

Commercial Aspects of Active Debris Removal: Technical and Legal Challenges

Ghadawala R^{1*}, Singh B² and Kantroo P¹

¹Aryavarta Space Organization, India

²R & D, Aryavarta Space Organization, India

Abstract

Earth Orbit is a limited resource and its sustainability is at stake. Various commercial solutions are recommended to handle the trash in the space. Studies are reflecting that at this pace especially when the global space community participation is rapidly increasing, incidents of collisions are highly possible and in case of damage for commercial space application based operations. This new era of a 'space race' has embarked a few conclusions raising not only technological concerns, but also a host of economic, legal/regulatory, and corporate responsibilities associated with debris remediation and mitigation. The intent behind this paper is to identify what elements would be necessary for an ADR concept to be considered both technical and non-technical and how to address them. Lastly the gravity of the situation of debris removal is also assessed through a comparative analysis of various case study methods across the global.

Keywords: Space debris; Removal; Technique; ADR; Limitations; Liability issues; Policy concern; Commercial aspect

Introduction

The market for commercial space launchers has witnessed a tremendous growth in the last decade. Today, the generated revenue in the international satellite network has crossed the huge amount of 16 billion USD, with the growth in the commercial space revenue above 200 billion USD. Individual consumers are a growing source of demand for the services, particularly SATCOM and SATNAV. In the last few years there has been a significant growth in commercial remote sensing business, with rising concern on utilization of Space Applications for Climate Change. A few years ago, Earth imaging data was only available to a select number of government institutions. Today, any individual and/or organization with an access to the internet can use these services free of cost through various online mapping applications.

Furthermore, studies have shown that at this pace when the participation from global space community is increasing, a 'space race' has been triggered amongst the government and private players, especially based on the high demands of television, communication and personalized GPS devices. This has actually resulted into lower launch costs, efficient operations in LEO and GEO with significant growth in the remote sensing business along with empowering space flights capacity. At the same time, because of limited competition in certain areas like launching capacity, GEO operations, liability concern considering the possible collisions with the space debris, and limited profit are also one of the major challenges which have an excessive reliance on public spending [1-6].

This new era of a 'space race' has embarked a few conclusions raising technological concerns, legal challenges, liability issues and corporate responsibilities for the upcoming opportunities of space sector. Because of the intensive competition with the government sector, private companies have triggered a number of innovative ideas those have resulted in successful and efficient implementations of projects with high amount of energy and cost efficiency. However, the significant dependency on communication and navigation satellites in the private space sectors, issue has been raised regarding additional noise in bandwidth for imaging which is ultimately compromising the quality of the results and of course, the limited orbital space also increases the probability of collisions in space. In particular, in case of collision, the generated debris cloud would be 'occupying orbits' and

become a severe threat to all other operational satellites and probes passing through those orbits.

Studies are reflecting that at this pace especially when the global space community participation is rapidly increasing, incidents of collisions are highly possible and in case of damage for commercial space application based operations, there should be rewarding compensation framework to be developed and adopted by the international community. Today, none of the international insurance underwriters provide coverage for the damage occurred because of space debris to the space faring organizations.

As reflected in the table, in the last few decades there have been major collisions which have created significant debris clouds in the earth's orbits, which have been widely spread over the orbits, creating potential threat to the currently operational satellites in that orbits and the probes fly by from there. Results from NASA studies demonstrates the potential threat of increased numbers of debris pieces in coming few years. Such space debris comprise a wide range of inactive and/or malfunctioned satellites, rocket upper stages and tools mistakenly left in orbit by astronauts during their spacewalks.

