation of debris released during normal operations, it is important to recall once again that ADR activities are intended to ameliorate rather than deteriorate the space debris situation. Therefore, if by mission design, it can be expected that a certain amount of space debris is planned to be released in an ADR operation, the State engaging in such operation would need to assess whether it is worthy to proceed with the operation from an environmental protection perspective.

With regard to the minimisation of on-orbit break-ups, a potential risk is the accidental explosion of the target object. The existing debris objects in space are mostly not designed for removal, and their physical states may be unknown after years in space. In fact, the harsh space environment can degrade the materials and structures of debris objects, making them fragile

124 According to the FCC, "[a] specific sub-category of ISAM missions are those performing a remediation or removal function for preexisting space debris". See FCC. (8 August 2022). *Facilitating Capabilities for In-space Servicing, Assembly, and Manufacturing*. FCC 22-66, para. 29. <https://docs.fcc.gov/public/attachments/FCC-22-66A1.pdf>.

125 See Section 4.1.1.1 *supra*.

to physical contact or sudden manipulation.[126] Objects such as defunct orbital stages and derelict spacecraft failing to be fully passivated may have residual fuel or stored energies onboard which could possibly trigger the explosion of these objects if disturbed.[127] This kind of risk should be duly taken into account by ADR operators when selecting removal targets and designing mission profiles.

With regard to post-mission disposal, NASA Standard 8719.14C points out that the use of atmospheric re-entry to limit the orbital lifetime of space structures in compliance with post-mission disposal requirements "results in the transfer of an orbital environment risk to a potential human casualty risk".[128] Similarly, when an ADR operation is performed to de-orbit from LEO a target object with a very long orbital lifetime, such operation also shifts on-orbit collision risks to human casualty risks on Earth.[129] Therefore, the casualty risks resulting from ADR operations should be limited, following the same rationale to limit the re-entry risks associated with the end-of-mission disposal of LEO objects.[130] When it comes to GEO objects, the post-mission disposal strategy is to re-orbit these objects to a graveyard orbit in order to avoid their long-term interference with the GEO region. China's Shijian-21 mission has proven the technical feasibility of using ADR to clean up defunct spacecraft in GEO.[131] Remarkably, the mission relocated the target debris object to an orbit 3,000 km above the GEO belt, an altitude far higher than the usual graveyard orbit around 300 km above GEO, which has effectively moved it out of harm's way.[132]

Finally, as ADR activities may involve close proximity operations and physical contact between the removal spacecraft and the target debris object, limiting the probability of accidental collision between them is a key consideration in mission design and operations.[133] Therefore, it is essential for ADR operators to develop and employ reliable strategies to safely de-spin, capture and control their target debris objects. In addition, ADR operators should take reasonable measures to estimate and limit the risk of accidental collision with space objects of third parties during mission operations.

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126 Weeden, B. (2011). Overview of the Legal and Policy Challenges of Orbital Debris Removal. *Space Policy*, *27*(1), p. 41.

127 Ibid.

128 Sec. 4.7.1.1, NASA Standard 8719.14C, "*Process for Limiting Orbital Debris*", approved 5 November 2021.

129 Liou, J.-C., Kieffer, M., Drew, A., & Sweet, A. (2020). Project Review: The 2019 U.S. Government Orbital Debris Mitigation Standard Practices. In *Orbital Debris Quarterly News*, *24*(1), p. 7.

130 Ibid.

131 See Chapter 2 Section 2.3.1.

132 Andrew, J. (27 January 2022). China's Shijian-21 towed dead satellite to a high graveyard orbit. *SpaceNews*. <https://spacenews.com/chinas-shijian-21-spacecraft-docked-with-and-towed-a-dead-satellite/>.

133 Liou *et al.* (2020), *supra* note 129, p. 7.

4.1.1.5 *Implementation of the Space Debris Mitigation Guidelines and Standards at the National Level*

As Martinez submits, "although soft law instruments are *non-binding*, this does not mean they are *non-legal*", for States may choose to implement the norms contained in these instruments in their national regulatory frameworks for space activities.[134] In other words, while the international space debris mitigation guidelines do not have binding force under international law, States may decide to make them binding in their national legal order and require private entities to comply with these guidelines as a licensing condition. Reference can be made to the UN General Assembly resolution 68/74 of 11 December 2013, which provides a set of recommendations on the development of national legislation applicable to the peaceful exploration and use of outer space.[135] The resolution refers explicitly to space debris by noting "the need to maintain the sustainable use of outer space, in particular by mitigating space debris, and to ensure the safety of space activities and minimize the potential harm to the environment".[136] The resolution further recommends that licensing conditions should help to ascertain that space activities are carried out in a safe manner and do not lead to harmful interference with other space activities.[137] To this end, States should verify the experience, expertise and technical qualifications of the applicants and may include in the licensing conditions safety and technical standards that are in line, in particular, with the COPUOS Space Debris Mitigation Guidelines.[138]

In fact, as COPUOS notes, many States and international intergovernmental organisations are implementing space debris mitigation measures in line with the COPUOS Space Debris Mitigation Guidelines, and a number of States have harmonised their national space debris mitigation standards with these guidelines.[139] COPUOS also notes that some States are using the COPUOS Space Debris Mitigation Guidelines as well as the guidelines and standards developed by the IADC, ISO and ITU as reference points in their regulatory frameworks for national space activities.[140] COPUOS further urges those countries that have not yet done so to consider implementing the COPUOS Space Debris Mitigation Guidelines on a voluntary basis.[141] With the continuous growth of private space activities, the implementation

134 Martinez, P. (2020). The Role of Soft Law in Promoting the Sustainability and Security of Space Activities. *Journal of Space Law*, *44*(2), p. 530.
135 UN Doc. A/RES/68/74 (2013), *supra* note 13.
136 Preamble, ibid.
137 Recommendation 4, ibid.
138 Ibid.
139 A/77/20 (2022). Report of the Committee on the Peaceful Uses of Outer Space on its sixty-fifth session, para. 97.
140 Ibid, para. 98.
141 Ibid, para. 96.

of international mechanisms at the national level will play an increasingly important role in their regulation. Reference can be made to the Space Debris Compendium, where many States have affirmed their support and adherence to the international space debris mitigation guidelines and standards, especially those of the IADC and COPUOS.[142]

While the incorporation of the international space debris mitigation guidelines into national legal order by many States shows a wide acceptance within the international community of these guidelines, an examination of the rate of practical compliance indicates that more efforts are needed to ensure effective adherence to these guidelines. Reference can be made to the *IADC Report on the Status of the Space Debris Environment* published in January 2023 ("IADC Report of 2023"), which aims to verify the effect of IADC Space Debris Mitigation Guidelines in practice and to monitor their level of implementation.[143] The key finding of this IADC Report is that:

> "The widespread adoption of the IADC space debris mitigation guidelines […] continue to remain the most effective method to reduce the long-term environmental impacts of global space activity by slowing the rate of growth of the space debris population observed. However, the adoption of the IADC space debris mitigation guidelines is not yet at a level that is sufficient to induce substantial benefits or slowing of the population growth."[144]

A similar observation is made in the *ESA's Annual Space Environment Report* published in September 2023 ("ESA Report of 2023"), which aims to provide a transparent overview of the ongoing global debris mitigation efforts.[145] According to the ESA Report:

> "Whereas adoption of, and compliance to, space debris mitigation practices at a global level is noted as slowly increasing, it is of importance to note that the successful implementation is still at a too low level to ensure a sustainable environment in the long-run."[146]

In particular, one of the core principles of the space debris mitigation guidelines is to remove end-of-mission objects from the LEO and GEO protected regions with a probability of success of at least 90% for those orbits where a natural disposal mechanism is absent.[147] Naturally compliant means that "[s]pace objects that operate in an orbit such that they naturally re-enter

142 Space Debris Compendium, *supra* note 30.
143 IADC. (2023). *IADC Report on the Status of the Space Debris Environment*. IADC-23-01.
144 Ibid, p. 6.
145 ESA. (12 September 2023). *ESA's Space Environment Report 2023*, p. 3. The document is available at: <https://www.esa.int/Space_Safety/ESA_s_Space_Environment_Report_2023>.
146 Ibid, p. 8.
147 IADC Report of 2023, *supra* note 143, p. 6.

within 25 years (i.e., without requiring any manoeuvre)".[148] Most objects deployed below the altitude of 600 km will generally decay within 25 years at the end of their mission.[149] According to the IADC Report of 2023, the general "[p]ost mission disposal compliance remains low".[150] This is problematic because unsuccessfully disposed spacecraft and launch vehicle orbital stages provide the mass to trigger and sustain a collisional cascade of objects in orbit.[151]

According to the IADC Report of 2023, between 45% and 90% of all spacecraft reaching end-of-life for any given year in the last decade in LEO are in compliance with the post-mission disposal measures, with the compliance trend increasing.[152] However, this increase is mainly due to the growth of spacecraft placed in naturally compliant orbits.[153] When it comes to non-naturally compliant spacecraft, the compliance rate is only between 10% to 40%.[154] As to end-of-mission rocket bodies in the LEO region, the IADC Report finds that between 30% and 90% of them are in compliance with the recommended post-mission disposal measures during the last decade, with an increasing compliance trend mainly due to an increasing number of spacecraft delivered to naturally compliant orbits.[155] Similar figures are provided in the ESA Report of 2023.[156] The finding in a Report published by the NASA OIG in 2021 seems even more concerning.[157] According to this Report, over the last decade, the global compliance rate for spacecraft and rocket bodies with the 25-year post-mission disposal rule has only averaged between 20% to 30%, much lower than the 90% success rate set in the international space debris mitigation guidelines.[158] The Report further notes that compliance with post-mission disposal guidelines "will have greater impact on mitigating the risks of orbital debris than pursuing the development of costly remediation technologies".[159] Hence, to stabilise the orbital environment, space operators should significantly increase their compliance with the 25-year rule.

With regard to the situation in GEO, the IADC Report of 2023 finds that between 85% and 100% of all spacecraft in the GEO region reaching end-of-

148 Ibid, p. 4.
149 Lewis, H. G. (2020). Evaluation of Post-Mission Disposal Options for a Large Constellation. *Journal of Space Safety Engineering*, *7*(3), p. 192.
150 IADC Report of 2023, *supra* note 143, p. 6.
151 Support to the IADC Space Debris Mitigation Guidelines, *supra* note 32, p. 30.
152 IADC Report of 2023, *supra* note 143, p. 6.
153 Ibid.
154 Ibid.
155 Ibid.
156 ESA Report of 2023, *supra* note 145, p. 7.
157 NASA OIG. (2021). *NASA's Efforts to Mitigate the Risks Posed by Orbital Debris*. Report No. IG-21-011.
158 Ibid, p. 17.
159 Ibid.

life during the last decade attempt to comply with the disposal guidelines and between 60% and 90% do so successfully, with the compliance trend asymptotically increasing.[160] The same figures can also be found in the ESA Report of 2023.[161] Meanwhile, the compliance rate of rocket bodies in GEO appears less satisfactory. According to the IADC Report of 2023, between 20% and 70% of the orbital stages delivering spacecraft in or near the GEO region during the last decade are in compliance with the recommended disposal measures, with the compliance trend also increasing.[162] Similarly, the compliance rate for the post-mission disposal of GEO orbital stages found in the ESA Report is between 40% and 50%.[163]

The above figures show that more ambitious efforts are needed to ensure the proper disposal of spacecraft and launch vehicles at the end of their missions. As well summarised by ESA: "The adoption of space debris mitigation measures is improving, but, given the sheer number of new satellites and amount of existing debris, the rate is still not enough and our behaviour in space appears to be unsustainable in the long term."[164] Hence, it is important for States to ensure that their space activities are carried out in compliance with the space debris mitigation guidelines and to make stronger commitments to preserve the outer space environment.

4.1.2 The LTS Guidelines

An issue closely connected to space debris mitigation is the long-term sustainability of outer space activities. While the UN has addressed the concept of sustainable development on Earth for over four decades, the extension of this concept to outer space is a more recent development.[165] With the increasing dependence of humankind on space assets and applications, the issue of long-term sustainability for outer space activities has attracted growing attention within the international community.[166] This culminated in the adoption by COPUOS of twenty-one LTS Guidelines in 2019, which provide insights into the practical steps that can be taken to enhance the

160 IADC Report of 2023, *supra* note 143, p. 6.
161 ESA Report of 2023, *supra* note 145, p. 7.
162 IADC Report of 2023, *supra* note 143, p. 6.
163 ESA Report of 2023, *supra* note 145, p. 7.
164 ESA (2023), *supra* note 145.
165 Martinez (2020), *supra* note 134, p. 537. The first commonly recognised definition of "sustainable development" was provided in the 1987 Brundtland Report: "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future". See Brundtland, G. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. UN Doc. A/42/427 (4 August 1987).
166 Preamble of the LTS Guidelines, para. 5.

sustainability of outer space activities.[167] Space sustainability is closely related to ADR because, as mentioned in Chapter 2, ADR operations are needed to stabilise the amount of space debris, which is a critical threat to the long-term sustainability of outer space activities. Section 4.1.2.1 will introduce the development of the LTS Guidelines, including how the issue of ADR was addressed in this process. Section 4.1.2.2 will analyse the relevance of the adopted LTS Guidelines to ADR, and Section 4.1.2.3 will discuss the implementation of the LTS Guidelines.

