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Space Debris Removal for a Sustainable Space Environment

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At the same time when outer space activities become increasingly important to states, the room for actions and new actors tends to get smaller and the risk that outer space becomes inaccessible is rising. Decision-makers have recently taken the topic of space sustainability on their agenda, investigating policies to coordinate future actions. Nevertheless, they are ignoring the danger that already existing threats pose to the space environment. Attempts to counter existing space debris are rare and lack a sound concept that takes international treaties and interests into account. This issue of the ESPI Perspectives series takes legal, policy and commercial issues into consideration, in an attempt to find out how a comprehensive model for mitigating the space debris threat could be designed. In doing so, it calls for a legal definition of space debris, amendments to existing treaties and a programme guided by the international community in order to unleash the power of the commercial space sector.

1. Introduction

Outer space activities are increasingly threatened by a past that were driven by "big-sky-policies", assuming that outer space reserved endless possibilities for human activities. Already in the early 70's scientists questioned these policies, pointing out that most of the objects sent to outer space would stay there for years and ultimately collide with each other, exponentially multiplying the number of objects in orbit and creating the potential for further collisions. Early scientists named this evolutionary process the "cascade-effect" that, once started, would prevent human access to outer space.

In recent years, two major incidents caused alarm to politicians, space-operators, academics and other space activity stakeholders. In 2007, China conducted an anti-satellite (ASAT) test, destroying one of its own old satellites and thus dramatically increasing the population of objects orbiting Earth. While this intentional test shook up the space community, the second major incident displayed the helplessness of states against accidental collisions in space: in 2009, an Iridium satellite collided with an inactive Russian Cosmos satellite.

Objects resulting from these collisions are known as space debris, keeping in mind that other kinds of objects also fall under this category, such as inactive satellites, or lost human spaceflight equipment. The total number of space debris items has not been accurately determined. Estimates assume up to 150 million objects, while the US is able to monitor up to 20,000 objects larger than 10 cm, which demonstrates the limited possibility of even the most advanced space-faring nation to be fully aware of the incidents that create space debris.[1] The latter estimate of space debris is attributed 43% to China, 27.5% to the US and 25.5% to Russia.[2] While the "cascade-effect" constitutes a major problem, it is far from being the top-priority on the agenda. Interferences of space debris with satellite signals or the increasingly limited space in the GEO region for new states are currently the most debated topics by the space community.

1 "Space Debris." 18 Dec. 2011 Technische Universität Braunschweig 4 Apr. 2011. http://www.tu-braunschweig.de/ilr/forschung/raumfahrttechnik/spacedebris/index.html.

2 Ansdell, Megan. "Active Space Debris Removal: Needs, Implications and Recommendations for Today's Geopolitical Environment." 2 June 2010 Princeton University 5 Apr. 2011 http://www.princeton.edu/jpia/past-issues-1/2010/Space-Debris-Removal.pdf.

2. Current Policies for Space Sustainability

Acknowledging the threat to the space environment, the current US administration in its National Space Security Strategy defines the present situation as "congested, contested, and competitive".[3] To counter this problem, one of the first objectives is to get a better account of the situation in space. Therefore, the US, Russia and certain European states have developed assets that are able to monitor orbiting objects. The US is currently the actor with the greatest capacity, capable to monitor objects in orbit by utilising ground-based sensors around the world. Despite their capabilities, these systems are in great need of upgrading, in order to cope with rapidly growing space activities worldwide. In addition to the US system, ESA and the EU also have a Space Situational Awareness System (SSA) under development, while its Russian counterpart dates back to the cold war era and is of marginal relevance.

Apart from technical monitoring, the UN operates a register of space objects, as mandated by the Registration Convention and the privately owned Space Data Association, representing the bulk of satellite operators, has set up a voluntary data base of space objects, in an effort to assist in reducing in-orbit collisions.

While monitoring objects in orbit is a rather passive approach to preserving outer space, best practice models, that try to determine commonly accepted principles of reasonable behaviour, are also under development. In this context, the draft Code of Conduct for Outer Space Activities, proposed by the EU and setting out space debris mitigation guidelines, should be mentioned. In spite of the high demand for coordinated actions, even the EUCoC tends to be questioned by a number of governments.

Although best practice models serve to mitigate the creation of further debris, they don't address the question of space debris already orbiting the earth.

On an international level, the topic of an active space debris removal has not been discussed thoroughly so far. Nevertheless, first steps were taken by the UNCOPUOS within the context of the agenda item "Long Term Stability of Outer Space Activities". The terms of reference foresee the discussion for "technical developments and possibilities regarding space debris removal".[4]

3. Current Approaches and Legal Issues

While putting active space debris removal on the agenda is a significant step forward, one must say that, given the necessity to arrive at solutions, there is a great need for developing comprehensive models for their implementation. Some technical proposals have been made by different institutions on how to collect objects. What is missing is a comprehensive idea on how to overcome arising legal, policy and commercial issues, assuming that removal will be technically feasible.[5] Only in the US have steps been taken to address this problem.

