

Elimination of Space Debris – A Path to ensure safe Space Exploration in Outer Space and Environment

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Abstract: Outer space is the universal possession of the whole mankind. Both earth and space environment have become a great matter of apprehension to mankind particularly in the arena of earth events. Space debris is a pre-dominant issue when it comes to the safety and security of outer space and threatens the durability and survivability of the space assets and the life of astronauts. The mitigation of space debris becomes very crucial for sustaining the atmosphere of the outer space and earth. Sufficient steps on behalf of the space faring nations must be taken to eradicate this problem. It should be considered as a duty of every nation to cooperate in the activity relating to removal of debris.

Introduction

Due to continuous and generation of debris, space environment is becoming more and more a subject of concern day by day. With the increase in space activities has generated good number of production of human made debris and has further resulted into the problem of space pollution. Proper attention should be paid for preserving the space environment by avoiding the growth of space debris by space activities. Outer space is considered as 'common heritage of mankind', so there arises a need to look after the outer space environment with proper protection and preservation from further misuse, change, devastation and pollution.

Definition

With the very beginning of the space age and its development has resulted in simultaneous increase in the orbital debris has created an absolute scrapyards which consists of out-of-date satellites, exhausted and depleted rocket booster, tools and components which got lost during extravehicular activities by the astronauts and cosmonauts¹. Space debris can also be called as 'refers to non-functional all man-made material in space'³. "Space debris is the collection of defunct objects in orbit around earth, which is also known as orbital debris, space junk and space waste. This involves everything which is spent on the stages of rocket, old satellites and fragments from disintegration, erosion and collisions"⁴. Debris includes 'things' of all sizes that are product of human activity and not of natural origin. These 'things' either never was functional or eventually became non-functional. Also, we need to consider only 'things' that are located in earth-orbit or are re-entering the atmosphere⁵.

The inter-agency space debris co-ordination committee's space debris mitigation guidelines⁶ and the subsequent UN space debris mitigation guidelines⁷ framed the first and the foremost internationally acclaimed definition of space debris, as 'all man-made objects, including fragments and elements thereof, in earth orbit or re-entering the atmosphere, that are non-functional.' It has been more than 50 years of space flight which has left more than 500 000 pieces of so-called debris of sizes bigger than one centimetre in diameter. In total, there are 150 million pieces of space debris starting from a size of smaller than one centimetre⁸. In June 2007, COPUOS adopted debris mitigation guidelines, which had been developed by a working group on space debris in scientific and technical subcommittee over the past few years. The guidelines include measures to be considered for mission planning, design, manufacture, and operational (launch, mission, and disposal) phases of spacecraft and launch vehicle orbital stages. Member states have pledged to implement these guidelines within their national licensing or other applicable mechanisms 'to the greatest extent feasible'⁹.

SPACE DEBRIS: A MAJOR CONCERN

¹ Listner, Michael, "International Space Law: An Overview of Law and Issues", New Hampshire Bar Journal, spring 2011.

² Kumar, Shailendra, "Space Legislation in India: Emerging Issues", Regal Publications, 2015, page no.109.

³ There are four types of manmade debris, 1. Active payload which are not in use and remain in space, 2. Operational debris, which is burnt out first while placing in orbit such as second stage rocket bodies, orbit transfer vehicles, 3. Fragmentation debris means object break up result of explosion, collision, 4. Micro particular debris, consist of cabin leakage, water dump, out gassing of heavy molecules.

⁴ See, http://en.wikipedia.org/wiki/space_debris, accessed on 3/11/14.

⁵ Hobe, Stephan, "Environmental Protection in outer space: Where we stand and what is needed to make progress with regard to the problem of space debris", The Indian Journal of Law and Technology, Volume – 8, 2012.

⁶ IADC Space Debris Mitigation Guidelines, Sept. 2007, available at <http://www.iadc-online.org/>.

⁷ UN Space Debris Mitigation Guidelines, Sept. 2007, Report of the COPUOS, as annexed to UN doc. A/62/20.

⁸ Hobe, Stephan, "Environmental Protection in outer space: Where we stand and what is needed to make progress with regard to the problem of space debris", The Indian Journal of Law and Technology, Volume – 8, 2012.

⁹ Ibid. see FN-9.