4.1.2.1 Development of the LTS Guidelines

At its forty-seventh session in February 2010, the COPUOS STSC established the Working Group on the Long-term Sustainability of Outer Space Activities ("LTS Working Group").[168] The Working Group was tasked with producing a report on the long-term sustainability of outer space activities and a consolidated set of voluntary and non-legally binding guidelines to enhance the long-term sustainability of outer space activities for all space actors and all beneficiaries of space activities.[169] To expedite its work, the LTS Working Group established four expert groups:

Expert Group A: "Sustainable space utilization supporting sustainable development on Earth";
Expert Group B: "Space debris, space operations and tools to support collaborative space situational awareness";
Expert Group C "Space Weather"; and
Expert Group D: "Regulatory regimes and guidance for actors in the space arena".[170]

The task of the expert groups was to provide inputs for the consideration of the LTS Working Group, which would then take necessary decisions.[171] This approach established a clear separation "between the expert groups as technical deliberative fora and the Working Group as a diplomatic negotiation

167 UN Doc. A/AC.105/C.1/2023/CRP.31/Rev.2 (16 February 2023). A practical and inclusive approach to identifying and studying challenges and considering possible new guidelines: Conference room paper submitted by Canada, Italy, Japan, Luxembourg, New Zealand, the United Kingdom of Great Britain and Northern Ireland and the United States of America, para. 2.

168 UN Doc. A/AC.105/958 (11 March 2020). Report of the COPUOS Scientific and Technical Subcommittee on its forty-seventh session, para. 181. For a detailed overview of the early phase of the discussions on the concept of space sustainability in COPUOS see Brachet, G. (2012). The Origins of the "Long-term Sustainability of Outer Space Activities" Initiative at UN COPUOS. *Space Policy*, *28*(3), pp. 161-165.

169 UN Doc. A/AC.105/2018/CRP.22/Rev.1 (28 June 2018), Report of the Working Group on the Long-term Sustainability of Outer Space Activities: Working paper by the Chair of the Working Group, para. 7.

170 Ibid, para. 15.

171 Martinez, P. (2021). The UN COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities. *Journal of Space Safety Engineering*, *8*(1), p. 99.

forum within COPUOS".[172] The four expert groups delivered their reports in 2014, providing proposed candidate guidelines and issues for further consideration. The finalisation of these reports marked the transfer of the discussion of the guidelines from the expert groups to the LTS Working Group.[173]

The issue of space debris was expressly addressed by *Expert Group B*. In its final report, Export Group B noted that "[c]oncepts for removing large debris from low earth orbit have been proposed since the early 1980s".[174] However, "reviews by panels of international experts have repeatedly failed to identify a single [removal] plan which is both technically feasible in the near-term and economically viable", and thus additional studies on this issue were needed.[175] Hence, Expert Group B concluded that "there is currently no established practice for space debris removal that can serve as the basis for a recommended guideline".[176] Expert Group B also pointed out that space debris mitigation measures alone might not be sufficient to limit the growth of the future space debris population and suggested States to move forward with concepts for ADR.[177] In addition to the draft guidelines proposed by the expert groups, a number of COPUOS member States also proposed draft guidelines for consideration by the LTS Working Group.[178] In particular, while Expert Group B did not propose any ADR-specific guidelines, Russia proposed draft guidelines addressing the issue of ADR, which provide recommendations regarding the safety of ADR operations.[179]

At its fifty-ninth session in 2016, COPUOS agreed on the first set of LTS Guidelines and extended the mandate of the LTS Working Group to June 2018.[180] The Working Group concluded its work by the end of this mandate, reaching consensus on nine additional guidelines and a preambular text. At its sixty-second session in 2019, COPUOS adopted the preamble and a

172 Ibid.

173 UN Doc. A/AC.105/1088 (27 February 2015), Report of the Scientific and Technical Subcommittee on its fifty-second session, Annex III, para. 7.

174 UN Doc. A/AC.105/2014/CRP.14 (16 June 2014), Working Report of Expert Group B: Space Debris, Space Operations and Tools to Support Collaborative Space Situational Awareness, p. 27.

175 Ibid.

176 Ibid.

177 Ibid.

178 Martinez (2020), *supra* note 134, p. 538.

179 UN Doc. A/AC.105/L.290 (4 March 2014). Long-term sustainability of outer space activities – Working paper submitted by the Russian Federation, pp. 6-7. UN Doc. A/AC.105/L.296 (30 April 2015), Additional considerations and proposals for building up understanding of the priority aspects, comprehensive meaning and functions of the concept and practices of ensuring the long-term sustainability of outer space activities – Working paper submitted by the Russian Federation, p. 11.

180 UN Doc. A/71/20 (2016). Report of the COPUOS on its fifty-ninth session, para. 130 & Annex.

comprehensive set of twenty-one LTS Guidelines, and "encouraged States and international intergovernmental organizations to voluntarily take measures to ensure that the guidelines are implemented to the greatest extent feasible and practicable".[181] Besides these twenty-one adopted guidelines, there are another seven draft guidelines for which consensus could not be reached by the LTS Working Group within the term of its mandate. These remaining guidelines, including the draft guideline regarding ADR originally proposed by Russia, are contained in a separate document.[182] As political tensions marked the discussions throughout the mandate of the LTS Working Group, it was more difficult to achieve consensus on the draft guidelines addressing more sensitive topics such as ADR.[183]

At the same session where the twenty-one LTS Guidelines were adopted, COPUOS decided to establish, under a five-year workplan, a new working group under the agenda item of the long-term sustainability of outer space activities of its Scientific and Technical Subcommittee ("LTS 2.0 Working Group").[184] COPUOS further decided that the Working Group would be guided by the following framework:
(a) Identifying and studying challenges and considering possible new guidelines for the long-term sustainability of outer space activities. This could be done by taking into consideration existing documents including, inter alia, documents A/AC.105/C.1/L.367 and A/AC.105/2019/CRP.16;
(b) Sharing experiences, practices and lessons learned from voluntary national implementation of the adopted guidelines;
(c) Raising awareness and building capacity, in particular among emerging space nations and developing countries.[185]

The explicit inclusion of UN document A/AC.105/C.1/L.367 into the guiding framework for the LTS 2.0 Working Group indicates that the draft guideline regarding ADR would be considered by this new working group in its future work. This draft guideline will be discussed in more detail in Chapter 5 in the context of the future development of international guidelines to address ADR activities.

181 UN Doc. A/74/20 (2019). Report of the COPUOS on its sixty-second session, para. 163.
182 UN Doc. A/AC.105/C.1/L.367 (16 July 2018), Draft Guidelines for the Long-term Sustainability of Outer Space Activities: Working paper by the Chair of the Working Group on the Long-term Sustainability of Outer Space Activities.
183 Masson-Zwaan & Hofmann (2019), *supra* note 2, p. 117. See also Martinez, P. (2018). Development of an International Compendium of Guidelines for the Long-Term Sustainability of Outer Space Activities. *Space Policy*, *43*, p. 16.
184 UN Doc. A/74/20 (2019), *supra* note 181, para. 165.
185 Ibid, para. 167.

4.1.2.2 Relevance of the LTS Guidelines to ADR

The twenty-one LTS guidelines address the policy, regulatory, operational, safety, scientific, technical, international cooperation and capacity-building aspects of space activities.[186] They are grouped into four categories: (A) Policy and regulatory framework for space activities; (B) Safety of space operations; (C) International cooperation, capacity-building and awareness; and (D) Scientific and technical research and development. These guidelines are not legally binding under international law, and States and international intergovernmental organisations are encouraged to voluntarily take measures to ensure their implementation to the greatest extent feasible and practicable, in accordance with their respective needs, conditions and capabilities.[187] Each guideline is composed of "a short action-oriented title text that summarizes the main intent of a given guideline, followed by several paragraphs of more detailed recommendatory text to support the implementation of the guideline".[188]

The adoption of the LTS Guidelines can be seen as "an important milestone" in the work of COPUOS to ensure that all nations can continue to benefit from the exploration and use of outer space over the long term.[189] The issue of space debris is expressly addressed in the LTS Guidelines. For example, Guideline A.2 recommends States to implement debris mitigation measures, such as those contained in the COPUOS Space Debris Mitigation Guidelines, when developing and revising national regulatory frameworks for outer space activities. However, the LTS Guidelines do not directly address the issue of ADR, though several guidelines are relevant to this issue to varying degrees. The following sections will assess four LTS Guidelines of close relevance in this regard to illustrate how the current long-term sustainability guidelines may support debris removal activities.

4.1.2.2.1 LTS Guideline D.2

Guideline D.2 "*Investigate and consider new measures to manage the space debris population in the long term*" may be seen as the guideline most relevant to ADR activities. It recommends States and international organisations to investigate new measures, including technological solutions, and consider the implementation thereof, in order to manage the space debris population in the long term.[190] Investigation of new measures could include, among others, methods for the extension of operational lifetime, novel techniques to prevent collisions with and among non-manoeuvrable objects, advanced

186 Preamble of the LTS Guidelines, para. 11.
187 Ibid, paras. 15-16.
188 Martinez (2021), *supra* note 171, p. 102.
189 UN Doc. A/AC.105/C.1/2023/CRP.31/Rev.2 (2023), *supra* note 167, para. 2.
190 LTS Guideline D.2, para. 1.

measures for spacecraft passivation and post-mission disposal, and designs to enhance the disintegration of space objects during re-entry.[191]

In reporting its implementation of this guideline, ESA refers to its ADR mission Clearspace-1 to de-orbit an ESA-owned space debris, which will, according to ESA, "pave the way to more ADR missions as well as commercial services for in-orbit servicing including management of end of life of future constellations".[192] Similarly, when sharing its implementation practices regarding this guideline, Japan notes that JAXA carries out research and development on space debris mitigation and removal.[193] It further proposes to form "a forward-looking international consensus on transparency and safety assurance to encourage private sectors to implement space debris removal activities".[194] The sharing of debris removal practices in the context of Guideline D.2 indicates that ADR can be regarded as an advanced measure to address the problem of space debris.[195]

Guideline D.2 also recommends that the "new measures aimed at ensuring the sustainability of space activities and involving either controlled or uncontrolled re-entries should not pose an undue risk to people or property". While not explicitly referring to ADR, this guideline stresses the need to limit the risk to the ground in the design and implementation of de-orbiting operations. Hence, ADR operators should duly assess and mitigate the risk to the ground when de-orbiting objects from the LEO region.

4.1.2.2.2 LTS Guideline B.8

Guideline B.8 "*Design and operation of space objects regardless of their physical and operational characteristics*" provides two key recommendations relevant to space debris and ADR. Firstly, it recommends States and international organisations to encourage manufacturers and operators of space objects "to design such objects to implement applicable international and national space debris mitigation standards and/or guidelines in order to limit the long-term presence of space objects in protected regions of outer space after the end of their mission".[196] It also encourages the sharing of "experiences and information on the operation and end-of-life disposal of space objects,

191 Ibid, para. 2.
192 UN Doc. A/AC.105/C.1/2022/CRP.14/Rev.1 (7 February 2022), Report on the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities in the European Space Agency, p. 13.
193 UN Doc. A/AC.105/C.1/2023/CRP.28 (8 February 2023). Report on the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities in Japan, p. 17.
194 Ibid.
195 Weeden, C., Blackerby, C., Forshaw, J., Martin, C., Lopez, R., Yamamoto, E., & Okada, N. (2019). Development of Global Policy for Active Debris Removal Services. *First International Orbital Debris Conference*, p. 4.
196 LTS Guideline B.8, para. 2.

in furtherance of the long-term sustainability of space activities".[197] The explicit reference to the international space debris mitigation guidelines, especially the post-mission disposal measures, underlines the importance of these guidelines and measures to space sustainability.

Secondly, Guideline B.8 encourages States and international intergovernmental organisations to "promote design approaches that increase the trackability of space objects, regardless of their physical and operational characteristics, including small-size space objects, and those that are difficult to track throughout their orbital lifetime, as well as facilitate the accurate and precise determination of their position in orbit".[198] Similar recommendations to enhance the trackability of space objects can also be found in the *IADC Statement on Large Constellations of Satellites in Low Earth Orbit* updated in 2021, which recommends constellation operators to enhance the trackability of their satellites by adding on-board components that can improve the orbit determination and prediction.[199] According to the IADC Statement, this would have a positive impact on conjunction analysis.[200]

The recommendation to increase the trackability of space objects is relevant to ADR because this could enhance the safety and effectiveness of missions to locate and capture these objects.[201] The ability to be tracked can be improved by incorporating cooperative servicing interfaces such as optical fiducial markers and beacons.[202] Hence, satellite operators may consider increasing the trackability of their satellites by installing these interfaces to their satellites. As a practice to implement Guideline B.8, ESA is developing technologies "targeting add-ons for small spacecraft to improve the capability of ground surveillance systems to track them ('design to track') and to provide identification means".[203]

4.1.2.2.3 LTS Guideline B.1

Guideline B.1 "*Provide updated contact information and share information on space objects and orbital events*" focuses on the exchange of orbital information to enhance space safety. More specifically, it recommends States and international intergovernmental organisations to voluntarily exchange the contact information on their designated entities authorised to engage in information exchange and conjunction assessment, through UNOOSA or

197 Ibid.

198 Ibid, para. 1.

199 IADC. (2021). *IADC Statement on Large Constellations of Satellites in Low Earth Orbit*. IADC-15-03. Initially published 10 November 2017, updated 6 July 2021.

200 Sec. 4.3.5, ibid.

201 Sec. 2, *CONFERS Recommended Design and Operational Practices* ("CONFERS Recommended Practices"), last revised in October 2022. <https://www.satelliteconfers.org/publications/>.

202 Ibid.

203 UN Doc. A/AC.105/C.1/2022/CRP.14/Rev.1 (2022), *supra* note 192, p. 8.

directly with other States and international intergovernmental organisations.[204] In addition, it recommends the establishment of appropriate means to enable timely coordination to mitigate orbital collision and to exchange information on space objects and information related to orbital events that may affect the safety of space operations.[205]

As noted by Weeden *et al.*, information sharing is essential to enhance the transparency and the understanding of space activities.[206] A good example in this regard is set by the CNES Space Situational Awareness Center, which makes use of existing platforms to widely communicate its contact details as well as the contact details of space operators in order to assist the coordination among operators to avoid on-orbit collisions.[207] Specific to ADR operations, Astroscale's command segment of the ELSA-d mission has been designed to include a round-the-clock point of contact to monitor conjunctions and provide an open line of communication with other orbital "neighbours".[208] Since ADR operations "may inadvertently generate more debris or increase the probability of collision",[209] the sharing of contact details and other relevant information could enable other space actors to coordinate with the ADR operators to reduce potential risks and concerns in a timely manner. In this sense, Guideline B.1 can be relevant to the safety and transparency of ADR operations.

