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**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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The central research question addressed in this dissertation is whether the current international legal framework for space activities, consisting of hard and soft law pillars, adequately governs ADR and if not, what are the gaps and how the current legal framework can move forward to fill these gaps. This question is addressed in Chapters 2 to 5 of this dissertation, each seeks to answer a specific sub-question in order to ultimately answer the central question.

Chapter 2 discusses why space debris is problematic and what are the potential issues surrounding ADR to solve the debris problem. Space debris is a problem because it threatens both the safety of space operations and the long-term sustainability of outer space activities. Mitigating the generation of new debris is indispensable but alone insufficient to halt the growth of space debris, and the active removal of about five to ten large debris objects from outer space per year is needed to stabilise the orbital environment. The practical need for debris mitigation and remediation raises a question as to whether the current international legal framework imposes an obligation to mitigate and remove space debris. Due to their high velocity orbiting the Earth, space debris can cause damage to other objects in orbit and thus raise liability issues, which is relevant to ADR activities as these activities involve a high risk of collision and may lead to the creation of more debris if such risk materialises. Therefore, the current liability regime for damage caused by space objects and its implications to ADR activities need to be studied. Meanwhile, if one State cannot effectively remove its own dangerous space debris from orbit, other States may want to do it on its behalf for the sake of protecting their space assets or maintaining long-term space sustainability. Therefore, it is important to understand which State has what rights over space debris under the current legal framework. Finally, the dual-use potential of removal spacecraft may raise security concerns, and it is thus essential for the legal framework to regulate the use of these dual-use systems and the way to carry out ADR activities in a manner to reduce the risks of misperceptions and misunderstandings.

In light of the above issues, **Chapter 3** analyses how the hard law pillar of international space law applies to ADR and whether there are regulatory gaps. This pillar, with the UN space treaties being at its core, provides some basic answers to the regulation of the four issues relating to space debris

and ADR, but these answers do not respond satisfactorily to the need for the effective governance of these issues.

Firstly, while the hard law pillar contains provisions that require States to conduct their space activities with due regard to the rights and interests of others and to avoid contaminating outer space, it fails to impose a clear obligation upon States to mitigate and remove space debris, which is problematic in view of the continuing growth of space debris. Secondly, the existing international legal framework for space activities does not provide a specific standard of care for the determination of fault to attribute liability for damage caused in outer space. This creates legal uncertainty for ADR operators in terms of liability exposure and may disincentivise them from conducting ADR operations. Thirdly, under the existing legal framework, the State of registry retains jurisdiction and control over its space object. The interpretation of this provision indicates that the jurisdiction and control over a space object remains after such object ceases to function, and even after such object has been disintegrated into pieces. Therefore, express consent of the State of registry must be obtained before the removal of a space debris object under its jurisdiction. Non-consensual removal may be excused by invoking the circumstances precluding wrongfulness such as necessity and distress under certain conditions. However, non-consensual removal should in general be avoided and should in any event be conducted with caution because this kind of operations can be considered as threatening actions and could thus adversely affect international peace and security in outer space. Therefore, the international community needs to find a way to promote ADR activities undertaken on a consensual basis, namely to facilitate the seeking and granting of permission for debris removal. Fourthly, due to the inherent dual-use nature of ADR systems, namely their capability to remove space debris and to degrade or damage another satellite according to the intention of their operators, the deployment and use of ADR systems can potentially raise security concerns. The hard law pillar imposes restrictions on the use of ADR mechanisms for hostile purposes, but it does not contain specific rules on how ADR operations should be conducted in a manner to assuage potential dual-use concerns.

Chapter 4 discusses whether and how the soft law pillar of international space law contributes to filling the regulatory gaps in the hard law pillar. The analysis shows that some of the gaps in the hard law pillar have been addressed in the soft law pillar of international space law, but there still remain some gaps to be filled in future legal development.

Firstly, the international community has taken some positive steps forward in the form of non-binding instruments on the mitigation of space debris and the preservation of long-term space sustainability. Despite their voluntary nature, these instruments can be implemented by States in their national legal order and become binding to private operators at the domes-