In the beginning, not much attention and concern was devoted to the problem of space debris, but today it's one of the major problem to be worried for. Some of the space debris revolving in the orbit is kind enough, while others of them cause navigational threats to the spacecraft in process. These particles of debris are hazardous in nature no protection is available against them. It has the ability to cause damage to larger space objects like satellites and space crafts and so thereby it is essential to give a thought for the eradication of this problem. As per the statistics available it can be known that the space debris is increasing at an alarming stage which can make difficult in undertaking outer space activities.

Aggression for destructive purposes is among several ways in which outer space could be rendered unfit for use and for the greatest adventure i.e. exploring the Universe. Space Debris, some of which might be radioactive, could cause harmful interference with communications, weather prediction and navigation. Contamination could occur between the Earth and outer space; harmful influences could affect the atmosphere of the Earth. Scientists and Engineers have been anxious to prevent any type of irreversible damage from experiments or operation systems. We have suffered on earth from unintentional irreversible damage and the experience compels planning to protect the environment. To guard outer space from all harmful influences is an overriding motive in designing space systems¹⁰. This gives escalation to a big variety ranging from the legitimacy of creating the space debris and obligations arising therefrom in order to lessen and provide remedy in order to avoid the space debris in the outer space environment to involvement in collision avoidance. Also this would further lead to active eradication and reprocessing of space debris as well as distribution of financial resources and technology transfer is of major worry in the present case.

For the same purpose, the international legal regime needs to be properly studied and examined with regard to legal rights and obligations arising there from, as necessary steps needs to be taken in the form of preventive measures in order to address the dangerous situation created in the form of space debris. Also would lead to the situation when actually the consequence follows and risk takes place. The former statement basically refers to the measures taken in order to reduce the possibility of risk and damaging the spacecraft and after effects of space debris in order to save and preserve the outer space environment. This leads to extensive range of legal queries from the legality of creation of space debris and obligations/duty to mitigate and to provide remedy to the pollution created by space debris in the environment. Also, to take measures for collision avoidance and exchange of data. The other process of removal and recycling of space debris can further lead to technology transfer and can raise financial burden concern. The later statement gives rise to liability and responsibility in case of space debris and allocation of risks¹¹. There seems no doubt in the impact of space debris which may harm other objects (spacecraft or satellites) in the orbit. Space debris is considered as a problem because of its potential to cause damage to the spacecraft in the orbit which is on a mission and functional, along with the safety of crew members in the space craft. Also, such debris poses potential hazards if it falls on the ground.

APPLICABILITY OF SPACE LAW TO THE PROBLEM OF SPACE DEBRIS

If we read all the outer space treaties carefully it doesn't exclusively uses the term '*space debris*'. The current space law doesn't apply to the aspects of the space debris problems, so party can disregard the body of soft law or international documents and declarations. There seems no need for an exclusive treaty or agreement drafted specially to address the problem of space debris or for the eradication of space debris. The answer lies probably in reading all the treaties carefully which are giving us solutions to all our problems related to space debris directly and indirectly. To support the treaties, United Nations is also providing directions for preserving the outer space environment for the upcoming generations. This is going to give rise to a big spectrum of questions. For the same reason the international legal regime needs to be properly understood and scrutinised with regard to legal rights and obligations to take precautionary steps in order to address the hazard placed by the space debris.

CREATION OF SPACE DEBRIS

Before getting down directly to eradication and mitigation of space debris we need to know whether creating space debris is illegal. In order to answer this question generating space debris is illegal as such article I of the outer space treaty¹² provides that '*it is fundamental freedom of all states to explore and use outer space*'. But as such, no such freedom is granted unlimitedly it is subject to certain limitations. Such activity of generating of space debris may not be covered by freedom to explore and use of outer space or under any environmental law. Whether, the international law imposes upon states the obligation to take appropriate measures to prevent the generation of space debris or at least to minimize related risk when conducting space activities in outer space. It seems that generating space debris is not considered as illegal, but there comes a question whether international law imposes upon states the obligation to take appropriate measures to prevent the generation of space debris or at least to minimize risk posed by them while conducting space activities. For this article IX¹³ of outer space treaty specifically says that 'in the

¹⁰ Galloway, Eilene, "Law and Security in Outer Space: The Role of Congress in Space Law and Policy", Journal of Space Law, Volume 11, Spring & Fall 1983, Number 1 & 2.