4.1.2.2.4 LTS Guideline B.2

Guideline B.2 "*Improve accuracy of orbital data on space objects and enhance the practice and utility of information sharing*" recognises that "spaceflight safety strongly depends upon the accuracy of orbital and other relevant data".[210] As such, the guideline recommends States and international organisations to "promote the development and use of techniques and methods to improve the accuracy of orbital data".[211] While data accuracy is important for the safety of space missions in general, accurate and ongoing SSA data is particularly essential for ADR operations, especially in the rendezvous and

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204 LTS Guideline B.1, para. 1.
205 Ibid, para. 2.
206 Weeden *et al*. (2019), *supra* note 195, p. 3.
207 UN Doc. A/AC.105/C.1/2022/CRP.20 (7 February 2022). General presentation of French activities and views concerning the long-term sustainability of outer space activities, in relation with the implementation of the 21 Guidelines, paras. 23&40.
208 FCC. *FCC Report: ELSA-d CONOPS and Debris Mitigation Overview* ("ELSA-d CONOPS Report"), p. 11. <https://fcc.report/IBFS/SES-STA-INTR2020-00086/2166969.pdf>.
209 US. (January 2021). *US National Orbital Debris Research and Development Plan*, p. 11. <https://www.space.commerce.gov/white-house-releases-orbital-debris-rd-plan/>.
210 LTS Guideline B.2, para. 2.
211 Ibid, para. 1.

capture phases of the mission, which requires a thorough assessment of the location of the target object.[212]

In view of the importance of data accuracy, the *CONFERS Recommended Design and Operational Practices* recommend that operators should use external resources to provide independent and coordinated data and information to plan and inform their on-orbit servicing activities, including the removal of debris objects.[213] These external sources can include external SSA and modelling or simulation capabilities.[214] As a practical example, in its ELSA-d mission, Astroscale has signed an agreement with ESA for the provision of data on the environmental monitoring of space debris and conjunction assessment.[215] Considering the high demand for data accuracy in ADR activities, it would also be beneficial for States with SSA capabilities to enter into cooperation to increase the accuracy and reliability of their data for the safety of ADR operations.

4.1.2.3 Implementation of the LTS Guidelines at the National Level

The twenty-one LTS guidelines "are intended to support States in engaging in activities aimed at preserving the space environment".[216] As Martinez comments, these guidelines are "not at all prescriptive about the manner of implementation, recognizing the wide variety of ways in which States organize, conduct and regulate their space activities", and they "will only achieve their intended purpose if they are implemented as widely as possible".[217] Therefore, it would be helpful to provide guidance to States on the possible ways of implementation.

To promote the implementation of the LTS Guidelines, UNOOSA has established, with the support of the UK, the project "*Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities*" ("UNOOSA LTS Project") on 26 January 2021.[218] The Project aims to showcase how the LTS Guidelines "can be implemented in a multi-stakeholder perspective in order to protect the

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212 Weeden *et al.* (2019), *supra* note 195, p. 3. See also Palmroth, M., Tapio, J., Soucek, A., Perrels, A., Jah, M., Lönnqvist, M., Nikulainen, M., Piaulokaite, V., Seppälä, T., & Virtanen, J. (2021). Toward Sustainable Use of Space: Economic, Technological, and Legal Perspectives. *Space Policy*, *57*, 101428, p. 7.

213 Sec. 1.4.5., *CONFERS Recommended Design and Operational Practices* ("CONFERS Recommended Practices"), last revised October 2022. <https://www.satelliteconfers.org/publications/>. This document will be further discussed in Chapter 4 Section 4.2.2.

214 Ibid.

215 ELSA-d CONOPS Report, *supra* note 208, p. 11.

216 Preamble of the LTS Guidelines, para. 7.

217 Martinez (2021), *supra* note 171, p. 103.

218 Information on the UNOOSA LTS Project is available on a dedicated UNOOSA webpage: <https://spacesustainability.unoosa.org/>.

Earth's limited orbital space environment and relevant space activities".[219] The first phase of the Project led to the publication of the LTS Guidelines in all six official languages of the UN and the production of over forty operational case studies of implementation practices.[220] In the second phase of the Project, UNOOSA conducted a series of interviews with States and international organisations to identify their experiences and challenges associated with the implementation of the LTS Guidelines.[221] The information gathered in the interviews is contained in a report published by UNOOSA in May 2022.[222] According to this report, ADR missions were flagged by some interviewees in the context of scientific and technical research and development under Section D of the LTS Guidelines.[223] This affirms the relevance of the LTS Guidelines to ADR activities. The UNOOSA LTS Project is currently in its third phase, where UNOOSA will create an open access e-learning tool to help improve understanding about the LTS Guidelines and enhance their implementation.[224]

As COPUOS serves as "the principal forum for continued institutionalized dialogue on issues related to the implementation and review of the guidelines",[225] many States and international organisations have reported their implementation practices at COPUOS.[226] An increasing number of such reporting can be observed over the years, probably because the LTS Guidelines were adopted several years ago and there are already some practices and experiences gathered with the passing of time. As noted by France, sharing and reviewing best practices on the implementation of the LTS Guidelines will enhance communication, international cooperation and capacity building towards the preservation of space sustainability.[227] To coordinate the reporting, the UK has proposed a template for States and international organisations to document their progress on and challenges of implementation.[228] The template contains four categories of information: (i) Thoughts or approach to implementation; (ii) Current progress and/or

219 Ibid.

220 UN Doc. A/AC.105/C.1/L.409 (14 September 2022), Information and views for consideration by the Working Group on the Long-term Sustainability of Outer Space Activities, p. 5.

221 UNOOSA LTS Project, *supra* note 218.

222 UNOOSA. (May 2022). *Awareness-raising and capacity-building related to the implementation of the Guidelines for the Long-Term Sustainability of Outer Space Activities (LTS Guidelines): Stakeholder Study Report*.

223 Ibid, pp. 30-31.

224 UNOOSA LTS Project, *supra* note 218.

225 UN Doc. A/74/20 (2019), *supra* note 181, para. 164.

226 The submissions of States and international organisations on their implementation of the LTS Guidelines can be found on the UNOOSA website: <https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html>.

227 UN Doc. A/AC.105/C.1/2022/CRP.20 (2022), *supra* note 207, para. 4.

228 UN Doc. A/AC.105/C.1/2022/CRP.22 (14 February 2022). United Kingdom Update on its Reporting Approach for the Voluntary Implementation of the Guidelines for the Long-Term Sustainability of Outer Space Activities, para. 2 & Annex 1.

proposed future activities; (iii) Experiences, challenges and lessons learnt; (iv) Comments on specific needs for capacity building necessary to support implementation.[229] Some brief guidance is provided to explain the meaning of each category.[230] As the UK notes, understanding the challenges surrounding the implementation of the LTS guidelines is critical to identifying the form of future capacity-building activities.[231] Moreover, significant participation in the sharing of implementation practices will allow States to uncover the various approaches that could be adopted to implement the LTS Guidelines, which would form a basis for States to work towards potential coherency in their approaches to implementation.[232] Some States such as Austria[233] and Canada[234] have already used this template to report their implementation practices.

The importance of the sharing of implementation practices can be viewed from the concept of "regulatory impact assessment", which refers to the procedure to evaluate the practical effectiveness and identify the possible deficits of the non-binding norms.[235] As submitted by Brünner and Königsberger, such an evaluation may inform future efforts to further promote compliance and strengthen the public awareness of the norms as well as their power to steer behaviour.[236] From this perspective, both the UNOOSA LTS Project and the reporting of implementation practices by States and international organisations represent effective tools for them to understand the methods of implementation, the progress achieved, and the challenges and experiences identified. In particular, as the template proposed by the UK addresses various aspects of the implementation, which could help to reveal the potential areas for improvement, it is advisable for States to consider using the template to report their implementation practices.

The sharing of implementation practices regarding the LTS Guidelines may serve as a model of regulatory impact assessment to enhance the compliance and effectiveness of other soft law instruments. As noted earlier, efforts are needed to increase compliance with the space debris mitigation guidelines. Modelling after the UK-proposed template, States may also

229 Ibid.

230 Ibid.

231 UN Doc. A/AC.105/C.1/L.409 (2022), *supra* note 220, p. 6.

232 Ibid.

233 UN Doc. A/AC.105/C.1/2023/CRP.19 (6 February 2023). Austria: Report on the voluntary implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities.

234 UN Doc. A/AC.105/C.1/2023/CRP.8 (6 February 2023). Canada – Annex to update on its reporting approach for the voluntary implementation of the Guidelines for the Long-term Sustainability of Outer Space Activities.

235 Brünner, C. & Königsberger G. (2012). 'Regulatory Impact Assessment' – A Tool to Strengthen Soft Law Regulations. In Marboe, I. (Ed.), *Soft Law in Outer Space: The Function of Non-Binding Norms in International Space Law*, Böhlau Verlag, pp. 96-97.

236 Ibid.

report their implementation practices in a more systematic manner including their progress, challenges and lessons learnt in the implementation of each of the seven space debris mitigation guidelines endorsed by COPUOS. This evaluation process may contribute to assessing the effectiveness of implementation and enhancing compliance with the space debris mitigation guidelines. As both the LTS Guidelines and the COPUOS Space Debris Mitigation Guidelines are intended as living documents, the review of their implementation practices could help to inform their future update.

4.1.3 Section Conclusion

The international instruments providing space debris mitigation guidelines and standards constitute a significant step forward towards tackling the space debris problem. They focus on limiting the generation of new debris and not the remediation of existing debris from orbit. This does not mean that they are irrelevant to ADR. Rather, the IADC Space Debris Mitigation Guidelines touch upon the issue of ADR by recognising direct retrieval as a potential post-mission disposal option. In addition, the space debris mitigation guidelines and standards are applicable to ADR operations in the aspect of limiting the number of debris created as a result of these operations. However, while these instruments encourage their addressees to limit the generation of space debris as a result of their space activities, they neither call upon States to actively remediate previously created debris from orbit, nor provide clear recommendations on how ADR activities should be carried out in a manner to reduce the risk of creating more debris. In other words, while these guidelines set out general debris mitigation measures that apply to ADR like other space activities, these measures are not specifically designed for ADR and they need to be translated into more specific technical or operational practices to guide ADR operators towards complying with these measures.

The issue of protecting the orbital environment from the continuous growth of space debris is also considered within the context of the long-term sustainability of outer space activities. The adoption by COPUOS of the twenty-one LTS Guidelines is another positive step forward towards preserving the outer space environment. Space debris, which is recognised as a critical threat to space sustainability, is also addressed in the COPUOS LTS Guidelines. Several LTS Guidelines are of close relevance to ADR in the sense that faithful compliance with these guidelines may contribute to promoting the advances in ADR technologies and enhancing the safety of ADR operations. However, the issue of ADR is not sufficiently addressed in the COPUOS Guidelines. Firstly, the term ADR is not expressly mentioned in any of the twenty-one LTS Guidelines. Secondly, even Guideline D.2, which is understood as being of direct relevance to active remediation of space debris, only recommends States and international organisations to invest new measures to manage the space debris population in the long term, without more outrightly encouraging them to clean up their existing debris from congested orbital areas. Thirdly, although some draft guidelines regarding the safety of ADR operations were proposed during the negotiation of the 21 COPUOS LTS Guidelines, consensus could not be reached on these guidelines. In view of the intimate relation between ADR and space sustainability, i.e., ADR activities are necessary to maintain orbital sustainability while these activities, if not undertaken properly, may cause more harm than good to the space environment, it is important to ensure that ADR operations are carried out in a manner furthering the long-term sustainability of the orbital environment. In this regard, the commercial space industry is already moving ahead of the COPUOS LTS Guidelines and has developed principles and recommended practices that are directly applicable to ADR missions. The initiatives taken by the commercial space sector will be discussed in the next section.

4.2 *Issue 2*: The Role of Soft Law for the Clarification of "Fault" and the Industry-Led Initiatives in Developing ADR Guidelines

This section will discuss how soft law instruments can contribute to the clarification of the notion of "fault" and underline the need to develop safety guidelines and standards for ADR missions from a legal perspective. As mentioned in Chapter 2, the ambiguity of the concept of "fault" regarding the determination of liability for damage caused in outer space may create legal uncertainty and thus disincentivise States from undertaking ADR activities. To overcome this hurdle, an ideal solution would be for States Parties to the Liability Convention to develop a protocol specifying what "fault" means for the attribution of liability for damage caused by space objects in space. However, considering that the last of the five UN space treaties was adopted over four decades ago, it appears that the adoption of new space treaties is not a feasible option in the near future. Therefore, the most plausible method to clarify the notion of "fault" lies in the adoption of soft law instruments. The previous section has addressed several environmentally relevant instruments for outer space activities, and Section 2.1 will use these instruments as examples to discuss how soft law instruments may contribute to the clarification of the notion of "fault".