Already the name of the Orbital Debris Removal and Recycling Fund proposal indicates that one of the major objectives when referring to space debris removal is the financial aspect.

The Space Frontier Foundation presented an "Orbital Debris Removal and Recycling Fund (ODRRF) Scenario" at the International Conference on Orbital Debris Removal.[6] The objective was to stimulate the private sector and to give incentives for the development of a comprehensive system for conducting active space debris removal operations. The incentives of an ODRRF, set up by launching states and private operators, lie in creating lower insurance costs for commercial satellite operators, coupled with a decreased probability of collision.[7] The great advantage of this approach is that the private sector, which has the greatest capabilities in developing removal systems, is activated. Nevertheless, this approach overlooks crucial elements of the space debris problem, as well as of the international space policy environment.

First and foremost, there is no adopted legal definition of what space debris actually is. For

3 US Department of Defence. National Security Space Strategy: Unclassified Summary. Jan. 2011: 8 http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf.

4 United Nations Committee on the Peaceful Uses of Outer Space: Scientific and Technical Subcommittee. Terms of Reference and Methods of Work of the Working Group on the Long-term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee. Held in Vienna from 7 February to 18 February 2011. UN Doc. A/AC.105/C.1/L.307 of 24 January 2011. Vienna: United Nations.

5 Weeden, Brian. "Overview of the legal and policy challenges of orbital debris removal". Space Policy 27 (2011) 38-43: 40-42.

6 Dunstan, James E. "Legal and Economic Implications of Orbital Debris Removal: A Free Market Approach." Presentation. International Conference on Orbital Debris Removal. Reston, VA, US. 8-10 December 2009.

7 "Space Debris". TRACKINGSAT 21 Jul. 2011 www.geosats.com/spacedebris.html.

the time being existing definitions, provided by the International Academy of Astronautics (IAA), the Inter-Agency Space Debris Coordination Committee (IADC) and the UNCOPUOS, try to depict the population and nature of a great variety of space debris objects.[8] These non-binding definitions make the situation very vague and leave room for launching states to debate if certain types of objects constitute space debris or not.[9] This situation is particularly crucial when it comes to collisions and to the question of what objects should be removed, considering that the state that launched the object which caused damages is liable under Article III of the Liability Convention, if at fault.[10] In practice however, liability issues are often subject to negotiations.[11] As for who owns an object in the first place, Article VII of the Outer Space Treaty gives the jurisdiction to the state that launched the object.[12]

Implementation of the Orbital Debris Removal and Recycling Fund scenario is problematic under the current legal framework of the Outer Space Treaties.

Keeping these articles in mind, problems arise for space debris removal itself. So far, not too many incidents have happened that evoked the need to implement Article III of the Liability Convention. However, even these few examples demonstrated that the consequences for liable states are generally diminished, because they avoid full liability by going into negotiation and compensation payments.[13] This development decreases the level of space actors' commitment to prevent collisions, also because orbital debris removal would be costlier than compensation payments and fault is difficult to establish. Consequently, this might be a good reason to reconsider the legal concept.

The ODRRF foresees orbital debris to be removed by private actors. According to Article VII of the aforementioned Treaties, such an operation can only be conducted with the consent of the launching state. Such an elaborate process would cause problems as it would require strenuous negotiations on the removal of every single object in orbit.

When addressing a state's willingness to remove objects, one also has to keep in mind objects that serve important or secret purposes, such as military satellites. Governments are generally reluctant to disclose the orbital paths of such assets, or approve their removal. Hence they proportionally decrease the incentive for private space actors to invest in systems that remove space debris.[14] In this respect, one cannot forget that companies seek to maximise their profit, which in this context can only be achieved by removing a large number of debris, rather than isolated objects, every time subject to government approval. The ODRRF further assumes that every satellite operator will have to develop its own space debris removal systems, which is a very unlikely scenario given the budgetary constraints that all private companies and government space agencies are facing.

Summarising the current state of affairs, it appears that the crucial factor in getting private actors involved in active space debris removal would be the presence of considerable market incentives that could motivate companies to invest in such a sophisticated system in the first place. Furthermore, current approaches ignore the various legal concepts and political interests that constrain efforts for the development of an effective space debris removal system.