The spread over time of debris clouds from the collision Figure 1 (Figure credit: Wang Ting)

Active Space Debris Removal-Recommendations and Case Studies

Case studies

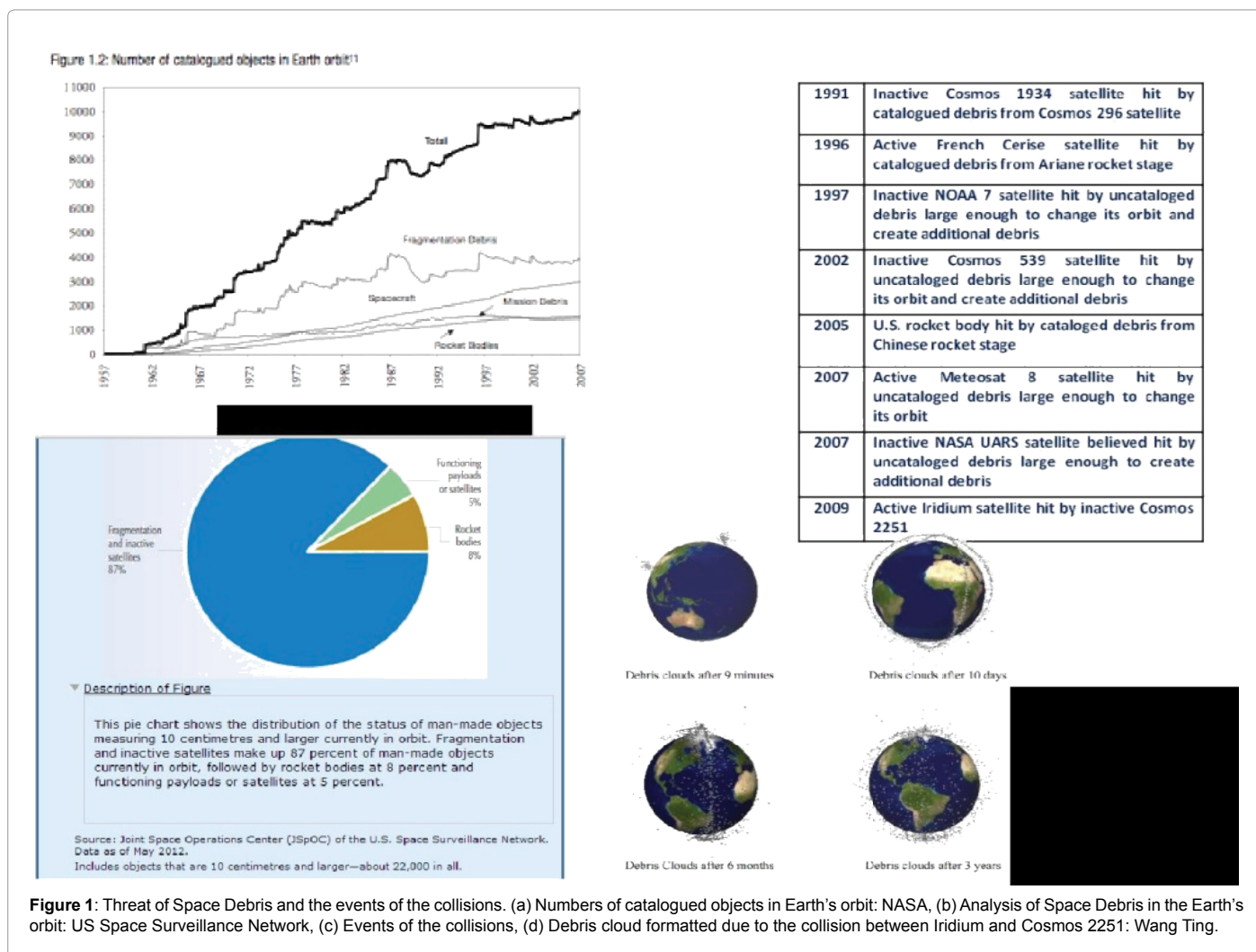
A few studies have been initiated by the national space agencies,

***Corresponding author:** Ghadawala R, President, Aryavarta Space Organization, India, Tel: +1 (416) 909-3795; E-mail: pd.aryavarta@gmail.com

Received January 04, 2016; **Accepted** February 22, 2016; **Published** February 25, 2016

Citation: Ghadawala R, Singh B, Kantroo P (2016) Commercial Aspects of Active Debris Removal: Technical and Legal Challenges. J Aeronaut Aerospace Eng 5: 159. doi:10.4172/2168-9792.1000159

Copyright: © 2016 Ghadawala R, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



academic institutions and private organizations, which have come up with innovative technologies and are still exploring new possibilities to successfully implement the project of space debris removal (Figure 2).