The previous section also notes that while the space debris mitigation guidelines and the COPUOS LTS Guidelines are relevant to ADR activities, they do not provide clear guidance on how ADR activities should be carried out safely in furthering the long-term sustainability of outer space activities. In the absence of clear guidance, the determination of "fault" may be difficult when an ADR operation causes damage to space objects of third parties. Therefore, it would be useful for the international community to develop specific guidelines and standards for the design and operation of ADR missions. This standardisation would not only contribute to enhancing the safety of ADR operations but also specify a standard of care against which fault could be assessed when, for instance, a removal spacecraft accidentally causes damage in outer space. Currently, States have not yet adopted international guidelines for ADR operations like the COPUOS Space Debris Mitigation Guidelines and COPUSO LTS Guidelines. In the meantime, the commercial space industry has formed associations and working groups that are developing best practices and recommended standards to ensure the safety of ADR activities.[237] Sections 2.2 to 2.5 will examine several industry-led initiatives expressly addressing ADR and discuss their relevance to the undertaking of ADR activities. More specifically, Section 2.2 will discuss the guiding principles and best practices published by CONFERS, which are directly applicable to commercial ADR operations. The publications of CONFERS were used as a foundation for the development of ISO 24330: 2022, the first-ever thorough set of international standards regarding ADR and other satellite servicing operations, which will be discussed in Section 2.3. Section 2.4 will assess another industry-led initiative that could contribute to ensuring safe ADR operations, which is the *Best Practices for the Sustainability of Space Operations* published by the Space Safety Coalition. Section 2.5 will discuss the Space Sustainability Rating, which is not a new set of guidelines but a rating system to evaluate the compliance with existing guidelines and promote more sustainable behaviours in outer space. Section 2.6 will summarise this section and point out the areas where future development of space law is needed in order to clarify "fault" for the attribution of liability for damage caused by ADR operations in space.

4.2.1 The Role of Soft Law for Clarifying the Notion of "Fault"

As discussed in Chapter 3, while the UN space treaties and general international law lay down the general legal framework for space activities, which sets forth fundamental rules and principles relevant to the governance of space debris and ADR, the issue of space debris is neither mentioned nor specifically addressed in these legally binding rules and principles. Therefore, clarification is needed to understand the specific meaning and requirements of these rules and principles. In particular, since the Liability Convention does neither define "fault" nor provide a standard of care for the determination of "fault", it is difficult to understand what "fault" means for the attribution of liability when damage is caused in outer space. However, the development of a binding agreement to define "fault" does not seem a possible option in the near term, as there has been no new space treaty adopted within the UN after the conclusion of the Moon Agreement. Rather, a trend can be observed where recourse has been made to the soft

237 Weeden *et al*. (2019), *supra* note 195, p. 6.

law instruments for the further development of space law. Therefore, a question is whether soft law can contribute to the clarification of "fault".

In general, fault denotes "the failure to adhere to, or breach of, an obligation imposed by law".[238] Reference can be made to the most environmentally relevant provision in the Outer Space Treaty, i.e., Article IX of the OST, which requires States to carry out their space activities with due regard to the corresponding rights and interests of other States. As the rights and interests of States to freely and safely explore and use outer space are hindered by the growth of space debris, a duty to take appropriate measures to reduce space debris when carrying out space activities can be inferred from the due regard principle. However, Article IX itself does not provide clear guidance to States on how to fulfil this requirement. In the context of the law of the sea, the Seabed Dispute Chamber of the ITLOS has highlighted the inter-linkage between the obligation of due diligence and the obligation to apply best environmental practices:

> "[I]n light of the advancement in scientific knowledge, member States of the [International Seabed] Authority have become convinced of the need for sponsoring States to apply "best environmental practices" in general terms so that they may be seen to have become enshrined in the sponsoring States' obligation of due diligence."[239]

In transposing this reasoning to the space law context, it can be likewise argued that the best practices for the protection of the space environment should be duly applied in order to fulfil the due regard requirement. In this regard, the internationally accepted space debris mitigation guidelines, as embodying best practices for limiting the creation of space debris, can be seen as instruments "giving concrete shape to the substantive requirements that States have to fulfil for meeting the obligations under Art. IX OST".[240] In fact, as Masson-Zwaan observes, "Article IX of the Outer Space Treaty is often considered as the main basis for further rules on space debris mitigation and remediation, even if the article itself does not seem to impose a very strong legal obligation on States Parties".[241] Therefore, conformity with soft law addressing space debris may be considered by judges in assessing the degree of due diligence exercised by States in the course of space activities. In addition, as argued in Chapter 3, space debris can be regarded as a form of "contamination" in the context of Article IX of the OST. Following this understanding, the space debris mitigation measures

238 Smith, L. J. & Kerrest, A. (2013). Article III (Fault Liability) LIAB. In *CoCoSL Vol. 2*, p. 132.

239 *Responsibilities and obligations of States with respect to activities in the Area, Advisory Opinion, 1 February 2011, ITLOS Reports 2011*, para. 136.

240 Stubbe, P. & Schrogl, K.-U. (2015). The Legal Significance of the COPUOS SDM Guidelines. In *CoCoSL Vol. 3*, p. 647.

241 Masson-Zwaan, T. L. (2023). Widening the Horizons of Outer Space Law. Doctoral Thesis at Leiden University, *Meijers-reeks*, p. 44.

contained in the non-binding instruments can also be seen as specification of the "appropriate measures" to be taken to avoid harmful contamination in outer space.[242] As space debris mitigation guidelines can be viewed as specifying the general requirements under Article IX of the OST, they may be used by judges in determining the existence of "fault" by virtue of Article IX.[243]

Meanwhile, the meaning of "fault" is not limited to the violation of an international legal rule.[244] As noted by Stubbe, by the time the Liability Convention was adopted, the concept of "internationally wrongful act" was already accepted as a prerequisite for State responsibility.[245] Hence, the deliberate reference to "fault" instead of "a breach of an international obligation" as a precondition for establishing liability for damage caused in outer space indicates that these concepts address different instances.[246] An understanding otherwise would make the fault-based liability regime of the Liability Convention rather redundant, as the victim State could in any event claim compensation against the wrongdoing State under general international law when the wrongdoing State breaches its international obligation and thereby causes damage.[247]

Through a comparative analysis of various jurisdictions, Marboe submits that the general understanding of the notion of "fault" is "a violation of required standard of behaviour of a reasonable person in the circumstances".[248] In this sense, non-binding instruments become once again relevant for the determination of "fault", for these instruments embody what is commonly regarded as reasonable behaviour in outer space. In fact, when endorsing the COPUOS Space Debris Mitigation Guidelines, the UN General Assembly recognised that these voluntary guidelines "reflect the existing practices as developed by a number of national and international organizations".[249] In addition, the COPUOS Guidelines state that "[t]he implementation of space debris mitigation measures is recommended since some space debris" can endanger space missions and that "[t]he prompt implementation of appropriate debris mitigation measures is therefore considered a prudent and necessary step towards preserving the outer space environment for future generations".[250] Similar statements can be found in the IADC Space Debris Mitigation Guide-

242 Stubbe & Schrogl (2015), *supra* note 240, pp. 644-646.
243 Smith & Kerrest (2013), *supra* note 238, p. 133.
244 Stubbe & Schrogl (2015), *supra* note 240, p. 648. Marboe (2012), *supra* note 36, p. 122.
245 Stubbe & Schrogl, ibid.
246 Ibid.
247 Marboe (2012), *supra* note 36, p. 122.
248 Ibid, pp. 125-135.
249 UN Doc. A/RES/62/217 (22 December 2007). International cooperation in the peaceful uses of outer space, para. 27.
250 Secs. 1&2, COPUOS Space Debris Mitigation Guidelines.

lines.[251] This indicates the common understanding of the international community that adherence to the space debris mitigation guidelines is essential to avoid posing risks to others and to safeguard the sustainability of outer space for future use. Therefore, these guidelines can be considered as "objective standards and practices that define the reasonable conduct with respect to the avoidance of space debris".[252] For instance, "[n]ot de-orbiting an object after its useful life could be considered an element of fault, just as de-orbiting it could be seen as a factor mitigating fault".[253] This understanding could incentivise States to strengthen their adherence to the space debris mitigation guidelines, for this could be used by them as a basis to claim "no-fault".[254]

Besides the space debris mitigation guidelines, the LTS Guidelines can also be considered in the assessment of "due diligence" and "fault". For instance, the recommendations addressing information sharing and conjunction assessment contained in the LTS Guidelines can be used to determine whether a satellite operator has taken reasonable measures to prevent collisions in space.[255] As such, these and other relevant guidelines concerning expected behaviours in outer space could become highly relevant for the determination of fault after a collision or some other events causing damage, when the issue of liability arises.[256]

Admittedly, soft law instruments have their limits for the clarification of concepts contained in the UN space treaties due to their non-binding status, which makes it unclear with regard to the exact level of relevance of these instruments for specifying the concepts of "due regard" and "fault" in the space treaties. Although this non-binding character can be regarded as an inherent shortcoming of soft law instruments as they do not create legal duties and cannot be enforced, it should be noted that it is precisely this character that enables States to reach consensus on the adoption of these instruments.[257] If the connection between soft law instruments and the space treaties can be clearly established from the beginning, then States would likely be hesitant to adopt these instruments in the first place to avoid subjecting themselves to binding obligations. Therefore, the non-binding character of soft law should be regarded as an opportunity which allows States to move forward when the adoption of a treaty does not seem a realistic option. Without these soft law instruments, States may have to conduct their space activities with an even greater degree of uncertainty.

251 IADC Space Debris Mitigation Guidelines, p. 6.
252 Stubbe & Schrogl (2015), *supra* note 240, p. 648.
253 Masson-Zwaan (2023), *supra* note 241, p. 224.
254 Smith & Kerrest (2013), *supra* note 238, p. 133.
255 Byers & Boley (2023), *supra* note 1, p. 83.
256 Ibid.
257 Freeland, S. (2012). The Role of 'Soft Law' in Public International Law and Its Relevance to the International Legal Regulation of Outer Space. In Marboe, I. (Ed.), *Soft Law in Outer Space: The Function of Non-binding Norms in International Space Law*. Böhlau Verlag, p. 29.

It should also be noted that non-binding instruments can have normative impacts in their own right.[258] According to the constructivist theories of international relations, ideational factors including normative beliefs can influence how States think of and pursue their interests.[259] As observed by Slaughter and Hale, constructivism is attentive to the role of social norms in international politics, which distinguishes between a "logic of consequences" — rational actions aimed at maximising the interests of a State — and "logic of appropriateness", where rationality is heavily mediated by social norms.[260] This "logic of appropriateness" constitutes a basis for decision-making that is influenced by social norms rather than pure cost-benefit considerations.[261] From this perspective, non-binding guidelines containing shared views on the necessary measures to take for preserving the outer space environment are of normative values to influence State behaviour. Finally, guidelines and recommended measures contained in soft law instruments may be later incorporated into treaties or may evolve into customary international law with sufficient State practice and *opinio juris*.[262] Once that happens, the Liability Convention would operate more effectively as the notion of "fault" can by then be measured against clear, legally binding standards of required behaviour.[263]

Like other space activities, ADR activities should also be carried out in accordance with the due regard principle under Article IX of the OST, which thus imposes a general obligation upon States engaging in ADR activities to avoid interfering with the space activities of other States. As such, the COPUOS Space Debris Mitigation Guidelines and LTS Guidelines are also relevant in determining whether States are acting reasonably in carrying out ADR activities. What is special about these activities is the complexity of ADR operations and the inherent risks of collision involved in these operations. To mitigate such risks and enhance mission safety, specific guidelines on how ADR activities should be performed need to be developed. In this regard, industry-led initiatives have taken one step ahead of State-centered efforts as the industry sector has already published guidelines, principles

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258 Rose, C. (2022). Chapter 2: Sources of International Law. In Rose, C. et al. *An Introduction to Public International Law*. Cambridge University Press, p. 33.

259 Grieco, J. M., Ikenberry, G. J., & Mastanduno, M. (2019). *Introduction to International Relations: Perspectives, Connections, and Enduring Questions*. 2nd ed., Red Globe Press, p. 102. For a general overview of the theories of international relations see Walt, S. M. (1998). International Relations: One World, Many Theories. *Foreign Policy*, No. 110, pp. 29-46.

260 Slaughter, A. M. & Hale, T. (2011). International Relations, Principal Theories. *Max Planck Encyclopedia of Public International Law*, para. 22.

261 Balsiger, J. (2014), Logic of Appropriateness, *Encyclopedia Britannica*. <https://www.britannica.com/topic/logic-of-appropriateness>.

262 Masson-Zwaan (2023), *supra* note 241, p. 47.

263 Von der Dunk, F. G. (2010). Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?. *Proceedings of the International Institute of Space Law 2009*, *52*, p. 206.

and best practices for the performance of ADR activities. These industry-led initiatives will be discussed in the sections below.

4.2.2 CONFERS Guiding Principles and Recommended Practices

Founded by the US Defense Advanced Research Projects Agency (DARPA) in October 2017, CONFERS is an industry-led initiative that identifies and leverages best practices from government and industry to establish non-binding technical and operational standards for RPO, OOS and In-Space Assembly, Servicing, and Manufacturing (ISAM).[264] The members of CONFERS include space companies, academic research institutions, and other private sector participants in the commercial satellite servicing industry.[265] Government agencies may also join CONFERS in the role of observer.[266] CONFERS has published a series of documents for the design and operations of RPO and OOS. Among these documents, the *CONFERS Lexicon* contains definitions of the relevant terminology, which aims to provide consistency within CONFERS and other international organisations for the discussion of OOS and RPO.[267]

The relation between OOS and ADR is outlined in *CONFERS On-Orbit Satellite Servicing Mission Phases.*[268] This document "establishes a baseline of mission phases that is intended to describe the functions of all OOS missions".[269] What deserves specific attention in the context of ADR is its Section 9 entitled "Service", which describes a series of on-orbit services. Subsection 9.7 entitled "'Debris' Collection and Removal" reads as follows:

> "This service includes the collection of debris, including non-functioning Client Space Objects. In this case, the RPOC functions are with uncontrolled debris objects (note that these objects may be tumbling, which creates a new technical challenge for the servicer, especially during final approach and capture.) Functions during the service include operation and control of the mated stack, *Orbit Transfer (9.3)* of the debris, and disposal of the debris in a specific orbit (graveyard or reentry)."[270]

Subsection 9.3 "Orbit Transfer" refers to the use of a servicer spacecraft to transfer a client space object "to a new orbit instead of using the Client's

264 For more information see CONFERS website <https://satelliteconfers.org/>.
265 Ibid.
266 Ibid.
267 CONFERS. *CONFERS Lexicon Terms and Definitions*. Released in April 2022, updated in March 2023.
268 CONFERS. *CONFERS On-Orbit Satellite Servicing Mission Phases*, updated 1 October 2019.
269 Ibid.
270 Sec. 9.7, ibid, emphasis added. The document does not provide a definition of the acronym "RPOC" and it is used only once in the document. According to correspondence with a member of the CONFERS Secretariat dated 21 April 2022, CONFERS currently just uses the acronym "RPO" (Rendezvous and Proximity Operations) and no longer "RPOC".

on-board propulsion (if it has any)". This service "may be used to assist with decommissioning" the client space object, which will be transferred to "either a graveyard orbit or a re-entry orbit".[271] A conjunct reading of Subsections 9.7 and 9.3 indicates that in the context of the CONFERS documents, ADR is categorised as a subset of OOS, which is therefore covered under these documents.

