SESSION 2
SPACE DEBRIS: Legal and Policy Issues of Active Debris Removal and On-Orbit Servicing

International Legal and Political Context of Active Debris Removal (ADR) and On-Orbit Servicing (OOS)

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Table of Contents

1. Six Decades of State Practice

Six decades of practice in outer space has resulted in over 4,800 rocket launches placing over 6,000 spacecraft into orbit. Of these, less than 1,300 are still operational. The Space Surveillance Network (SSN) tracks over 23,000 man-made objects in space, of which less than 5% are operational spacecraft. They further estimate that, besides these 23,000 objects, there are an additional 500,000 objects between 1 and 10 cm in size, and over 100 million objects less than 1cm. So, have we reached the tipping point of the *Kessler Syndrome* yet?[1]

[1] NASA Orbital Debris Program Office, *Orbital Debris - Frequently Asked Questions*, http://www.orbitaldebris.jsc.nasa.gov/faqs.html

2. International Space Law

Some basics of applicable space law related to space debris and on-orbit servicing need to be addressed. The 1967 Outer Space Treaty established four important pillars: 1) the exploration and use of outer space is the province of all mankind; 2) there is no national appropriation of outer space, including the moon and other celestial bodies (and therefore outer space is an area where state sovereignty is absent); 3) states are internationally responsible for their national space activities and potentially internationally liable for damage to the space objects of other states; and 4) states retain jurisdiction and control over the space objects which they place on their national space registry.[2]

To sum up, states have the *right* to access, use, and explore space. They have the corresponding *positive obligation* of international responsibility for national activities and potential liability for physical damage. They also have the *negative obligation* against national sovereignty over outer space, and the corresponding *right* to assert jurisdictional powers (an element of sovereignty) over space objects on their registry. However, keep in mind that the Outer Space Treaty is merely a treaty of principles that is only 17 articles in length, rather than a comprehensive framework, such as the United Nations Convention on the Law of the Sea (UNCLOS).

3. Policy and Law Approaches to Debris

- 1979 – NASA established its Orbital Debris Program Office[3]
- 1997 – NASA Debris Mitigation Guidelines[4]
- 2002 – IADC Space Debris Mitigation Guidelines[5]
- 2007 – COPUOS Space Debris Mitigation Guidelines[6]
- 2011 – ISO Standard 24113[7]
- 2011 – COPUOS STSC LTS guidelines begins work[8]

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2 And while there can be more than one "launching state", there should be only 1 "registering" state (and that registering state should be a "launching state").

3 NASA Orbital Debris Program Office, *Orbital Debris – Frequently Asked Questions*, http://www.orbitaldebris.jsc.nasa.gov/faqs.html.

4 NASA Orbital Debris Program Office, *Orbital Debris – Mitigation*, http://www.orbitaldebris.jsc.nasa.gov/mitigate/mitigation.html.

5 Inter-Agency Space Debris Coordination Committee, *IADC Space Debris Mitigation Guidelines*; *AVAILABLE AT:* http://www.iadc-online.org/Documents/IADC-2002-01,%20IADC%20Space%20Debris%20Guidelines,%20Revision%201.pdf.

6 United Nations Office for Outer Space Affairs, *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, 2010, *AVAILABLE AT*: http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

7 International Organization for Standardization, *"ISO 24113:2011, Space Systems – Space Debris Mitigation Requirements,"* 2011; *AVAILABLE AT*: http://www.iso.org/iso/catalogue_detail?csnumber=57239

8 See for example of recent work and progress of this group in the 2016 *Report of the Working Group on the Long-term Sustainability of Outer Space Activities*, A/AC.105/C.1/LTS/2016/L.1, *AVAILABLE AT*: http://www.unoosa.org/res/oosadoc/data/documents/2016/aac_105c_1lts/aac_105c_1lts2016l_1_0_html/AC105_C1_LTS_2016_L01E.pdf.

Various policy approaches, not rising to the level of new and binding international law, have been undertaken. The IADC mitigation standards are technical in nature, as are the ISO standards. The COPUOS mitigation guidelines are more political in nature, as the recent work at the Scientific and Technical Subcommittee of COPUOS on the Long-term sustainability of space activities is ongoing. Additionally, these approaches are aimed at the mitigation of creating new debris, through the design and operation of new spacecraft, and the planning for the deorbiting or "graveyarding" of spacecraft already on orbit. The reduction of space debris is a separate issue.