¹¹ Hobe, Stephan, "Environmental Protection in outer space: Where we stand and what is needed to make progress with regard to the problem of space debris", The Indian Journal of Law and Technology, Volume – 8, 2012.

¹² Article I of the outer space treaty of 1967 provides 'to be carried out for the benefit and in the interests of all countries, irrespective of their degree of scientific and economic development, and shall be the province of all mankind; Shall be free for exploration and use by all states without discrimination of any kind, on a basis of equality and in accordance with international law, and to have free access to all areas of celestial bodies; Freedom of scientific investigation in outer space and states shall facilitate and encourage international co-operation in such investigation.'

¹³ Article IX of the outer space treaty provides that 'in the exploration and use of outer space, including the Moon and other celestial bodies, state parties to the treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of

exploration and use of outer space, including the moon and the other celestial bodies, state parties to the treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including moon and other celestial bodies, with due regard to the corresponding interest of all other state parties to the treaty.’

Also, the states need to counterbalance their activities for freedom to explore and use outer space and avoid harmful contamination and causing adverse changes in the environment of the earth¹⁴. The term used in article IX of the outer space treaty¹⁵, ‘contamination’ is subject to different interpretation since the outer space treaty is silent about the same and doesn’t provide a proper definition for the same. What does contamination includes whether space debris to things that are in earth orbit or are re-entering the earth’s atmosphere. Or it might be defined as any ‘thing’ which poses as a potential threat of damage that is internationally recognized and may be termed as ‘harmful contamination’. The terminology used in Liability Convention of 1972 ‘space object’ does not clarify the question of whether the term ‘space debris’ falls within the ambit of outer space treaty provisions or not. While going through Article I of the Liability Convention it defines ‘space object’ to include ‘component parts of space object as well as its launch vehicle and parts thereof.’ The treaty fails to define what a ‘component part’ of a ‘space object’ actually is, or whether either term includes ‘space debris’, the applicability of this treaty to space debris is far from established.

DUTY TO MINIMISE SPACE DEBRIS (IN THE FORM OF TREATY PROVISIONS)

Outer space activities are extremely dangerous. Space debris has the potential and is recognised by the international community to cause hazardous damage to the space craft in space and on the earth. It’s therefore seems necessary to clarify the legal consequences in case if the risks materializes.

The next step which comes in for International law is to impose upon states the obligation to take relevant measures and steps in order to prevent the series of space debris or at least minimise them in number while carrying on activities in outer space. Article III of the Liability Convention states that, ‘when a launching state causes damage in space to a space object or to persons on board that space object, the state causing the damage ‘shall be liable only if the damage is due to its fault or the fault of person for whom it is responsible.’ Accordingly, absent fault, which can be difficult to prove in the space environment, no liability attaches when space debris unintentionally causes damage in space. One major difference is to be made between cases where a state complies with its international obligations and the risk related to space debris materialize and cases where the state is in question is in breach of its international obligations. The former may give rise to international liability under Article VII¹⁶ of the outer space treaty and article II¹⁷ of Liability Convention, whereas the latter may additionally entail responsibility of intentionally wrongful act.

It is very necessary to avoid clash between the two space objects or between the space objects and space debris, which is to be taken care of for a successful mission, safety of the crew and for limiting the growth of space debris population. According to Article IV of the Registration Convention of 1976¹⁸, it is required for the state parties to furnish essential information about the

all other states parties to the treaty. State parties to the treaty shall pursue studies of outer space, including the Moon and the other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the earth resulting from the introduction of extra-terrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a state party to the treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies in the peaceful exploration and use of outer space including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A state party to the treaty which has reason to believe that an activity or experiment planned by another state party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.’

¹⁴ Article IX of the outer space treaty of 1967, sentence II,

¹⁵ Article IX of the outer space treaty of 1967 states that, ‘state parties to the treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the earth resulting from the introduction of extra-terrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.’

¹⁶ Article VII of the outer space treaty 1967, states that, ”Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.”

¹⁷ Article II of the Liability Convention 1972, “A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.”