For example, the European Debris Avoidance System is a kind of space traffic monitoring network which guides the satellite operators via its satellite network map, to avoid the collision with the possible debris in the orbit. Similarly, the methodology of electrodynamic tether (EDT) is also a potential solution to de-orbit the large debris from orbit; however, it is still under development as the failure of the mission may lead to the catastrophic disasters. Aryavarta space organization (ASO) from India is developing a research on energy and cost efficient space debris removal system which runs with the hybrid propulsive system of ion and solar-electromagnetic propulsion system. The initial studies have generated a hypothetical project where a probe would be attached to the inactive satellites and would de-orbit them from the active orbits. However, this is still under research and not applicable to smaller debris pieces (less than 10 cm) spread in the orbit. One interesting study has been done by Cranfield university (UK) and where its mission is designed to remove the Ariane 4 upper stages from the LEO. For very small space debris, a laser ablation technique is currently under research in order to burn the small pieces using a laser

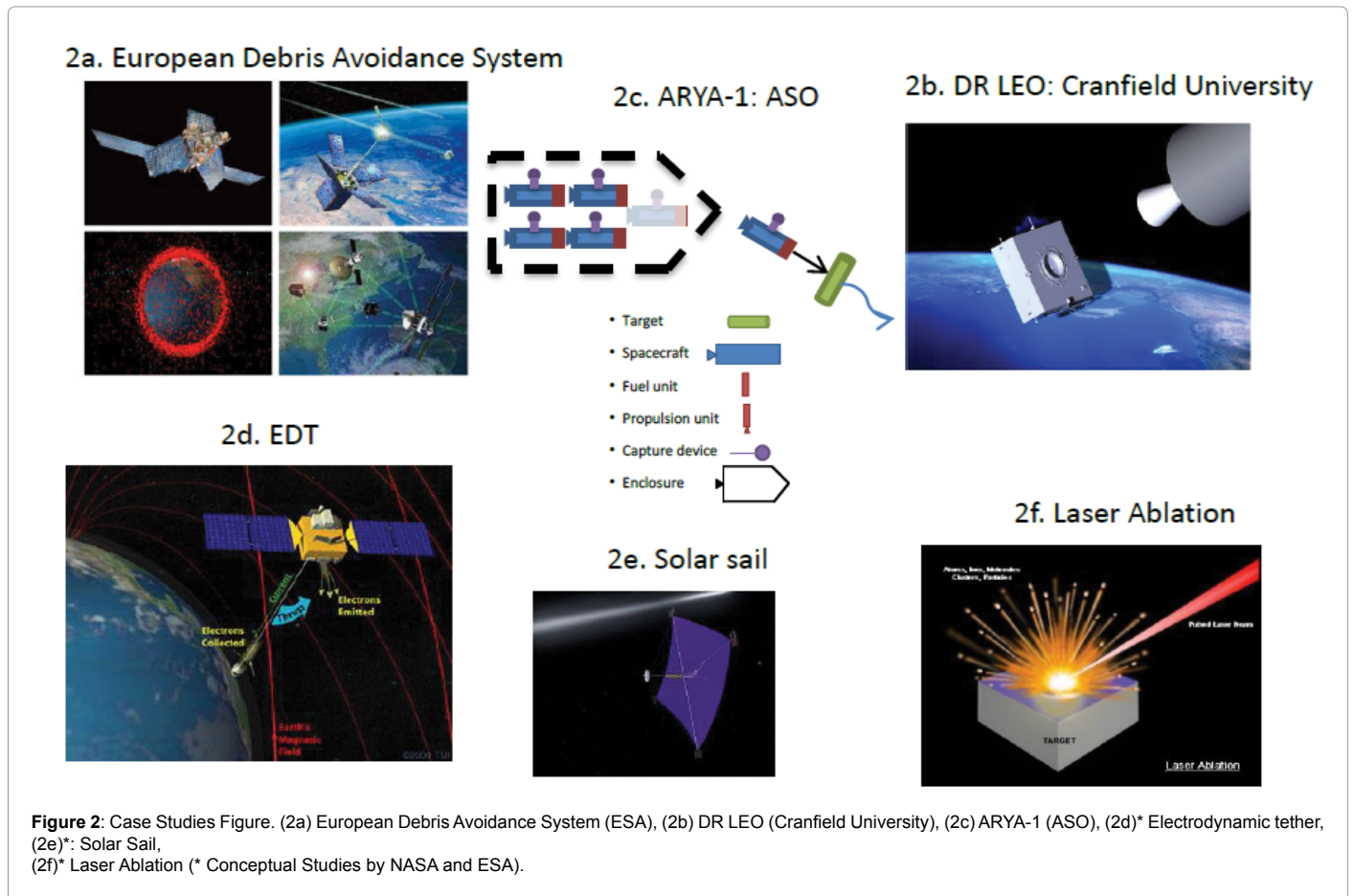
beam from space or from Earth. This technological development is still under active research and is to be implemented [7-9].