tic level. However, in practice, these instruments are not complied with at a sufficient rate to effectively tackle the space debris problem. In addition, these instruments focus on the mitigation of space debris and the long-term sustainability of outer space activities, yet they do not specifically address ADR. Therefore, further efforts are needed from the international community to promote the mitigation and remediation of space debris. Secondly, soft law instruments, such as the COPUOS Space Debris Mitigation Guidelines and COPUOS LTS Guidelines, can contribute to clarifying the general concepts and provisions of the UN space treaties, including in particular the notions of “fault” and “due regard”. Therefore, it would be advisable for the international community to develop specific guidelines and standards on the design and operations of ADR missions, which could be used as a benchmark for the determination of “fault” when an ADR mission causes damage to other space objects. The commercial space sector has stepped forward in this regard by publishing some guiding principles and recommended practices for ADR, and some of these publications served as the foundation for the development of ISO Standard 24330:2022. To enhance the authoritativeness of the relevant standards, States could adopt commonly accepted guidelines for ADR operations like the international space debris mitigation guidelines developed within the IADC and COPUOS, which can embody their political commitments and endorsement on the way to carry out ADR activities in a safe manner. Thirdly, although the UNGA resolution 62/101 provides some recommendations on the provision of additional information to the UN Secretary-General regarding the change of status in operations, this does not solve the legal obstacle of jurisdiction and control as the prior consent of the State of registry is still needed even for the removal of a non-functional object. Currently, an international mechanism facilitating the requesting and granting of approval for the removal of space objects under the jurisdiction of another State is not available, which thus represents a domain for improvement in the future development of space law. Fourthly, a critical manner to reduce dual-use concerns over ADR activities is to enhance the transparency of these activities. This makes the GGE Report of 2013 particularly relevant in this regard, which contains a series of recommendations to enhance the transparency of space activities and build confidence and trust among States. While these recommendations provide useful guidance on the way to carry out space activities, they do not explicitly address ADR and the development of more specific guidelines regarding the way to conduct ADR activities in a transparent manner would be beneficial to reducing the risk of misperceptions over these activities.

In sum, while soft law provides some answers to the legal gaps of hard law for the governance of the four issues relating to ADR identified in Chapter 2, there are still domains where the current international space law needs to move forward to better regulate these issues. In this regard, soft law represents a step-wise approach for the further development of space

law, which may pave the way for the conclusion of a binding agreement to govern ADR in the future.

Therefore, when it comes to the central question as to whether the current international legal regime adequately regulates ADR, the answer of this study is no. Through its hard and soft law pillars, the existing regime provides for a basic legal framework applicable to the governance of ADR activities. Yet, there are regulatory gaps calling for further legal development. In this context, **Chapter 5** examines the current initiatives relevant to the governance of ADR activities and assesses how the current legal framework may move forward to accommodate the regulatory needs of these activities.

Firstly, to fill the gap of the lack of an explicit obligation under international law on debris mitigation and remediation, States with a strong intent to ensure the long-term sustainability of outer space activities may lead international efforts by making unilateral and multilateral commitments to mitigate and remove space debris. This process can contribute to the shaping of political will, and an example in this regard is the moratorium on the testing of destructive, direct-ascent anti-satellite missiles, which was initiated by the US and has been subsequently joined by other States, including all EU members. This process could hopefully lead to the conclusion of an international agreement to systematise the process of States to make and review their commitments regarding debris mitigation and remediation, modelling after the 2015 Paris Agreement. In the meantime, all sorts of stakeholders in the space sector, public and private, may commit to taking concrete actions to mitigate the creation of new debris and remediate existing debris within the Net Zero Space initiative.

Secondly, States can develop consensus general principles for ADR activities within the LTS 2.0 Working Group as these activities, due to their inherent risk of collision, can affect the safety of all actors in space. In addition, it is advisable for spacefaring nations, especially those engaging actively in the development of ADR technologies and missions, to develop more specific guidelines to guide the design and operations of ADR activities. IADC represents an appropriate forum in this regard because it has already started to address the issue of ADR and its members are the most technologically feasible ones to perform ADR missions in the near future. In the process of producing these guidelines, the IADC may obtain information from the contributions of the commercial space industry such as the publications of CONFERS, the ISO 24330:2022, and the legal development made by States for the governance of ADR activities.

Thirdly, as prior consent of the States of registry is needed, it would be advisable for States to develop an international mechanism to facilitate the seeking and granting of permission for the removal of debris under foreign

jurisdiction. This could be achieved through the adoption of a UN General Assembly resolution providing recommendations on the following areas (i) the elements for consideration in bilateral arrangements for the granting of permission including liability apportionment and export control; (ii) the furnishing of information on the removable status of debris objects to UNOOSA; and (iii) the joint granting of consent to the removal of debris objects below a certain size threshold in order to provide definitive legitimacy for the lawful removal of these objects.

Fourthly, to ensure that peaceful ADR operations would not be mistaken as a threat, the international community could establish, on the basis of the GGE Report of 2013, specific norms and principles to enhance the transparency of ADR operations. As communication will be an important tool to enhance both mission safety and transparency, it would be beneficial for the OEWSG 2.0 to work in coordination with the LTS 2.0 Working Group and other relevant initiatives to develop norms and principles for the notification, consultation and information sharing regarding ADR operations.

In sum, the current international space law establishes the fundamental legal framework for the governance of space activities, yet the existing regime is not sufficient to effectively govern ADR. This dissertation identifies the gaps in the existing legal regime and points out the way forward for further legal development to better regulate ADR activities. As stated at the beginning of the preamble of the Outer Space Treaty, the States Parties to the Treaty were “[i]nspired by the great prospects opening up before mankind as a result of man’s entry into outer space”. To ensure that such great prospects would not be “closed down” by the continuous growth of space debris, it is now a time and a mission for space lawyers to demonstrate the contribution and significance of space law to clear up space debris and preserve the future use of outer space.