¹⁸ Article IV of Registration Convention of 1976 provides that : ‘

- i) Each state of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry :
 - (a) Name of launching state or states
 - (b) An appropriate designator of the space object or its registration number;
 - (c) Date and territory or location of launch;
 - (d) Basic orbital parameters, including :
 - i) Nodal Period
 - ii) Inclination

space objects to the Secretary-General. Further in order to *minimise* risk related to space debris, Article III of the outer space treaty states that, 'the state of origin shall take all appropriate measures to prevent significant trans-boundary harm or at any event to minimise the risk thereof.'

It is necessary for space faring nations to take necessary steps not only for the mitigation but along with that for the active removal of the debris from the orbit, in order to make environment free from space debris. Is it the duty of the space faring nation to remove 'its' space debris from the atmosphere while conducting space venture or space debris enjoys legal protection from removal or any other forms of interference by the other space faring nations which includes any recycling done, or any kind of manipulation as a means of collision avoidance, further leads to many such questions and issues of concern Article III and IV¹⁹ of the outer space treaty contains the procedural rights and obligations to enter into consultation in case there is a reason to believe that 'harmful interference' with outer space activities may occur.

For the same reason, Article VI of the outer space treaty²⁰ provides that, 'states to bear international responsibility for national activities.' Article VII of the outer space treaty and liability convention imposes liability on the launching state if the damage occurs through a space object. So such what would be the way in which the liability would be measured? Through a piece of space debris which would be identified as belonging to a certain launching state. In such case, polluter-pays principle emerges as one of the pillars of general international environmental law, arguably being of relevance for outer space activities pursuant to article III²¹ of the outer space treaty. Each state should be individually loaded with the costs for measures related to its space debris and it should not leave any obligation to transfer the technology on unilateral terms.

The Liability Convention²² does nothing to force nations to remove the existing space debris that fails to cause physical damage, even though it causes launch delays or collision-avoidance manoeuvres. Instead, the Liability Convention serves, 'only as a limited deterrent to states' generation of space debris. The Registration Convention does not 'require a launching state to provide appropriate identification markings for its space craft and its component parts. Whether 'only active satellites are required to be registered or whether additional information on such things as inactive satellites, failed missions and space object breakup might also be required, all of which could increase the amount of space debris in outer space should also be registered is still unanswered. Another major difference is to be drawn depending upon the location as to where the damage has incurred by state or its natural or its juridical persons in outer space, air space or on the earth. As regard risks associated with the atmospheric re-entry of space debris, Article II of the Liability Convention might be appropriate, as it provides that 'a launching state shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.' Whereas, Article II of the Liability Convention talks about absolute liability pursuant to Article III of the same convention is based upon fault: 'in the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching state or to persons or property on board such a space object by a space object of another launching state, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.'

EXAMPLES OF SPACE DEBRIS

A recent example is the collision between Iridium 33 and Cosmos 2251 on 10th February, 2009 over Siberia. The incident marks the first time an intact, active satellite collided with another intact, but otherwise derelict space craft, but it is not the first time that

iii) Apogee

iv) Perigee

e) General function of the space object

ii) Each state of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.

iii) Each state of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit.'

¹⁹ Article III of outer space treaty of 1967 provides that, 'activities carried out in accordance with international law, including the charter of United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.'

Article IV of the outer space treaty of 1967 provides that, 'not to place in orbit around the earth any objects carrying nuclear weapons or any other kind of weapons of mass destruction, install or station such weapons in any other manner.'

The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies for peaceful and scientific purposes.'

²⁰ Article VI of the outer space treaty 1967 states that, 'State parties to bear international responsibility for national activities, whether such activities are carried on by governmental agencies or by non-governmental entities and also to see that activities are carried out in conformity with the provisions of treaty.'

(i) Activities on non-governmental entities require authorization and continuing supervision by the appropriate state party to the treaty

(ii) Activities carried out by international organization responsibility for compliance with this treaty shall be borne both by international organization and by the state parties to the treaty.

²¹ Ibid. see FN no. 18.