4. The Dispensation Approach

The following theoretical model assumes feasibility of debris removal and that every state is interested in avoiding collisions, but is unable to do so depending exclusively on its own capabilities and efforts. Therefore, the following analysis ponders adjustments to the legal set-up that would stimulate countries to adopt collision avoidance practices through international cooperation.

A first step would be to agree a definition of space debris that corresponds to the liability aspects of the problem. As will be shown, this

8 "Position Paper on Space Debris Mitigation Implementing Zero Debris Creation Zones." 15 Oct. 2005 International Conference of Astronautics 12 Apr. 2011 http://iaaweb.org/iaa/Studies/spacedebrismitigation.pdf.

9 Weeden, Brian. "Overview of the Legal and Policy Challenges of Orbital Debris Removal." Space Policy 27 (2011) 38-43: 41.

10 Convention on International Liability for Damage Caused by Space Objects. http://www.oosa.unvienna.org/oosa/SpaceLaw/liability.html.

11 Hobe, Stephan, Schmidt-Tedd, Bernhard and Schrogl, Kai-Uwe (eds.). Cologne Commentary on Space Law. Cologne: Carl Heymanns Verlag, 2009: 137.

12 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. http://www.oosa.unvienna.org/oosa/en/SpaceLaw/outerspt.html.

13 Dunstan, James E. "Legal and Economic Implications of Orbital Debris Removal: A Free Market Approach." Presentation. International Conference on Orbital Debris Removal. Reston, VA, USA. 8-10 December 2009.

14 Weeden, Brian. "Overview of the Legal and Policy Challenges of Orbital Debris Removal." Space Policy 27 (2011) 38-43: 40-42.

development would also free up potential in the private sector for investing in active space debris removal.

As mentioned above, it would be crucial for companies undertaking debris removal that their developed systems are profitable and that their use is not limited to their own objects, or to objects agreed by governments to be removed. Informed by the question of what is exactly the threat from space debris -namely endangering the sustainable use of space environment- the following definition could hence be introduced:

Space Debris is any man-made object that is in Earth orbit and that is not controllable.

Controllable in this context means that a state or an organisation has the capability to avoid a collision by any means possible. This definition obviates the need for governments to debate which objects are space debris. The issue is rather decided by an object owner's capacity to control a space object. At the same time, this doesn't mean that the classification of an object in orbit as space debris takes place automatically. Stakeholders will still have the possibility to determine themselves what are the limits of their respective capabilities, as well as how much effort they would like to put in preventing collisions in orbit.

The sensitive area of objects affiliated with military purposes and serving sensitive security purposes is also treated in this approach. If a country judges one of its space assets as important and does not trust other stakeholders to interfere with it, then it would make every possible effort to keep the object under control. If the same government qualifies its own capabilities to be insufficient to control the object, then it might as well be declared as debris, since no other state would be able to control it either and its further existence would only increase the potential for collision. Once a country decides to give up jurisdiction over such an object, it would immediately be subject to removal.

A second issue, as it was mentioned before, is the problem of liability in case of collision. In the context of avoiding a collision, which is a goal shared by all space actors, the Liability Convention already operates on a fault principle. What would be needed would be to define more clearly what 'fault' means. What should be achieved is a motivation to develop greater capabilities to monitor and assess objects in orbit. Consequently, a more detailed definition could ultimately create a greater interest in space debris removal, for the purpose of avoiding in-orbit collisions. In this case as well, the underlying assumption is the following: if a state is not capable of avoiding a collision on its own, it will seek to make communication efforts to avoid the collision, which serves also as a Transparency and Confidence Building Measure in terms of spurring a learning process among all stakeholders involved.

The stalemate in the international debate on defining orbital debris could be bypassed, by focusing on whether objects in orbit are controlled by their operators or not.

Problems with this detailed definition arise when thinking about the current practices. Predictions of collisions are made only on approximation and with no guarantee. Therefore, a precondition is that existing monitoring capabilities will be further developed in order to give realistic warnings.

On the operational aspects of the model, organisations that are suitable to keep track of abandoned space objects would have to be identified or established. For example UNOOSA, which is already implementing the Registration Convention which requires countries to register their objects, could conceivably keep an account of which objects are controllable and which are not.[15] Consequently, interested countries would inform UNOOSA about their objects that they assess to be out of control. At the same time, UNOOSA would also bear the responsibility to announce the number of space debris objects, according to the status which states would have assigned to their objects. UNOOSA would then collect this information and disseminate "debris packages" regularly.