For any active debris removal project, the mission risk assessment is shown in the following Table 1.

Commercial Activities

To reduce space debris from the Earth's orbits, the following recommendations are proposed for mutual/joint operations at international level, involving private organizations, companies, civil society organizations (CSOs), non-governmental organizations (NGOs), academics and R&D institutions, governments and international community. The step-by-step methodology is widely being proposed as below, waiting for global adaptation.

1. A project of active space debris removal can be initiated by the international community, e.g. national space agencies/companies/private organizations, based on the studies carried out by CSOs, NGOs and research academic institutions.
2. Based on the 'project outline' drawn in the phase 1, government and national space agencies can define the scope of issues, in consultation of national universities and academic institutions, along with considerable inputs from the private space sector.



- Once the project framework is prepared, participation and involvement of governments is essential for the large investments and funding the project. At the same time, it is equally important that the insurance companies should also cover the damage which may be caused by the collision with the debris-during active space debris removal from LEO the tumbling rate and velocity of the debris objects are unknown and this may result into failure of the project.
- Based on phase 3, the project should be initiated and implemented by the stakeholders in the constant supervision of the governments and CSOs at the global platform.
- NGOs and CSOs can also play a vital role for raising the awareness of governments, national space agencies and insurance companies over the project development and its outcome.
- Information Exchange is essential between the government and national space agencies and companies and private organizations, in order to create a Space Traffic Control System, which shows the positions of the active satellites and their operations along with the space debris in orbit.

Legal Challenges

The present international space law conventions and instruments fail in creating a legal regime for ADR and even the relatively new Space Debris Mitigation Guidelines fails in clearly providing for a legal regime, which would impose. Merely monitoring along with mitigation

are passive means to face the debris situation alone and are not effective enough to curb this menace which is growing exponentially. The passive solutions should be combined with an active removal of debris, which is currently not incentivized by the unclear definition of debris and the complicated liability and licensing regulations that expose contingent public and private efforts to high risk [10-12]. The various legal challenges that block the roadmap for commercial ways of debris remediation are as follows.

Liability Issues

The Liability Convention instituted an absolute liability policy for damage on the Earth's surface, or in airspace, caused by space objects. However, a state is only liable for damage to another state's space objects if "the damage is due to (the state's) fault or the fault of persons for whom (the state) is responsible." An injured party cannot recover compensation under this Convention if another entity of the same state harmed its space object. A point to ponder is that the term "damage," as used in the Liability Convention extends to people and property, but not to the space environment itself. Thus, under the Liability Convention, states cannot be held liable for polluting Earth orbit with debris unless that debris harms a person or property. An analysis of the Liability Convention helps to understand that there is no legal provision, which imposes any clear obligation upon the states to prevent the space debris creation or to undertake the mitigation measures. However, the consequences of liability are mitigated since whenever a similar situation occur states generally go in to negotiations and compensation payments to avoid fully liability [13].

Severity	Effect on Mission	Impact	Cost
Catastrophic	Impossibility fulfilling the mission specific objectives	Loss of systems, launcher launch facility	Increment result into project cancellation
Critical/Major/Significant	Major mission requirements	Loss of Major damage to flight ground facilities	Critical Major Significant increment in estimated cost
Critical	Major mission objectives	Major damage to onboard systems	Critical increment in mission cost
Critical/Major	Significant damage to fulfilling mission requirements	Damage onboard systems, Significant effects on environment	Significant impact on overall mission cost

Table 1: Mission risk assessment for active debris removal.