²² Convention on the International Liability for Damage Caused by Space Object, 1972

orbital space debris had collided in space²³. Derelict Satellites are those that wander in geosynchronous orbit²⁴ after a sudden failure also present an orbital space debris problem. Unlike satellites that are moved to a graveyard orbit²⁵, after their useful life is over, satellites that fail unexpectedly occupy a valuable orbital slot in the geosynchronous belt and can wander and collide with functioning satellites or interfere with their transmissions²⁶. The Outer Space Treaty is trying its level best by making launching state to preserve and maintain the environment of outer space in the course of its space activities. Perhaps, there is no treaty to define the responsibility of state and ways through which space debris can be mitigated. As no treaty defines or identifies the problem of space debris, then in that case there can only be one solution where national space legislation of space faring nations play a very important role. For example, the national space policy directs government agencies involved in space activities to stabilise the current environment of orbital space debris through practices like United States Government Orbital Debris Mitigation Standard Practices²⁷.

The National Space Policy of the United States²⁸ recognises the challenges posed by the current environment of orbital space debris and that it should take a leadership role in addressing the problem. However, the National Space Policy also recognizes that the United States cannot address the issue alone. All space faring nations need to take some or the other step to mitigate this problem from our environment. The United Nations, through the Committee for the Peaceful Uses of Outer Space addressed the issue of space debris for the first time under an agenda item entitled 'Space Debris' on March 10, 1994. This led to the adoption of space debris mitigation guidelines by the work of Committee through its Scientific and Technical Subcommittee, endorsed by the General Assembly. The Space Debris Mitigation Guidelines²⁹ are not legally binding under the international law, but states are encouraged to make proper measures to make sure that the guidelines are followed. Also space faring nations are encouraged to use guidelines for mission planning, new space craft design and existing space craft design whenever possible³⁰. Like other environment, space is damaged by human activity, primarily through the creation of space debris. But space is fragile like no other environment. Travelling at the speed of 7.5km/second, even the smallest piece of space debris can be deadly for space craft. While outer space may seem to provide boundless room for operations, the limited availability of suitable orbits coupled with growing contamination threaten sustainable use. In the first six weeks of 2007, the amount of large space debris (larger than 10 cm in diameter) in popular orbits increased by over 20 per cent due to Chinese anti-satellite test on 11th January and the explosion of a Russian rocket on 19th February were the two of the worst manmade debris creating events in history.

With the increase in the number of more launches, accidents and intentional explosions and collisions in space and the natural process of debris breakup are contaminating the environment at rates reminiscent of the height of the Cold War. This is an area marked by significant international co-operation, but the challenges remain pretty frightening. Despite landmark guidelines adopted by the UN Committee on the Peaceful Uses of Outer Space this year, the creation of debilitating space debris threatens to outpace the mitigation efforts. Although exceptional, these events reinforce a long-term trend of increasing space debris production³¹. According to a report by UNESCO made public in London on 28th April 2002, there were nearly 2.7 tons of various missile fragments in orbit. US Space Command's Space Catalogue currently tracks some 9000 man-made objects in orbit, ranging in size from 10 cm in lower orbit to over 1 meter in geo-stationary orbit. Approximately 94 per cent of these objects are

²³ Cosmos 2251 belonged to the Russian Federation and Collided with Iridium LLC's Iridium 33 on February 10, 2009 over Siberia at an altitude of 490 miles (790 km). The collision was the first ever of two intact spacecraft and left a debris cloud that continues to be tracked by US Space Surveillance Network.

²⁴ Geosynchronous orbit refers to 'an orbit where a satellite will appear to hover stationary over a point on the earth's surface.'

²⁵ A graveyard orbit is 'an orbit where spacecraft are intentionally placed at the end of their operational life so that they do not interfere with other satellites/spacecraft or otherwise occupy and orbital slot.'

²⁶ Listner, Michael, "International Space Law: An Overview of Law and Issues", New Hampshire Bar Journal, spring 2011.

²⁷ The United States Government Orbital Debris Mitigation Standard Practices are guidelines adopted by the United States to curtail or limit the amount of space debris in orbit. The objectives of the guidelines through practice are :

- (i) that spacecraft and upper stages should be designed to eliminate or minimize debris released during normal operations;
- (ii) The minimization of debris generated by accident explosions;
- (iii) The selection of safe flight profiles and operational configuration; and
- (iv) The post mission disposal of space structure

US Government Orbital Debris Mitigation Standards available at:

http://orbitaldebris.js.nasa.gov/library/USG_OD_Standard_Practices.pdf.