Since the practice in the registration of objects is already complicated, it is emphasised that the approach advocated here should appeal to the potential of a unified action among space-faring nations, towards the common goal of preventing collisions. In particular, it is expected that they will seek all the possible options in order to avoid collisions and therefore they would have a vested interest in registration. Perhaps the enhanced relevance of the registration through this approach could also serve as an additional incentive for registering space assets. A further

[15] Robinson, Jana. "The Role of Transparency and Confidence-Building Measures in Advancing Space Security." ESPI Report 28 27 Mar. 2011. http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_28_online.pdf

incentive in this direction would be the fact that compliance would set the basis for improving the private sector's integration as well, as it will be demonstrated in the following policy related section.

The benefit of the abovementioned definition of space debris is that objects that cannot be controlled can be removed without prior consent. Once this is achieved, an incentive similar to the ODRRF scenario has to be created. While the ODRRF would cover the cost of removing single orbiting objects using a fund that will be shared by private actors and launching states alike, the new approach takes into account other nations besides launching states as well. By doing so, it allows for future space-faring nations to already take an active part in preserving outer-space activities, in view of their own future activities in space.

The idea is to assign an amount of money, depending on the debris population number announced by UNOOSA in its "debris-package." For example, if UNOOSA had listed 3,000 uncontrollable objects with a calculated total weight of 23,000 kg, a price tag of, say, €10,000 per Kg could be assigned, automatically creating a market of €2.3 billion for their removal, which should be a lucrative proposition for the enterprises in the sector. In this respect, the funds would be set as a single prize, serving as an incentive for an enterprise that would win the contract for removing the "debris-package". The money itself would come directly or indirectly form the originator of the debris.

Once the proper funds would be collected, the responsibility to supervise this fund would have to be given to a suitable institution. In relation to this, three models are imaginable. On the one side, one can think about the integration of such a mechanism into an existing institution. Considering that space constitutes a global heritage for all Humankind, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) could be an institution suitable to undertake this responsibility. Its affiliation to the United Nations Organisation would further serve the vision of making space debris removal a global project. In addition to this, UNESCO's experience in public-private partnerships and l management of large projects would create the most favourable conditions for the success of this undertaking.[16] The necessity for supervising the method's implementation is exacerbated by the dual-use nature of removal systems, as they could also be potentially used to remove active satellites - not excluding military assets.

On the downside, the fact that UNESCO has no prior experience in dealing with space projects could hinder the effectiveness of the active space debris removal programme.

An alternative organisation that would posses the necessary institutional experience in this field would be the International Telecommunication Union (ITU). Like UNESCO, the ITU represents all relevant states and additionally 700 private entities.[17] Especially the latter's participation could be the source of considerable know how. Furthermore, a recognised stakeholder like the ITU would be widely accepted within the global space community, increasing its chances of assuming the responsibility to supervise the necessary public-private-partnership. Reassessing the role of ITU, which is already delegated to allocate satellite orbits, would be a pragmatic solution.

On the other hand, a new institution, with space related financial and policy expertise could also assume responsibility for the management and disposal of the "debris package". Possibility of profits for the companies that would receive the annual removal contract would also spur healthy competition in the private space sector. Within a newly established institution, representatives of countries would set up the fund, examine the proposals of bidders, choose the appropriate contractor, supervise the contract's implementation and attribute the monies.

The integration of a space debris removal capacity into an international institution already in existence might prove to be more feasible in practice.

Especially for the supervising part of the implementation process, one should consider a wide range of options. With the danger of sensitive information falling into the wrong hands omnipresent, the technical capabilities of the removal method applied should be evaluated by the supervising institution in advance. As for military satellites, only a system especially designed to de-orbit them in a safe and secure fashion would be granted approval.

16 "Public-Private Partnerships." 9 May 2007 UNESCO 16 Jul 2011 http://portal.unesco.org/en/ev.php-URL_ID=36918&URL_DO=DO_TOPIC&URL_SECTION=201.html.

17 "Overview." International Telecommunication Union 20 July 2011 http://www.itu.int/en/about/Pages/overview.aspx.

5. Conclusion

Active space debris removal is an issue that merits the attention of decision-makers. Existing treaties and concepts are not able to tackle the problems of the 21st century related to the space debris issue. Therefore, this issue of the ESPI Perspective series seeks to illuminate all related challenges and possibilities. First and foremost, the introduced concept puts a high degree of pressure on states to take care that collision in space is avoided. Second, it allows for a realistic self-assessment of every country's capabilities in space. Through the method proposed, a country's technical inability to deal with the space debris issue would not lead to a sense of inferiority compared to others, but rather to a constructive attitude with the potential to create benefits for its space industry. Furthermore, the model described above engages the potential of the private sector.

It should be mentioned that the space environment itself would benefit from this approach, as processes for orbital clean-up would be picking up speed and a sustainable space environment would gradually take form. It is therefore recommended to consider the ideas outlined above and to use them as a stepping stone to the next level of efforts to preserve the benefits of space activities for all.

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