Liability in terms of ADR is also ambiguous. There are unresolved questions as regard to liability from ADR operations. Liability convention is silent on standard care mode and hence it is difficult to establish if stand care was taken while ADR operation. In case of a third party intervention to use ADR as a method of clearing the junk, additional complexities are foreseen if the removal spacecraft incurs damages in the process of the removal, or if they damage other spacecraft as a result of the removal operations.

Sovereignty Issues

The Liability Convention and Outer Space Treaty establishes the jurisdiction of launching states on space objects making it cumbersome for third party venture to remediate the debris. It is possible that the third party seeks permission from the launching state but as of now there seems no protocol to mandate that. The registration convention does not make it mandatory of member states to get the fragments of such objects (now debris) be registered or catalogued, hence making it a challenge from a legal standpoint as to who is the launching state of such debris and who has the sovereignty rights to clear this junk [14-15].

Further Recommendations

- For active debris removal from orbit, Public Private Partnership is one of the key essentials ensuring the economical safety and efficient operations based on intra-government treaties for the commercial development.
- The Joint Ventures should be more and more encouraged to reduce space debris from LEO and GEO with the involvement of global community (CSOs, NGOs and academic institutions which are the largest knowledge pool) and the knowledge should be implemented by the companies, national space agencies and private organizations.
- NGOs and CSOs involvement is essential in coordination with UNCOPUOS for the strict enforcement of orbital debris mitigation regulations and to find out the potential solutions for the present challenges to remove space debris.
- Vital participation of Private Sector, along with CSOs and NGOs at global level can prepare a draft for space debris legal regime, which can be adopted by the governments under the universal regime of UNCOPUS.
- Identification and prioritization of candidate orbital debris can help to reduce the threat to the most vulnerable active satellite operations, which may avoid the collision.
- Re-registration of orbital debris is required at global level for liability purpose.
- Mission implementation to remove orbital debris, jointly with support of the international communities will ensure smooth and efficient operations.
- Preparation of a common platform, to prepare voluntary guidelines for the countries for the adoption, may address the present challenges in order to avoid any disasters in space

- More and more genuine stake-holders from respective fields should be encouraged to participate in the better governance of space, in coordination with active involvement of research institutions and universities along with CSOs and NGOs to reach out to the global community
- Other actors, such as amateur astronomical societies and international societies should be encouraged for the active participation in finding innovative and efficient operational techniques and spread awareness about the direct and indirect threat of the space debris to the global community.
- Thus it is established that the present international space law conventions and instruments fail in creating a legal regime for ADR and even the relatively new Space Debris Mitigation Guidelines fails in clearly providing for a legal regime, which would impose. Hence a comprehensive binding legal framework or a code of conduct is needed to curb the menace for these tombs of trash in space and pave way to commercial methods of remediation and mitigation.

References

1. (2012) Aerospace Review 2 Reaching Higher Canada's Interest and Future in Space.
2. (2011) Space Security Index Secure World Foundation.
3. (2012) Joint Space Operations Center US Space Surveillance Network.
4. (2013) Marshal Space Flight Center NASA.
5. (2013) Near space Environment.
6. (2013) Space debris international response.
7. (2011) Protocol for a Space Deris Risk and Liability Convention (UN-COPUS).
8. (2014) Space Situational Awareness Secure World Foundation.
9. Listner M (2012) Addressing the challenges of space debris part 2: liability.
10. (2013) The shortcomings of microeconomic policy mechanisms for space debris.
11. Ghadawala R (2009) Space Environment Needs Proper Management Spaceflight.
12. (2012) Annual Report Aryavarta Space Organization.
13. Art III of the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) ratified in 1972
14. (2008) Convention on International Liability for Damage Caused by Space Objects United Nations Treaties and Principles on Outer Space United Nations New York.
15. (2008) Treaty on the Principles Governing the Activities of States in the Exploration and use of Outer Space including the Moon and Other Celestial Bodies United Nations Treaties and Principles on Outer Space United Nations New York.