²⁹ The guiding principle enunciated by the United Nations Space Debris Mitigation Guidelines are :

- (i) Limit debris released during normal space operations;
- (ii) Minimize the potential for break-ups of space objects during operational phases;
Limit the probability of accidental collision in orbit;
- (iii) Avoid intentional destruction and other harmful activities;
- (iv) Minimize the potential for post-mission break-ups resulting from storeyed energy;
- (v) Limit the long term presence of spacecraft in the low-earth orbit region after the end of their mission.

UN General Assembly, 50th Session. Committee on the Peaceful Uses of Outer Space Report of the Scientific and Technical Subcommittee on its forty-fourth session, held in Vienna from 12 to 23 February 2007, official record, Vienna, Austria, 2007.

³⁰ Listner, Michael, "International Space Law: An Overview of Law and Issues", New Hampshire Bar Journal, spring 2011.

³¹ West, Jessica, "Back to future – Outer Space Treaty turns 40", see <http://www.thespacereview.com/article/982/1>, accessed on October, 2007.

considered space debris and a hazard to satellites and other space craft. While this material flying at speeds of almost 8 km/s (which is 10 times more than that of rifle bullet), a collision with a functional space object would cause it serious damage or even more destruction.

In February 1984, the commercial satellite Palapa B2 was launched for the Indonesian government, but it failed to reach geosynchronous orbit due to a malfunction of its perigee motor stage. While it was circling the earth in a useless orbit, the satellite was purchased by Sattel Technologies of California from the insurance group that covered the loss. Sattel subsequently contracted with NASA to retrieve the satellite, which it did in 1984. Sattel then contracted with Hughes Aircraft Company, which originally manufactured the satellite, and McDonnell Douglas, which was the launch service provider, to refurbish and re-launch the satellite. The satellite, which was renamed Palapa, was successfully re-launched in April 1990. After the re-launch title of the satellite was transferred back to Indonesia³².

The Swiss announcement of its space debris removal demonstration is a positive step forward in space debris removal efforts. The Swiss Space Center at the Swiss Federal Institute for Technology in Lausanne announced on February 15 its plan to develop and launch satellite to remove space debris from low earth orbit. Switzerland has traditionally taken a neutral political stance in larger world affairs. It has no on-going geopolitical issues with China and Russia, and it stands to reason that the planned flight of Clean Space One will not raise political objection that the use of the technology demonstrates a space weapon capability. If no objections are raised and Clean Space One completes its mission, Switzerland may unintentionally create two routes to nullify political concerns about space debris removal and open up the activity for masses. The Swiss Space Center at the Swiss Federal Institute for Technology in Lausanne announced on February 15 its plan to develop and launch a satellite to remove space debris from low earth orbit³³.

NASA is monitoring 16,000 objects larger than 10cm in diameter travelling around the earth at the speed of several kilometres per second, primarily in low earth orbit – less than 2,000km in altitude. Hence, the process of identification of the space debris would be difficult task³⁴. The European Space Agency is of opinion that space debris mitigation is not enough to maintain the clean and safe outer space environment: there should be some necessary step for the active debris removal from the orbit. As removal of space debris is the only solution, there should be some permanent solution which is in the form of implementing an international treaty on the issue that can assist in drawing attention to the need for cost effective debris removal techniques.

Conclusion

The junkyard that is created in the orbit is already blocking our path in use and exploration of outer space. So in future if any international agreement is coming up it needs to explicitly define the term '*space debris*'. There are many treaties for outer space on use and exploration, astronauts, liability and registration they should also emphasis on space debris. Lack of knowledge and awareness under the present issue may cause irreversible significances. Through mitigation of space debris it is going to provide with the temporary solution, we need to have a permanent solution through the process for removal of debris. The treaties provide freedom to explore and use outer space for nations and not carry any activity which is going to affect the outer space. All the treaties seem to be insufficient to tackle with the problem of space debris. Definition for '*space*' and '*space debris*' are vital in order to protect the outer space environment and also to make sure that countries to at least perform three major things which are as follows:

- i) Reduction in the formation of space debris
- ii) Steps to be taken to get rid of debris in the space environment
- iii) Notify the countries when they cause space debris

The liability laid upon the states in case of accidents for astronauts is an absolute one. Space debris is a serious threat not only to the outer space environment but also to the life of the astronauts.