4. Tragedy of the Commons

Outer space suffers from, in some respects, the same disincentives for sustainability as previous examples from history. The *"Tragedy of the Commons"* scenario, as written about by Hardin, seems to apply, as: 1) nobody owns space, yet; 2) everybody can use it (and many do), yet: 3) nobody is in charge. Consequently, there is: 4) no clear solution to prevent its despoliation as a common resource.

5. Active Debris Removal and On-Orbit Servicing

The potential technological developments to capture debris are similar to the technologies for OOS, mostly involving advances ranging and proximity operations (RPO). The can be divided along three lines: 1) pull; 2) push; and 3) contactless.

Types of ADR deorbiting technologies

Category	**Application**	**Actor**
Pull	Throw Net	ESA
	Harpoon	ESA
	Tether	JAXA
	Tentacles	EPFL
Push	Robotic Arm	DLR
	Adhesive	Astroscale
Contactless	Ion Beam	ESA
	Laser	Riken

An example of a **pull technology** is an electrodynamic tether that will slow down the space

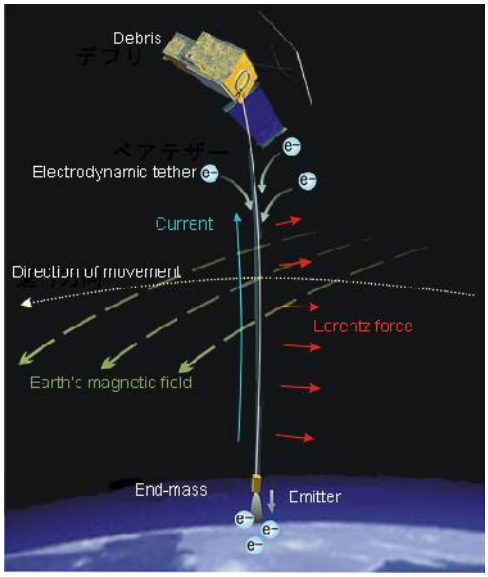

Figure 1 - Electrodynamic tether. Source: JAXA and ExtremeTech at http://www.extremetech.com/extreme/175230-japan-is-preparing-to-launch-a-giant-magnetic-net-that-will-trawl-space-for-junk

debris, causing it to fall into increasingly lower orbits until it burns up in the atmosphere. JAXA has made advancements in this technology.[9]

Another pull technology is a proposed by ESA, and is a catcher satellite that shoots out a weighted net on the end of a tether. The net spreads and engulfs the target spacecraft.

Push technologies are also being developed in Europe by DLR. The DEOS Mission could catch debris using a robotic arm, and this technology seems to be applicable to both debris and satellite servicing.

Contactless technologies include Riken, a private company, proposing to mount a laser on the side of the International Space Station to sweep away disease.

6. International Reception to ADR and OOS

The business case for ADR and OOS is difficult enough, with technology people needing funding, legal counsel unsure of the technology before they can create the appropriate legal framework, and funders needing both clear ideas on the technology and legal framework before they are willing to invest. Consequently, ADR and OOS is having a difficult time getting started.[10]

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[9] Sebastian Anthony, *Japan is preparing to launch a giant magnetic net that will trawl space for junk*, EXTREMETECH, Jan. 14, 2014, http://www.extremetech.com/extreme/175230-japan-is-preparing-to-launch-a-giant-magnetic-net-that-will-trawl-space-for-junk

[10] Matthew Weinzerl, Angela Acocella, and Mayuka Yamazaki, *Astroscale, Space Debris, and Earth's Orbital Commons*, Harvard Business School Case Study 9-716-037, March 10, 2016.

Compared to international legal and political context, these business issues seem tame and solvable. The space domain is increasingly seen as a domain for conflict (either in or through space), and the concept of the inevitability of conflict in outer space is growing as a consensus opinion.[11] Considering this tense geopolitical climate, where conflict might be either 1) on Earth, using space-based assets, 2) on Earth, with space-assets targets from earth-launched missiles, or 3) entirely space-based, and where dependence on space-based infrastructure renders economies and militaries with an *"Achilles's heel"* in space, the criticality and strategic importance of space-based assets is clear. With this in mind, what reception would greet some of the proposed technologies like space tethers, harpoons, space tentacles, and laser and ion beams mounted in space?