CONFERS has published two other documents that provide guidance for the performance of RPO and OOS activities, namely the *CONFERS Guiding Principles for Commercial RPO and OOS* and the *CONFERS Recommended Design and Operational Practices*.[272] The CONFERS Guiding Principles provide for a set of principles that CONFERS members believe will help establish responsible norms of behaviour for RPO and OOS.[273] The CONFERS members commit to endeavour to comply with these principles and to promote them throughout the global industry.[274] The four basic principles contained in the CONFERS Guiding Principles are:

I. Consensual Operations: OOS should be conducted via commercial agreements between consenting parties.
II. Compliance with Relevant Laws and Regulations: OOS should be carried out in compliance with appropriate national laws and the Outer Space Treaty.
III. Responsible Operations: commercial OOS operator should ensure that their activities are planned and conducted in a responsible manner to promote safety and mission success.
IV. Transparent Operations: OOS should be conducted in accordance with the principle of transparency to promote safety and trust.[275]

Principles III and IV entail several more specific recommendations. For instance, as to responsible operations, Principle III contains a recommendation that reasonable provisions should be made in mission planning to mitigate the adverse consequences of close approaches and to avoid the generation of space debris. As to transparent operations addressed in Principle IV, the recommendations concern mainly the notification, communication and information sharing regarding the servicing operation.

The CONFERS Recommended Practices were developed to implement the CONFERS Guiding Principles.[276] The recommended design and

271 Sec. 9.3, ibid.
272 *CONFERS Guiding Principles for Commercial Rendezvous and Proximity Operations (RPO) and On-Orbit Servicing (OOS)* ("CONFERS Guiding Principles"), revised in October 2022. *CONFERS Recommended Design and Operational Practices* ("CONFERS Recommended Practices"), revised October 2022.
273 CONFERS Guiding Principles, p. 1.
274 Ibid.
275 Ibid, pp. 1-2.
276 CONFERS Recommended Practices, p. 1.

operational practices contained in the document represent lessons learned from prior servicing and RPO operations and are intended to evolve on the basis of experience gained through future commercial and government servicing operations.[277] The adoption of these practices is considered by the document as "an effective way to enhance operational safety and mission success".[278] The recommended practices are grouped into four categories:

1. "Design servicer vehicles and operations for mission success by taking into account a layered risk mitigation and operational safety approach";
2. "Design future satellites, including both servicer and client vehicles, to facilitate safe and effective satellite servicing";
3. "Share information, to the extent permissible, on success and resolution of spacecraft anomalies";
4. "Promote the long-term sustainability of space".

The *first* category recommends that OOS providers "should develop a holistic approach to the design and operations of their servicing system to enhance flight safety and mission success".[279] This approach can be divided into five layers: spacecraft hardware, spacecraft software, ground segment, mission operations, and security. The first layer provides that spacecraft hardware design is "fundamental to ensuring flight safety" and it addresses aspects with regard to the design of the servicer spacecraft including reliability, redundancy and compatibility.[280] The second layer provides that spacecraft software "should provide adequate levels of autonomy to ensure safe operations when ground control is limited", which includes autonomous on-board systems to identify faults and perform appropriate recovery actions.[281] The third layer addresses the ground segment, which "consists of the hardware and software systems located on earth to allow mission operations to interface with the spacecraft".[282] The fourth layer sets out a series of practices and processes "to ensure that RPO and OOS missions are performed in a safe and responsible manner", including to avoid causing harmful interference to other space objects.[283] The fifth layer addresses the issue of cyber security and provides that access to telemetry and commanding systems should be protected from cyber-attacks.[284]

The *second* category of recommended practices provides that servicer spacecraft "should be designed in such a way as to facilitate the safety and effectiveness of commercial satellite servicing activities".[285] In particular,

277 Ibid.
278 Ibid.
279 Sec. 1, CONFERS Recommended Practices.
280 Sec. 1.1, ibid.
281 Sec. 1.2, ibid.
282 Sec. 1.3, ibid.
283 Sec. 1.4, ibid.
284 Sec. 1.4.6, ibid.
285 Sec. 2, ibid.

one practice is to design and install grappling fixtures on client spacecraft in a location where the spacecraft "can be safely grappled even in an uncontrolled or tumbling condition".[286] As one operational challenge in ADR missions is for the removal spacecraft to capture and relocate uncooperative and tumbling target objects, the equipment of spacecraft with relevant interfaces would facilitate their future removal.

The *third* category encourages OOS providers to share best practices and information on the detection, resolution, recovery and attribution of spacecraft anomalies, to the extent practicable and allowed by applicable law.[287] It is pointed out by practitioners that anomaly sharing can help to "reinforce safe practices for on-orbit servicing, including debris removal".[288] Hence, as the CONFERS Best Practices notes, while competition is essential to a healthy satellite servicing sector, it is also in the best interest of the servicing community to share relevant information to help prevent anomalies and failures that could undermine trust in the servicing community.[289]

The *fourth* category recognises the importance of a well-maintained space environment to the success of the industry and recommends that CONFERS members should strive to "[c]omply with relevant internationally recognized guidelines and standards for the long-term sustainability of space activities".[290] It also encourages members to "identify emerging space sustainability challenges and participate in the development of future guidelines and standards that enhance space sustainability".[291] Reference can be made to the Method of Work of the LTS 2.0 Working Group, which provides that the Working Group may decide "to invite contributions of information from international organizations and non-governmental entities, including from academia, industry and private sector".[292] Therefore, contributions of the industry sector, such as those of CONFERS, can constitute an important source of inputs for the development of future guidelines on space sustainability.

The development by CONFERS of guiding principles and recommended practices for satellite servicing is ground-breaking because they constitute the first-ever comprehensive set of standards for this nascent field. As the removal of space debris is regarded as a category of on-orbit services in the context of CONFERS, these CONFERS standards also provide guidance for the design and operations of ADR missions. In fact, the CONFERS members

286 Sec. 2.2, ibid.
287 Sec. 3, ibid.
288 Weeden *et al*. (2019), *supra* note 195, p. 3.
289 Sec. 3, CONFERS Recommended Practices.
290 Sec. 4.1, ibid.
291 Sec. 4.2, ibid.
292 UN Doc. A/AC.105/1258 (23 February 2022), Report of the COPUOS Scientific and Technical Subcommittee on its fifty-ninth session, Appendix, para. 16.

include leading commercial ADR companies such as Astroscale and ClearSpace, which may not only provide inputs into the development of the relevant standards but can also be expected to adhere to these standards in their missions.[293] In addition to the values of their own, the CONFERS publications were used as a foundation for the development of ISO Standard 24330, which will be discussed below.

4.2.3 ISO Standard 24330: From Industry-Led Initiative to International Standard

After the publication of the first version of CONFERS Recommended Practices in February 2019, CONFERS submitted a formal request to the ISO TC20/SC14 to add a new work item on satellite servicing and to begin discussions of an initial draft standard on the basis of the CONFERS principles and practices.[294] In April 2019, CONFERS provided a draft standard developed from its guiding principles and recommended practices to the ISO.[295] In June 2019, the new work item proposed by CONFERS was approved within the SC14. [296]

The initial draft produced by the CONFERS team formed the basis for the development of ISO 24330: 2022 "*Space systems — Rendezvous and Proximity Operations (RPO) and On Orbit Servicing (OOS) — Programmatic principles and practices*", which was published by ISO in July 2022.[297] ISO 24330:2022 is the first international satellite servicing standard of its kind.[298] The document establishes guiding principles and best practices at the programmatic level for all participants in the RPO and OOS industry, with the aim to ensure safe operations and promote the development of a healthy RPO and OOS industry.[299] It is intended to be the highest-level standard for the design and operation of RPO and OOS missions, and the principles and practices contained therein establish the broadest boundary of behaviours and precede more detailed standards.[300] Therefore, similar to ISO 24113 which constitutes the top-level standard in a family of standards addressing space debris mitigation, ISO 24330 may in the future also be elaborated by

293 CONFERS. Current Members. <https://satelliteconfers.org/members/>.
294 CONFERS Newsletter. (2nd Quarter 2019). From the Desk of the Executive Director, p. 1. <https://www.satelliteconfers.org/wp-content/uploads/2021/11/CONFERS-Q2-2019-Newsletterfinal.pdf>.
295 CONFERS Newsletter. (1st Quarter 2020). Updates on ISO Draft Standard on Commercial Satellite Servicing.
<https://www.satelliteconfers.org/newsletter-first-quarter-2020-edition/>.
296 Ibid.
297 The text of ISO 24330:2022 is available at: <https://www.iso.org/standard/78463.html>.
298 SWF. (2022). *Insight - Satellite Servicing Standards and Policy: A Progress Report*. <https://swfound.org/news/all-news/2022/09/insight-satellite-servicing-standards-and-policy-a-progress-report>.
299 Sec. 1, ISO 24330:2022.
300 Introduction & Sec. 1, ibid.

low-level standards and implementation measures on RPO and OOS, when more experiences regarding these operations are gathered.

Like the CONFERS publications, a critical issue is the applicability of ISO 24330:2022 to ADR activities. ISO 24330 provides definitions of the key terms for the purposes of the document. The term "servicing operation" is defined as "action provided by servicer spacecraft to the client space object, including but not limited to inspection, capture, docking, *relocation*, refuelling, repair, upgrade, assembly and release".[301] Relocation means "operation to change the orbit of the client space object".[302] Since in an ADR operation, the removal spacecraft either re-orbits the target debris object to a graveyard orbit or de-orbits it to a re-entry orbit, ADR operations could be covered within the ambit of "relocation". Reference can further be made to Annex B of ISO 24330, which outlines the mission phases of RPO and OOS operations. According to Section B.9 of Annex B, the scope of "Service" includes "'Debris' collection and removal", and the latter is defined as follows:

> "This service includes the collection of debris, including non-functioning client space objects. In this case, the RPO functions are with uncontrolled debris objects (note that these objects may be tumbling, which creates a new technical challenge for the servicer, especially during final approach and capture). Functions during the service include operation and control of the mated stack, orbit transfer (B.9.4) of the debris, and disposal of the debris in a specific orbit (graveyard or re-entry)."

According to Section B.9.4 of Annex B, the orbital transfer service may be used to transfer a client space object or debris to either a graveyard orbit or a re-entry orbit. Like the aforementioned *CONFERS On-Orbit Satellite Servicing Mission Phases*, Annex B of ISO 24330 makes it clear that the principles, practices and standards contained in the document are applicable to ADR missions.

The heart of ISO 24330 lies in its Clauses 4 and 5. Clause 4 reflects largely Principles III and IV of the CONFERS Guiding Principles, which sets out two programmatic principles for RPO and OOS. The first principle concerns "Responsible design and operations", which requires OOS operators to ensure that "their activities are planned and conducted to promote safety and mission success".[303] In particular, the principle requires OOS operators to ensure conformity to ISO 24113 and to avoid generating debris during servicing operations.[304] This underlines the application of space debris miti-

301 Clause 3.16, ibid, emphasis added.
302 Clause 3.11, ibid.
303 Clause 4.1.1, ibid.
304 Clause 4.1.2, ibid.

gation guidelines to OOS operations. The second programmatic principle concerns "Transparent operations", which requires the servicing operations to be conducted in accordance with "the principle of transparency to promote safety and trust".[305] It includes measures such as the sharing of mission-related information and lessons learned. Clause 5 of 24330 entails a series of programmatic practices for RPO and OOS missions, many of which reflect the practices contained in CONFERS Recommended Practices. The practices are grouped into the following four categories:

1. Design for mission success;
2. Design servicing operations to minimise the risk and consequences of mishaps;
3. Avoidance of interference;
4. Information sharing.

In sum, ISO 24330 was developed on the basis of and reflects in many aspects the guiding principles and recommended practices published by CONFERS.[306] Like the CONFERS publications, ISO 24330 also provides useful guidance for ADR operators to promote safety and mission success. The document establishes norms of expected behaviours that participants in the RPO and OOS industry are advised to perform. Therefore, when an ADR operation causes damage to other space objects, ISO 24330 may be used as a point of reference for determining whether such operation is conducted in a reasonable manner and can thus be relevant for the attribution of "fault".

4.2.4 Space Safety Coalition Best Practices for Space Sustainability

Besides CONFERS, the Space Safety Coalition (SSC) is another industrial association which has developed best practices that may support ADR activities. Founded in 2019, the SSC is "an *ad hoc* coalition of companies, organizations, and other government and industry stakeholders that actively promotes responsible space safety through the adoption of relevant international standards, guidelines and practices, and the development of more effective space safety guidelines and best practices".[307] The SSC published in September 2019 and updated in April 2023 the "*Best Practices for the Sustainability of Space Operations*" ("SSC Best Practices") to "address gaps in current space governance and promote better spacecraft design, operations and disposal practices aligned with long-term space operations sustainability".[308]

305 Clause 4.2.1, ibid.

306 An additional example is that Annex B of the ISO 24330:2022, which describes the functions of RPO and OOS mission phases, reflects the *CONFERS On-Orbit Servicing Mission Phases*.