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³² See <https://www.ukessays.com/essays/philosophy/legal-status-of-outer-space-philosophy-essay.php>, accessed on 11/05/2017.

³³ See <https://www.ukessays.com/essays/philosophy/legal-status-of-outer-space-philosophy-essay.php>, accessed on 11/05/2017.

³⁴ *Ibid.*, see FN 34.

11 Hobe, Stephan, "Environmental Protection in outer space: Where we stand and what is needed to make progress with regard to the problem of space debris", *The Indian Journal of Law and Technology*, Volume – 8, 2012.

12 Article I of the outer space treaty of 1967 provides 'to be carried out for the benefit and in the interests of all countries, irrespective of their degree of scientific and economic development, and shall be the province of all mankind; Shall be free for exploration and use by all states without discrimination of any kind, on a basis of equality and in accordance with international law, and to have free access to all areas of celestial bodies;

Freedom of scientific investigation in outer space and states shall facilitate and encourage international co-operation in such investigation.'

¹ Article IX of the outer space treaty provides that 'in the exploration and use of outer space, including the Moon and other celestial bodies, state parties to the treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other states parties to the treaty. State parties to the treaty shall pursue studies of outer space, including the Moon and the other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the earth resulting from the introduction of extra-terrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a state party to the treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies in the peaceful exploration and use of outer space including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A state party to the treaty which has reason to believe that an activity or experiment planned by another state party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.'

13 Article IX of the outer space treaty of 1967, sentence II,

Article IX of the outer space treaty of 1967 states that, 'state parties to the treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the earth resulting from the introduction of extra-terrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.'

14 Cosmos 2251 belonged to the Russian Federation and Collided with Iridium LLC's Iridium 33 on February 10, 2009 over Siberia at an altitude of 490 miles (790 km). The collision was the first ever of two intact spacecraft and left a debris cloud that continues to be tracked by US Space Surveillance Network.

15 Geosynchronous orbit refers to 'an orbit where a satellite will appear to hover stationary over a point on the earth's surface.'

16 A graveyard orbit is 'an orbit where spacecraft are intentionally placed at the end of their operational life so that they do not interfere with other satellites/spacecraft or otherwise occupy and orbital slot.'

17 Listner, Michael, "International Space Law: An Overview of Law and Issues", *New Hampshire Bar Journal*, spring 2011.

18 The United States Government Orbital Debris Mitigation Standard Practices are guidelines adopted by the United States to curtail or limit the amount of space debris in orbit. The objectives of the guidelines through practice are:

- (i) That spacecraft and upper stages should be designed to eliminate or minimize debris released during normal operations;
- (ii) The minimization of debris generated by accident explosions;
- (iii) The selection of safe flight profiles and operational configuration; and
- (iv) The post mission disposal of space structure

US Government Orbital Debris Mitigation Standards available at:

http://orbitaldebris.js.nasa.gov/library/USG_OD_Standard_Practices.pdf.

19 The guiding principle enunciated by the United Nations Space Debris Mitigation Guidelines are:

- (i) Limit debris released during normal space operations;
- (ii) Minimize the potential for break-ups of space objects during operational phases;
- (iii) Limit the probability of accidental collision in orbit;
- (iv) Avoid intentional destruction and other harmful activities;
- (v) Minimize the potential for post-mission break-ups resulting from stored energy;
- (vi) Limit the long term presence of spacecraft in the low-earth orbit region after the end of their mission.

UN General Assembly, 50th Session. Committee on the Peaceful Uses of Outer Space Report of the Scientific and Technical Subcommittee on its forty-fourth session, held in Vienna from 12 to 23 February 2007, official record, Vienna, Austria, 2007.

20 Listner, Michael, "International Space Law: An Overview of Law and Issues", *New Hampshire Bar Journal*, spring 2011.

21 West, Jessica, "Back to future – Outer Space Treaty turns 40", see <http://www.thespacereview.com/article/982/1>, accessed on October, 2007.

22 See <https://www.ukessays.com/essays/philosophy/legal-status-of-outer-space-philosophy-essay.php>, accessed on 11/05/2017.

23 See <https://www.ukessays.com/essays/philosophy/legal-status-of-outer-space-philosophy-essay.php>, accessed on 11/05/2017.

24 Ibid, see FN 34.