7. New Treaty Law, or Unilateral Domestic Solutions?

Does creating the right institutional/legal/regulatory framework mean creating a new and binding comprehensive international legal instrument to cover every facet of space debris and on-orbit activity. A "Space Debris" Treaty? A "Low-Earth Orbit Treaty"? If not, can these issues be solved through various UN General Assembly resolutions, perhaps similar to the yearly UNGA resolution on the international cooperation on the peaceful uses of outer space?[12] Should COPUOS adopt a new agenda item on space debris remediation, and perhaps aim to create new deliverables through the upcoming UNISPACE+50 initiative? Will the COPUOS LTS guidelines bring sufficient clarity to the discussion? Or is there already enough distrust and contention in the field?

The Russian Federation has already advanced the idea that space debris, as under the lasting jurisdictional control of a state (as being the component part of a space object), remains under their jurisdiction. Any interference with their space debris (so the argument goes) without prior notification and authorization by the launching and responsible state, is necessarily a violation of that state's jurisdictional competencies. As such - and especially as jurisdiction is a strong component of state sovereignty (the argument progresses) - a violation of jurisdiction and sovereignty is a provocative act. Indeed, it may rise to the level of the use of force, and perhaps even an armed attack (a greater use of force) and therefore legitimize the inherent right of self-defense held by all states.[13] They have raised this point in an abstract sense in various international fora:

> The intrigue lies in the provisions of the draft Code of Conduct which stipulate that Subscribing States shall express their intention to refrain from any action that might bring about, directly or indirectly, damage to, or destruction of, space objects unless such action is motivated, apart from the UN Charter, including the right of self-defence, by the interests of reducing space debris and

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[11] Dwayne Day, *Everybody Wants to Rule the World*, THE SPACE REVIEW, http://www.thespacereview.com/article/2999/1.

[12] *See for example* UNGA Res. 70/82, *International cooperation in the peaceful uses of outer space*, Dec. 15, 2015, *AVAILABLE AT*: http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/82.

[13] Working Paper submitted by the Russian Federation, *Achievement of a uniform interpretation of the right of self-defence in conformity with the United Nations Charter as applied to outer space as a factor in maintaining outer space a safe and conflict-free environment and promoting the long-term sustainability of outer space activities*, A/AC.105/C.1/2015/CRP.22, Feb. 2, 2015, *AVAILABLE AT*: http://www.unoosa.org/pdf/limited/c1/AC105_C1_2015_CRP22ER.pdf.

> imperative safety considerations. In addition, of key importance is the fact that the document does not specify whether such an intention of States concerns their own space objects or foreign ones as well. It turns out that actually, it is all about reserving the possibility of using coercive measures, including for the "good cause" of reducing space debris, without obtaining the consent of a State which exercises jurisdiction and control over space objects in accordance with the international space law. As a result of such legitimization, unauthorized measures may essentially cease to be considered an international wrongdoing.[14]

This is a strong and worrisome argument, but it highlights the security aspects of these technologies - which many proponents might initially seem as harmless. Given the structure of COPUOS, which operates by consensus – and where any one state can stall progress, the timely resolution of these issues may be quite distant. Many want COPUOS to develop an all-encompassing and comprehensive new legal instrument for space. Others feel that meddling with the structure of the Outer Space Treaty would be risky, if not disastrous.

8. Conclusion

Does the existing framework of national oversight, supervision and control, and continuing supervision, give enough guidance and impute enough responsibility to states? Or do new soft-law measures, such as a COPUOS-created set of guidelines or principles on ADR and OOS, seem the way forwards? It seems right to believe that the framework should not get ahead of the technology and the practice, nor should it fall to far behind. We want to create a regulatory framework which allows for ADR and OOS to progress, not one that strangles it before it can begin with overly burdensome and onerous regulation.

A further issue is "who pays", especially as (some estimate) that 90% of existing space debris has been created by the countries: Russia, China, and the United States.[15] *So, why should emerging space countries have to fund cooperative efforts to mitigate and/or capture space debris?*

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[14] *Ibid* at pg. 3 para. 9.

[15] Matthew Weinzerl, Angela Acocella, and Mayuka Yamazaki, *Astroscale, Space Debris, and Earth's Orbital Commons*, Harvard Business School Case Study 9-716-037, March 10, 2016, at pg. 8.