307 SSC. Home. <https://spacesafety.org/>.

308 Ibid. The document is available at: <https://spacesafety.org/best-practices/>.

The endorsees of the SSC Best Practices include space industry stakeholders ranging from satellite operators to manufacturers and launch providers.[309] They commit to "promote and strive to implement within their respective organizations the best practices identified and described [therein] as a valuable advancement towards the sustainability of space operations".[310] They also make similar commitments to the implementation of the space debris mitigation guidelines and standards published by the IADC, COPUOS and ISO.[311] In addition, according to the preambular text of the SSC document, the best practices "directly address many aspects of the twenty-one" LTS Guidelines.[312] Hence, the SSC document is closely linked to the guidelines and standards developed within the framework of international mechanisms.

The best practices identified and described in the SSC document are divided into nine sections. The most innovative part of the updated SSC Best Practices is the creation of "rules of the road" to avoid collisions in orbit, as provided in Section 8 of the document. Section 8 categorises five classes of objects in space according to their manoeuvrability: non-manoeuvrable, minimally manoeuvrable, manoeuvrable, objects with automated collision avoidance manoeuvring capability, and crewed spacecraft (presumed manoeuvrable).[313] The Section then sets out the general rules of CAMs that should be followed in the event of high-risk conjunctions. Another section that deserves particular attention in the context of space debris is Section 7, which provides for a number of best practices to limit debris generation and enhance space sustainability.

Section 6 is of direct relevance to ADR and other on-orbit services, which recommends spacecraft designers and operators to consider mission- and component-level design and operations to prepare spacecraft for on-orbit services such as inspection, refuelling, and timely post-mission disposal. More specifically, the SSC document recommends the consideration of the following elements:

a) Interfaces and physical features to enable RPO navigation operations and docking, such as features for grappling;
b) Features to improve the ability for spacecraft to be uniquely identified and tracked;
c) Modular spacecraft design features that facilitate the replacement or upgrade of failed or degraded components;

309 SSC. Endorsees. <https://spacesafety.org/endorsees/>.
310 SSC Best Practices, p. 4.
311 Ibid, p. 8.
312 Ibid.
313 Foust, J. (5 April 2023). Updated Space Safety Document Outlines Rules of the Road for Avoiding Collisions. *SpaceNews*. <https://spacenews.com/updated-space-safety-document-outlines-rules-of-the-road-for-avoiding-collisions/>.

d) The creation and preservation of detailed and up-to-date internal documentation of both spacecraft designs and status to the greatest extent practicable.

These recommendations on design improvement and information documentation could increase the readiness of spacecraft for ADR and other on-orbit services and thereby help to enhance the safety of these operations. In sum, as Victoria Samson comments, the publication of the updated SSC Best Practices, especially the development of the rules of the road for close conjunctions in space, shows that commercial space companies are "trying to get out ahead of governments making regulations for them".[314] Like CONFERS, the SSC is pushing forward the boundary of space law by developing new rules for space operations, including norms relating to the tracking and grappling of the target objects which may facilitate future ADR missions.

4.2.5 Space Sustainability Rating

The Space Sustainability Rating (SSR) is a rating system to assess the level of sustainability of space missions and operations. It is not a new set of guidelines but a system to evaluate the compliance with existing guidelines and to promote better-than-required behaviours in outer space.[315] The SSR was initiated by the World Economic Forum in 2016 and developed by a consortium involving ESA, the Massachusetts Institute of Technology (MIT), BryceTech and the University of Texas at Austin.[316] The Swiss Federal Institute of Technology Lausanne (EPFL) Space Center – eSpace has been selected in 2021 to drive the implementation of the SSR, which is managed by an independent association as of 2023.[317]

The SSR assesses the level of sustainability of space missions based on the evaluation of six modules covering different aspects of space sustainability.[318] Space operators participating in the SSR will receive one of the four tiers of rating badges according to the outcome of the assessment, which are Bronze, Silver, Gold or Platinum.[319] The rated entity may also earn additional credits for going over and above the baseline rating towards

314 Kramer, M. (11 April 2023). As Space Fills with Satellites, Operators Want to Create Rules of the Road. *Axios Space*. <https://www.axios.com/2023/04/11/satellite-rules-in-orbit>.
315 SSR. (15 April 2021). Space Sustainability Rating Virtual Workshop, p. 7. <https://www3.weforum.org/docs/WEF_Space_Sustainability_Rating_2021.pdf>.
316 SSR. Home. <https://spacesustainabilityrating.org/>.
317 Ibid.
318 SSR. The Rating. <https://spacesustainabilityrating.org/the-rating/>. The six SSR modules are: (1) Mission Index; (4) Detectability, Identification and Trackability; (3) Collision Avoidance Capabilities; (4) Data Sharing; (5) Application of Design and Operation Standards; and (6) External Services.
319 Ibid.

space sustainability, which are represented by stars on the side of the rating badge.[320] The first official SSR rating was launched in 2022 at the 4th Space Sustainability Summit in London, UK, where Stellar, a telecommunications company and founding member of the SSR, received a bronze badge with one star.[321]

Among the six SSR Modules, the "Application of Design and Operation Standards" Module is of particular relevance here for it concerns the compliance with international guidelines and standards for the design and operations of space missions.[322] The guidelines mentioned in this module include, *inter alia*, the space debris mitigation guidelines and standards published by COPUOS, the IADC and the ISO, as well as the LTS Guidelines.[323] Indeed, as pointed out by David and Saada, the SSR system uses many aspects of the LTS Guidelines and defines measures that can be directly implemented by space operators.[324] With regard to RPO, the module refers to the CONFERS Guiding Principles and CONFERS Recommended Practices.[325] Hence, for an ADR mission, compliance with these principles and recommended practices may be considered in the assessment of its sustainability level. By incorporating the relevant guidelines as a criterion of evaluation, SSR can serve as a tool to incentivise space operators to comply with these guidelines.[326]

Another SSR module with close relevance to ADR is the "External Services" Module, which addresses the activities and actions taken by space operators to make their missions more amenable to receiving external services and to increase the probability of successful external services.[327] The SSR does not assume that all operators will invest in external services, which in some cases are not deemed necessary, such as for low-altitude missions.[328] As a result, the "External Service" Module aims at providing a bonus rating for missions where the investment in external services capabilities is appropriate.[329] This Module includes three categories of actions by operators:

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320 Ibid.

321 Parker, S. (12 September 2022). A New Rating for Space Sustainability. *SSR News*. <https://spacesustainabilityrating.org/news/>.

322 SSR. Application of the Design and Operation Standards. <https://spacesustainabilityrating.org/the-rating/modules-standard-regulations/>.

323 Ibid.

324 David, E., & Saada, A. (8 February 2022). Space Sustainability Rating: a Voluntary Exercise to Incentivize Operators Towards Sustainable Behaviours in Space. *Presentation on 8 February 2022 at the 59th session of COPUOS Scientific and Technical Subcommittee*, p. 14. <https://www.unoosa.org/oosa/en/ourwork/copuos/stsc/technical-presentations.html>.

325 Ibid.

326 David & Saada (2022), *supra* note 324, p. 14.

327 SSR. External Services. <https://spacesustainabilityrating.org/the-rating/modules-external-services/>.

328 Ibid.

329 Ibid.

1. Actions during the design and pre-launch phase to make it easier for spacecraft to be serviced in the future, such as the installation of grapple fixtures;
2. Commitment to use or demonstration of use of OOS, such as external ADR services.
3. Utilising external services in line with current standards, such as those developed by CONFERS.[330]

Similar to the SSC Best Practices, the "External Service" Module of the SSR may encourage the improvement of spacecraft design to facilitate future ADR operations. The explicit reference to the standards developed and proposed by CONFERS could also provide an impetus for operators to procure external services from providers that adhere to these guidelines.

Through the SSR, space operators can get a clear picture of where their missions stand in terms of space sustainability, and they can publicly share the rating's outcome demonstrated by the badge awarded without the need to disclose sensitive mission data or proprietary information.[331] According to ESA, the rating may act as a differentiator among operators and a favourable score for a particular rated operator might lead to advantageous results including the reduction of insurance costs or improved funding conditions from financial backers.[332] As such, the SSR could contribute to incentivising safe and sustainable behaviours in outer space. In particular, by factoring the compliance with the CONFERS standards and the actions related to external services into the assessment of sustainability level, the SSR could help to promote the orderly development of the ADR industry.

4.2.6 Section Conclusion

The value of soft law for the governance of space activities lies not only in its capability to influence and steer the behaviours of States in outer space but also in its connection with hard law. In particular, non-binding instruments like the COPUOS Space Debris Mitigation Guidelines and the COPUOS LTS Guidelines can be used to specify the requirements under Article IX of the Outer Space Treaty, such as the due regard principle. In addition, these instruments could be used by judges in determining fault for the establishment of liability for damage caused in outer space. This can be argued in the context of Article IX of the OST, as well as from the perspective that these instruments embody the general understanding of States on

330 Ibid.
331 Micco, F. (23 June 2022). Space Sustainability Rating is Now Live. *SSR News*. <https://spacesustainabilityrating.org/space-sustainability-rating-now-live/>.
332 ESA. (17 June 2021). Space Sustainability Rating to Shine Light on Debris Problem. <https://www.esa.int/Safety_Security/Space_Debris/Space_sustainability_rating_to_shine_light_on_debris_problem>.

reasonable and responsible behaviours in the conduct of space activities. Therefore, the development of internationally accepted guidelines and standards for ADR could provide clarity to States engaging in these activities on how their missions should be conducted in compliance with the due regard principle and how they can reduce the risk of being held at fault if damage occurs to other space objects as a result of these missions. This is especially important in view of the technical complexity and challenges involved in ADR activities. Therefore, guidelines and standards on how ADR missions are to be designed and operated should be developed.

The commercial space industry has taken the first step to develop technical and safety standards for ADR. More specifically, CONFERS has published several documents setting out guiding principles and recommended practices on the design and operations of ADR missions. The compliance with these principles and practices could be used as an index in the SSR system to assess the level of sustainability of ADR missions. The publications of CONFERS were used as a basis for the development of ISO Standard 24330, which contributes to enhancing the universalisation of these publications across the globe. The SSC has also produced best practices that could facilitate ADR missions such as the installation of grappling and docking mechanisms in future satellites.

In terms of the determination of "fault", the abovementioned standards could be used as a yardstick in this regard as they reflect practical operational experience accumulated in the space industry. This is especially so for ISO 24330, which constitutes the first set of international standards for satellite servicing and could be implemented nationally by its national standard bodies. However, as the ISO is a non-governmental organisation, even ISO 24330 has a weak status from a formal point of view. Therefore, it would be desirable to develop international guidelines and standards regarding ADR with the direct involvement of States like the space debris mitigation guidelines adopted by the IADC and COPUOS. As Pronto submits, considering that States are the principal law-makers in the international legal field, "nonbinding tests adopted by states are inherently more authoritative than those negotiated under the auspices of non-state entities".[333] Non-binding instruments adopted by States can embody their political commitments, which can thus be politically binding upon States to act in a certain manner.[334] As such, the future development and adoption by States of ADR guidelines can not only reflect their endorsement of how ADR activities are to be carried out safely but also represent their political commitment to perform ADR operations in compliance with these guidelines to the greatest extent feasible. In addition, as discussed in Chapter 3, Article VI of the OST

333 Pronto, A. N. (2015). Understanding the Hard/Soft Distinction in International Law. *Vanderbilt Journal of Transnational Law*, *48*, p. 946.

334 Rose (2022), *supra* note 258, p. 31. Martinez (2020), *supra* note 134, p. 557.

requires States to authorise and continuously supervise space activities conducted by private entities, and many States have developed national space legislation to implement this obligation. To reduce the risk of a patchwork of different national standards and practices on ADR activities, it would be beneficial for States to develop commonly agreed guidelines on how these activities are to be carried out.

4.3 *Issue 3*: Recommendations Regarding Registration and the Need for Legal Development to Facilitate Consensual ADR

As was discussed in Chapter 3, Article VIII of the Outer Space Treaty has been elaborated in the Registration Convention, which sets out specific rules of how registration over space objects is to be made. However, the information required to be furnished to the UN Secretary-General under Article IV(1) of the Registration Convention is deemed as vague and general, which does not effectively enable States to identify objects in space after their launch into orbit.

Article IV(2) of the Registration Convention provides that each State of registry may, from time to time, provide the UN Secretary-General with additional information concerning a space object carried on its registry. While this provision is contained in a legally binding instrument, it is a recommended practice rather than a strong obligation, and the Registration Convention itself does not specify the nature and possible content of such information. Further clarification regarding "additional information" is provided in UN General Assembly 62/101 of 17 December 2007, which is adopted with an aim to increase the efficiency of the registration process.[335] In particular, the Resolution recommends that consideration should be given to the furnishing of additional appropriate information to the UN Secretary-General on any change of status in operations, for instance when a space object is no longer functional, on the approximate date of decay or re-entry, and on the date and physical conditions of moving a space object to a disposal orbit.[336] In other words, a State of registry could notify UNOOSA that its operational satellite has become space debris. The UNGA Resolution 62/101 also requests UNOOSA to prepare a model registration form to assist in the submission of registration information.[337] Pursuant to this request, UNOOSA presented in 2010 a template which provides guidance on the furnishing of such additional information.[338]

335 UN Doc. A/RES/62/101 (2007), *supra* note 12.
336 Sec. 2(b), ibid.
337 Sec. 5(a), ibid.
338 The model registration form is available on the UNOOSA webpage: <https://www.unoosa.org/oosa/spaceobjectregister/resources/index.html>.

The notification to the UN Secretary-General regarding the change of operational status of a space object can provide useful information on whether and when such object has become space debris. Yet, as discussed in Chapter 3, space debris should be considered as a subset of space objects under the current international space law. It follows that the change of functional status of a space object does not affect the jurisdiction and control retained by the State of registry over such object. Therefore, the provision of additional information that a space object is no longer functional does not grant other States the right to remove such object from orbit. Furthermore, it should be noted that the functionality-based definition of space debris under the IADC and COPUOS Space Debris Guidelines is made for the purpose of debris mitigation, i.e., to provide recommendations to limit the generation of artificial non-functional objects in earth orbit. It is a non-binding definition and it is thus not intended to create legal rights or obligations. Therefore, a State is not entitled to remove a space object of another State even after the operational status of such object changes, e.g., when it no longer serves a useful function.

In sum, even in cases where the State of registry of a space object provides additional information to the UN Secretary-General that such object is no longer functional, the prior consent of such State is still needed for the removal of this object. Admittedly, it can be said that the provision of this kind of information would facilitate the request for removal by other States, as it can be presumed that States would generally not allow others to remove their operational spacecraft from orbit. Yet, a non-functional object is not devoid of legal value, and it is subject to the discretion of its State of registry to decide whether or not to grant approval for the removal of such object. There is currently no known international mechanism facilitating the requesting and granting of approval for the removal of space objects under the jurisdiction of another State. To promote cooperative ADR programs on a consensual basis, it would be advisable for States to establish such mechanisms in future legal development.

4.4 *Issue 4*: Relevance of Transparency and Confidence-Building Measures for Addressing Dual-Use Concerns over ADR

As discussed in Section 4.1.2.2, although the LTS Guidelines do not specifically address the issue of ADR, some of these guidelines are of close relevance to ADR activities. For instance, Guideline B.1, which addresses the sharing of orbital information and the coordination among space actors in a timely manner, can help to enhance both the safety and the transparency of ADR missions. In fact, the preambular text of the LTS Guidelines states expressly that:

"The guidelines duly take into account the relevant recommendations contained in the report of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities (A/68/189) and could be considered as potential transparency and confidence-building measures."[339]

The above statement indicates the link between transparency and sustainability in outer space activities. As analysed in Chapter 3, the deployment and use of removal spacecraft in orbit for peaceful purposes do not contravene international law. Rather, in view of the necessity to remove around five to ten large debris objects from space per year in order to control the growth of space debris, ADR activities should be encouraged and enlarged to preserve the sustainability of the outer space environment. However, even when carried out lawfully, an ADR activity could still raise misperceptions and dual-use concerns. Therefore, the question is how to ensure that a peaceful ADR mission is not mistaken as a threatening action.

According to the Secure World Foundation (SWF), ADR operations may be perceived as threats to space security if not conducted transparently.[340] As a result, Transparency and Confidence-Building Measures (TCBMs) could serve as a useful tool to reduce mistrust and misperceptions in the conduct of ADR operations.[341] In 1993, the UN General Assembly convened a Group of Governmental Experts (GGE) to undertake a study on the application of TCBMs in outer space. The 1993 GGE adopted a report which emphasised the importance of appropriate TCBMs for ensuring space security and put forward a number of recommendations on this matter.[342] In particular, the 1993 GGE agreed that:

"[T]he application of space technologies is ambivalent in nature and that dual-purpose aspects of sensitive technologies should not be defined as harmful *per se*. It is the way in which they are utilized that determines whether they are harmful or not."[343]

While the above observation was made in the context of space systems that can collect and use data for both civil and military purposes,[344] it appears equally applicable to other dual-use technologies such as ADR. Following this understanding, removal spacecraft should not be perceived as "harm-

339 Preamble of the LTS Guidelines, para. 13.

340 SWF. Debris Removal/Rendezvous and Proximity Operations: Looking at Policy Implications. <https://swfound.org/media/167942/openingremarks_hitchens.pdf>.

341 UN Doc. A/AC.105/C.1/2012/CRP.16 (27 January 2012). Active Debris Removal — An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space: A Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing, p. 38.

342 UN Doc. A/48/305 (15 October 1993). Study on the application of confidence-building measures in outer space: Report by the Secretary-General.

343 Ibid, para. 304.

344 Ibid, paras. 51-54.

ful" simply because of their dual-use nature, but what matters is the way in which such spacecraft is used and operated.

In 2013, another GGE established by the UN General Assembly adopted a consensus report containing conclusions and recommendations on TCBMs for outer space activities.[345] The Report builds on the recommendations of the previous GGE and on proposals for outer space TCBMs submitted to the UN by Member States.[346] The GGE Report of 2013 describes TCBMs as "a means by which Governments can share information with the aim of creating mutual understanding and trust, reducing misperceptions and miscalculations and thereby helping both to prevent military confrontation and to foster regional and global stability".[347] TCBMs for outer space activities are part of a broader context of such measures, which can "augment the safety, sustainability and security of day-to-day space operations.[348]

The GGE Report of 2013 contains a set of non-legally binding TCBMs for outer space activities for consideration and implementation by States on a voluntary basis.[349] In the context of the establishment of norms and principles of responsible behaviours for space activities, a number of States refer to the GGE Report and describe the recommendations contained therein "as a foundation which should be re-examined, made better use of and implemented" for further legal development.[350] Specifically, five elements are highlighted in relation to the further elaboration, strengthening, agreement and implementation of TCBMs in outer space activities:[351]

i. Information exchange on national space policies and military expenditures;
ii. Information exchanges on space objects and activities;
iii. Risk reduction notifications;
iv. Policy and operational communication channels and consultative mechanisms;
v. Familiarisation visits.

The following sub-sections will assess the above five elements and discuss how these measures may contribute to enhancing the transparency of ADR activities.

345 UN Doc. A/68/189 (2013), *supra* note 14.
346 Ibid, p. 4.
347 Ibid, p. 12, para. 20.
348 Ibid, p. 13, paras. 25-26.
349 Ibid.
350 UN Doc. A/76/77 (13 July 2021), Report of the UN Secretary-General on Reducing space threats through norms, rules and principles of responsible behaviours, p. 10, para. 21. The establishment of norms of responsible behaviours in outer space will be taken up in Chapter 5 Section 5.4.
351 Ibid, pp. 15-16, para. 38.

4.4.1 Information Exchange on Space Policies

This element recommends States to exchange information and pursue dialogue on national space doctrines, goals, policies and strategies.[352] To implement this recommendation, States contemplating or preparing ADR activities may consider notifying other States of their future ambitions in this regard through the publication of national space policies. In practice, many States have explicitly addressed their ADR plans and activities in their national space policies. The policy document titled *China's Space Program: A 2021 Perspective* published in 2022 states that China will carry out technology verification in a number of areas including, *inter alia*, space debris cleaning.[353] It also states that China will foster and develop new space economy sectors such as debris removal.[354] Japan's 4th *Basic Plan on Space Policy* published in 2020 outlines its plans to develop technologies for removing and mitigating space debris and lead international rulemaking in this regard.[355] The UK's *National Space Strategy* published in 2021 states that the UK "will work to establish early leadership in potential and emerging markets" including ADR.[356] It refers to ADR as one of the emerging sectors in space, and recognises that ADR "will be increasingly required to keep orbits safe".[357] The US also highlights in a series of policy documents its plan to pursue ADR as a necessary long-term approach to ensure the operational safety in key orbital areas.[358] In particular, the 2020 US *National Space Policy* states that to preserve the space environment, the US shall "[e]valuate and pursue, in coordination with allies and partners, active debris removal as a potential long-term approach to ensure the safety of flight in key orbital regimes".[359]

The above national policies not only outline the ambitions, visions, strategies and plans of States pertaining to ADR but also demonstrate their political will to develop ADR technologies and lead ADR efforts, which may encourage other States to follow suit. Besides national space policies,

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352 Ibid, p. 15, para. 38(a). See also UN Doc. A/68/189 (2013), *supra* note 14, p. 16, para. 37.

353 The full text of the *China's Space Program: A 2021 Perspective* is available at: <http://www.scio.gov.cn/zfbps/32832/Document/1719693/1719693.htm>.

354 Ibid.

355 See *Outline of the 2020 Basic Plan on Space Policy (Provision Translation)*, published by the National Space Policy Secretariat of the Cabinet Office of Japan on 30 June 2020. <https://www8.cao.go.jp/space/english/basicplan/basicplan.html>.

356 UK *National Space Strategy*, published on 27 September 2021, last updated 1 February 2022, p. 7. <https://www.gov.uk/government/publications/national-space-strategy>.

357 Ibid, p. 16.

358 US Statement – Agenda Item 7 – Space Debris – 60th Session of the STSC of COPUOS (9 February 2023). <https://vienna.usmission.gov/u-s-statement-agenda-item-7-space-debris-60th-session-of-the-stsc-of-copuos/>.

359 *National Space Policy of the United States of America*, issued on 9 December 2020, p. 15. <https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf>.

States may also provide more detailed information regarding their planned, ongoing and completed ADR missions through other channels such as governmental websites. For instance, the UK updates periodically information regarding its space programmes and missions, including the progress of its planned ADR project.[360] This kind of information sharing can contribute to the avoidance of unwanted surprises and to the clarification of peaceful intentions.

4.4.2 Information Exchange on Space Objects and Activities

This element concerns the exchange of information on the basic orbital parameters, general function and mission objective of objects in Earth orbit.[361] It also includes notification of planned spacecraft launches, including data on the generic class of the space launch vehicle, the planned launch window, the planned launch area and the planned direction.[362] As the US notes:

> "Exchanging appropriate information about spacecraft operations in orbit may facilitate effective responses to orbital collisions, orbital break-ups and other events that may ultimately pose a risk to human lives, property and/or the environment. Such communications could contribute to risk reduction by helping to avoid misunderstandings and miscalculations."[363]

Similar recommendations on information exchange can be found in the LTS Guidelines, such as the aforementioned LTS Guidelines B.1, which reflect the character of the LTS Guidelines as TCBMs. To enhance mission safety and transparency, it is advisable for States engaging in ADR activities to provide other States with relevant information on their removal spacecraft and planned missions. According to the "*Guidelines on a License to Operate a Spacecraft Performing On-Orbit Servicing*" published by Japan in 2021 ("Japanese OOS Guidelines"), the relevant information to be shared could include, *inter alia*, the basic orbital parameters, the period of the sequence from rendezvous to separation between the removal spacecraft and target debris object, and the information disclosure policy in the event of emergencies.[364] Information exchange could facilitate other States to assess the conjunction risks posed to their space objects and to request appropriate international consultation where necessary.

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360 The UK government has a dedicated webpage to publish information on its space science and technology. <https://www.gov.uk/business-and-industry/space>.

361 UN Doc. A/76/77 (2021), *supra* note 350, p. 15, para. 38(c). See also UN Doc. A/68/189 (2013), *supra* note 14, p. 16, para. 39.

362 UN Doc. A/76/77 (2021), ibid, p. 15, para. 38(e).

363 Ibid, p. 99.

364 Sec. 4.3.1, Japanese OOS Guidelines. This document will be discussed in more detail in Chapter 5 Section 5.2.3.

4.4.3 Risk Reduction Notifications

The GGE Report of 2013 recommends States to "notify, in a timely manner and to the greatest extent practicable, potentially affected States of scheduled manoeuvres that may result in risk to the flight safety of the space objects of other States".[365] It also recommends States to notify other potentially affected States in a timely manner of events linked to natural and man-made threats to the flight safety of space objects, such as risks caused by the malfunctioning of space objects or loss of control that could result in a significantly increased probability of collisions.[366]

On the basis of the recommendations of the GGE Report of 2013, the UNSG Report of 2021 enumerates a series of manoeuvres calling for prior notifications including, *inter alia*, ADR operations.[367] As ADR activities entail an inherent risk of collision, notification of potentially dangerous events and operations could enable better preparation to respond to such risk. Reference can be further made to the CONFERS Guiding Principles, which recommend entities conducting on-orbit servicing operations to "develop and implement a protocol that provides timely public notification of anomalies or mishaps that could have an adverse impact on other entities or the space environment".[368] In sum, ADR operators should notify and coordinate with potentially affected entities when there are anomalies or other potential risks.

4.4.4 Communication Channels and Consultative Mechanisms

According to the GGE Report of 2013, timely and routine consultations among States through various mechanisms can contribute to preventing mishaps, misperceptions and mistrust, which may also be useful in clarifying information and ambiguous situations.[369] The UNSG Report of 2021 further recommends the establishment of national points of contact for the exchange of information and consultations on policy matters, as well as for round-the-clock operational communications.[370]

As stated by the US, the way space mechanisms with dual-use capabilities are operated will be an important factor of consideration when determining whether these mechanisms are to be considered as a threat.[371] More specifically, there will likely be less concern about such operations if the pattern

365 UN Doc. A/68/189 (2013), *supra* note 14, p. 17, para. 42.
366 Ibid, para. 44.
367 UN Doc. A/76/77 (2021), *supra* note 350, pp. 15-16, para. 38(g).
368 Principle IV(c), CONFERS Guiding Principles.
369 UN Doc. A/68/189 (2013), *supra* note 14, p. 19-20, para. 57.
370 UN Doc. A/76/77 (2021), *supra* note 350, p. 16.
371 Ibid, p. 98.

of life of a satellite is consistent with that of its stated intent.[372] In other words, concerns may arise as to the true intention of an ADR mission if the actual operation of the removal spacecraft deviates from the previously announced mission plan. In the case of deviation, notification and consultation in a timely manner can be useful for the avoidance of miscalculation and the clarification of ambiguity.

In addition, RPO conducted without advance notification, coordination or consent can be regarded as a threatening act, as the State whose satellite is approached is unable to know the intent of the manoeuvring satellite.[373] As Germany notes, in the absence of consent, explanation or consultation, the affected State cannot exclude the possibility that the approaching satellite is intended to cause interference or conduct hostile actions.[374] The situation could be even more concerning when a spacecraft equipped with a capture mechanism, such as a robotic arm, somehow approaches a satellite of strategic importance to another State. To reduce the risk of unintended tensions, States should establish appropriate communication channels to exchange views regarding ambiguous behaviours.

4.4.5 Familiarisation Visits

According to the GGE Report of 2013, "[v]oluntary familiarisation visits can provide opportunities to improve international understanding of a State's processes and procedures for space activities, including *dual-use* and military activities, and can provide context for the development and implementation of notifications and consultations".[375] This is the only time when the term "dual-use" is referred to in the Report. As ADR technologies are of an inherent dual-use nature, familiarisation visits may help to build trust among States.

The GGE Report further recommends that the demonstrations of rockets and other space-related technologies could be conducted on a voluntary basis and in line with existing multilateral commitments and national export control regulations.[376] As ADR items and technologies may be subject to national export control regulations, familiarisation visits to ADR facilities have to be carried out in compliance with these regulations. Given the sensitivity of ADR technologies, a possible way to initiate familiarisa-

372 Ibid.
373 Ibid, p. 7.
374 Ibid, p. 48.
375 UN Doc. A/68/189 (2013), *supra* note 14, p. 18, para. 46, emphasis added. As an example of familiarisation visits, in April 2017, the Director of UNOOSA and other UN officials participated in a familiarisation visit to the Wenchang Space Launch Centre in Hainan province, China. See UN Doc. A/AC.105/2017/CRP.11 (9 June 2017). Information on the official visit to China of the Director of the United Nations Office for Outer Space Affairs.
376 Ibid, para. 48.

tion visits may start with "observations of space object launches".[377] For instance, States may invite other States to observe the launch of removal spacecraft and arrange such visits on a reciprocal basis. Like information sharing, States may demonstrate publicly their peaceful intentions through familiarisation visits.

4.4.6 Section Conclusion

Due to their dual-use potential, ADR activities may raise security concerns. To respond to these potential concerns, States engaging in ADR activities should enhance the transparency of their missions through the sharing of relevant information in a timely manner to clarify their intentions, especially in ambiguous situations. While not explicitly addressing ADR, the GGE Report of 2013 contains a series of recommendations that could be useful for reducing the risk of concerns over ADR activities. On the basis of these recommendations, the relevant measures that could be adopted by States conducting ADR activities to reduce the risk of misperceptions can be summarised as below:

1. Publication of national policies relating to the development and use of ADR technologies;
2. Exchange of information on ADR activities such as the publication of mission plans;
3. Provision of risk reduction notifications to other States, especially before potentially dangerous operations and in the event of anomalies in the course of ADR activities;
4. Designation of a contact point and establishment of appropriate channels for effective communication, consultation, and coordination regarding ADR activities;
5. Organisation of familiarisation visits to ADR launches, on an equitable and mutually acceptable basis and in compliance with relevant export control laws and regulations.

ADR activities are not only a necessity for space sustainability but are becoming a reality, as some States and private entities are developing and planning their missions to remove defunct objects from orbit. Hence, it is essential for the potential dual-use concerns over these activities to be properly addressed to ensure that these activities would not become destabilising factors to international peace and security in outer space. The international discussion on the future legal development to address the security concerns over ADR activities is addressed by the OEWG convened under the UN General Assembly Resolution 76/231.[378] This will be taken

377 UN Doc. A/76/77 (2021), *supra* note 350, pp. 15-16, para. 38(i).

378 UN Doc. A/RES/76/231 (30 December 2021). Reducing space threats through norms, rules and principles of responsible behaviours, para. 5.

up in Chapter 5 Section 5.4 to assess the relevance of the initiatives on the development of norms of responsible behaviours for ADR operations.

4.5 Chapter Conclusion

As noted in Chapter 3, gaps can be found in the hard law pillar of international space law for the regulation of all four issues relating to the governance of ADR, viz., (1) the lack of a clear legal obligation to not create space debris and to clean up existing debris; (2) the ambiguity of "fault" in the current liability regime that may disincentivise ADR; (3) the jurisdiction and control over space objects that may constitute a legal hurdle for ADR; and (4) the absence of specific rules to address the dual-use concerns over ADR. The question of this chapter is how the soft law pillar contributes to filling these regulatory gaps in the hard law pillar. To answer this question, the current chapter examined a number of relevant soft law instruments to assess how the four issues are addressed by them.

As to the *first* issue, States and international organisations have developed several international guidelines and standards for the mitigation of space debris. These instruments recognise the need to implement space debris mitigation measures for the safety of space operations and they reflect the current practices regarding debris mitigation. They have been incorporated by States into their national legal order to varying degrees, and a growing trend of compliance in practice can be observed. However, the current rate of their compliance is insufficient to effectively control the growth of space debris. The adoption of the LTS Guidelines constitutes another remarkable milestone for the preservation of the long-term sustainability of outer space activities, and some guidelines are of close relevance to ADR, including the guideline recommending the investigation of new measures to manage the space debris population in the long term. However, the LTS Guidelines do not explicitly address ADR, and currently no international guidelines are found that encourage States to remove previously created debris, in spite of the general understanding of the space community that the removal of five to ten massive objects per year is necessary to preserve the sustainability of the orbital environment. This may be explained by the fact that ADR operations are in the nascent phase and it still takes time for ADR to develop into routine practices. Meanwhile, with the growth of the space debris population and increasing congestion in the orbital environment, it would be advisable to shape international commitments on space debris mitigation and remediation sooner rather than later.

As to the *second* issue, the ambiguity of the notion of "fault" under the current liability regime of international space law can be remediated by the adoption of soft law instruments governing space activities. In particular, the guidelines and standards regarding debris mitigation and space sustainability provide guidance on how space activities are to be carried out in a reasonable manner with due regard to the rights and interests of other States. Hence, the compliance with these soft law instruments can be an element of consideration in the determination of fault. Currently, States have not yet adopted specific guidelines for the performance of ADR activities. The commercial space industry has already taken some initiatives in this regard, including the guidelines and standards developed by industry associations such as CONFERS and the SSC to support ADR missions. In particular, CONFERS has published a set of guiding principles and recommended practices that can enhance the safety and mission success of ADR. These CONFERS publications served as a foundation for the development of ISO 24330, which contributes to the standardisation of ADR operations at the international level. The inclusion of the compliance with current standards such as those published by CONFERS in the SSR assessment of ADR missions could provide an additional incentive for operators to adhere to these standards. A further step that can be taken is to develop international guidelines for ADR that are adopted by States, which can not only represent the common understanding of States on the way to conduct ADR activities but also embody their political commitment that they will perform ADR operations in a manner that contributes to the long-term sustainability of outer space activities.

As to the *third* issue, UNGA Resolution 62/101 provides useful recommendations on the provision of additional information to the UN Secretary-General on the change of status in operations of objects launched into outer space. Yet, as space debris is still included in the scope of "space object" in the context of the UN space treaties, the information that a space object becomes no longer functional does not mean other States are entitled to remove such object. Therefore, prior approval of the State of registry is still needed for the removal of a debris object under its jurisdiction. Currently, there is no known international mechanism facilitating the requesting and granting of such approval. To promote cooperative ADR programs on a consensual basis, it would be desirable for the international community to develop such mechanisms in the future.

As to the *fourth* issue, the GGE Report of 2013 provides some general recommendations that could be considered by States to enhance the transparency of their ADR missions. These measures include, for instance, the publication of national policies on the development and use of ADR technologies as well as the notification and coordination regarding ADR activities in a timely manner. In view of the potential dual-use concerns over ADR activities, it would be advisable for States to develop more specific principles and norms for ADR to ensure that these activities are carried out in a transparent and responsible manner in order to reduce the risks of security concerns.

In sum, it can be concluded that the soft law pillar fills, to some extent, the regulatory gaps in the hard law pillar, but there are also areas where further development of space law is needed. For future legal development to address these gaps, an important question to consider is whether soft law is an appropriate vehicle for space law to move forward. As noted in Chapter 1, no new space treaty has been adopted within the UN ever since the adoption of the Moon Agreement in 1979. As COPUOS makes decisions by consensus, the expanding range of States taking part in space activities and becoming members of COPUOS makes the negotiation and adoption of an international space treaty within COPUOS increasingly challenging.[379] This does not necessarily mean that the development of a legally binding agreement for the regulation of space debris is completely out of reach, especially when considering that all space actors, whether governmental or private, whether large or small, have a common interest in safeguarding the sustainability of outer space for future use.[380] Meanwhile, in view of the fact that even the non-binding COPUOS LTS Guidelines took almost a decade to develop, it can be reasonably expected that developing a binding agreement for the governance of space debris will be a lengthy process marked with intensive discussions and negotiations among States. Moreover, as observed by Zannoni, within COPUOS, there is currently no consensus among States on whether legally binding rules should be established for the regulation of space debris.[381] Therefore, from where we stand, the most plausible path forward is to strengthen the compliance with the existing space law and to continue using soft law for furthering legal development to more effectively regulate issues relating to space debris and ADR.

When reflecting on the role of soft law for the further development of space law, it is important to note that the developments of soft law and hard law are not two mutually exclusive paths. Rather, the adoption of soft law instruments may later lead to the conclusion of new treaties for the governance of space activities. As one example in space law, the basic principles contained in the 1963 Declaration of Legal Principles were incorporated almost verbatim into the Outer Space Treaty.[382] As von der Dunk observes,

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379 Ibid.

380 Masson-Zwaan & Hofmann (2019), *supra* note 2, p. 119.

381 Zannoni, D. (2022). Out of Sight, Out of Mind? The Proliferation of Space Debris and International Law. *Leiden Journal of International Law*, *35*(2), p. 296.

382 Similarly, in the context of human right law, the Universal Declaration on Human Rights (UDHR) is a non-legally binding instrument adopted by the UN General Assembly in 1948. The UDHR served as a foundation for the development of two binding treaties regarding human rights which elaborate upon the norms contained in the declaration. See UDHR (adopted 10 December 1948) UNGA Res 217 A(III). See also Rose (2022), *supra* note 258, p. 32. The two treaties are: International Covenant on Civil and Political Rights, entered into force 23 March 1976, 999 UNTS 171; International Covenant on Economic, Social and Cultural Rights, entered into force 3 January 1976, 993 UNTS 3.

the adoption of soft law allows States, hesitant at the outset to subject themselves to clear-cut treaty obligations, "to start out accepting merely political 'obligations' which are not yet fully elaborated and/or not legally binding [...] [and] to gradually lose their cold feet in getting acquainted with the way such obligations turn out to affect their interests".[383] In this sense, soft law can serve as a stepping stone in the process towards the goal of concluding a legally binding agreement.[384] In addition, soft law instruments could be more easily revised compared to the amendment of treaties, a character allowing them to keep in step with technological developments.[385] This character makes soft-law instruments particularly suitable to govern areas involving rapid technological advances such as the space domain. Specifically, as ADR activities are currently at a nascent stage, the understanding of the international community regarding how these activities should be carried out safely and responsibly in order not to cause harmful interference with the space activities of others may evolve over time.

Finally, being non-legally binding does not mean being completely toothless. Since many international instruments reflect best practices and expected behaviours, non-conformity with them may cause reputational damage, lead to international condemnation, or result in other forms of backlash such as the loss of opportunities for international cooperation.[386] These factors can exert political pressure on States to ensure compliance with these instruments in spite of their lack of binding force. The importance attached to soft law can be observed in the process of their development. As Freeland submits, it is often the case that the negotiation and finalisation of the texts of a space-related soft law instrument has been a complex and time-consuming endeavour, making it difficult to argue that such instrument "is not intended to have *any* legal consequence whatsoever".[387] A similar observation is made by Dupuy that in some instances, State delegations approach the negotiation of soft law provisions "with extreme care, just as if they were negotiating treaty provisions".[388] The seriousness taken by States in the development of soft law instruments indicates that they do not view these instruments "as devoid of at least some political significance, if not, in the long term, any legal significance".[389] In practice, legal and political con-

383 Von der Dunk, F. G. (2012). Contradictio in Terminis or Realpolitik? A Qualified Plea for a Role of 'Soft Law' in the Context of Space Activities. In Marboe, I. (Ed.), *Soft Law in Outer Space: The Function of Non-binding Norms in International Space Law*. Böhlau Verlag, pp. 53-54.
384 Masson-Zwaan (2023), *supra* note 241, p. 4.
385 Wessel, B. (2012). The Rule of Law in Outer Space: The Effects of Treaties and Nonbinding Agreements on International Space Law. *Hastings International and Comparative Law Review*, *35*, p. 315.
386 Martinez (2020), *supra* note 134, p. 557.
387 Freeland (2012), *supra* note 257, p. 28.
388 Dupuy (1991), *supra* note 117, p. 429.
389 Ibid.

siderations often combine to influence the behaviours of States.[390] Hence, as articulated by Jennings, “recommendations may not make law, but you would hesitate to advise a government that it may, therefore, ignore them, even in a legal argument”.[391]

In light of the above considerations, the adoption of soft law instruments, especially those embodying political commitments of States, represents the most feasible way forward to fill the remaining regulatory gaps regarding the governance of the four issues relating to ADR. How these gaps are to be filled in future legal development will be discussed in the next chapter.

390 Abbott, K. W., Keohane, R. O., Moravcsik, A., Slaughter, A. M., & Snidal, D. (2000). The Concept of Legalization. *International Organization*, *54*(3), p. 419.

391 Jennings, R. Y. (1980). What is International Law and How Do We Tell It When We See It?. *The Cambridge-Tilburg Law Lectures*, 3rd series, p. 14. Quoted from Freeland (2012), *supra* note 257, p. 28.