OUTER SPACE DEBRIS: AN INTERNATIONAL OBLIGATION TO MITIGATE AND CONTROL

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Space flight is not a random activity, but one requiring decisions and Commitments with very long lead times and very long consequences.

—Albert Gore[1]

According to Ulf Merbold, the first West German astronaut, our genes are like a program that continuously pushes us beyond the horizon of our experience in order to conquer new positions, finally leading us into outer space.[2] The basic nature of the human being to explore its surroundings has been transformed to the extent of the exploitation of the outer space. The historic journey of exploration, previously unknown and inaccessible realm, was started fifty three years ago with Sputnik and reached upto the uncontrolled multipurpose use (like telecommunication, strategic, research, tourism etc.) of the outer space by the different countries which raised the serious global concern. Outer Space is *res communis* like Antarctica and High seas, any country of the international community can use and explore it.

Earlier concept shows that outer space is infinite and it is true in theoretical reality but practically only upto certain limit outer space can be used. The universe is infinite but the position of outer space is in reality just like a thin shell around Earth, where we have the ability to place stable satellite. Satellite in low earth orbit can reach a maximum altitude of about 5,000 km, which is just 10 to 15 per cent of earth radius, whereas satellites in geosynchronous orbit can reach a maximum altitude of about 36,000 km, which is less than 1/10 of the distance to the moon. Thus our boundless outer space is really minuscule compared with the size of universe we try to observe.[3]

The rapid growth of science and technology in the different parts of the world has provided the opportunity to the various counties to exploit the outer space and in the last half century the world has seen uncontrolled exploration and exploitation of the outer space by the developed and developing countries. Now the recent research shows that that the uncontrolled use of the space by the various countries in the limited and useful area of outer space has caused the pollution in form of junk of debris which is the great threat to the future satellites and space stations. This research paper will try to analyse the causes of the space pollution, the international measures and states obligation to mitigate the situation and what may be the effective control mechanism in this regard.

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Chief Pollutant: Space Debris

What is space debris?

Space debris' is synonymous with 'orbital debris'. There are, also, a number of colloquial phrases to describe 'space debris'.[4] These terms include 'space trash',[5] 'space garbage',[6] 'space refuse'[7] and most commonly 'space junk'.[8] However many expressions there are to refer to orbital debris, the international space community has yet to agree on a single definition.[9] A generous definition could, nonetheless, be provided. That is to say, 'space debris' are all man-made objects launched in to outer space by space actors undertaking space-related activities, and these objects served their or have no useful function.[10] It is suggested that the absence of a legal definition of space debris might have had attributed to the uncertainty for the space community to accept a universal one. The US National Science and Technology Council Committee on Transportation Research and Development is of the view that 'orbital debris is a popular rather than a legal term'.[11] Reading on the face of international space law framed by the United Nations, 'debris' is not even mentioned. Efforts have been invested by interested space bodies to form a definition in the absence of a legal one, nonetheless. In 1999, the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful uses of Outer Space states:

> '*Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized*'.[12]

In its Position Paper on Orbital Debris, the International Academy of Astronautics offers a closely related definition, and provides that 'space debris' are:

> '*any man-made Earth orbiting object which is non-functional with no reasonable expectation of assuming or resuming its intended function or any other function for which it is or can be expected to be authorized, including fragments and parts thereof. Orbital debris includes non-operational spacecraft, spent rocket bodies, material released during planned space operations, and fragments generated by satellite and upper stage breakup due to explosions and collisions*'.[13]

So mainly debris is man-made non-functional substance in the orbit. But when we consider about the dimension of space, it is difficult to imagine that problems of pollution could ever arise. But the rapid increase of pollution in outer space is a serious problem and is becoming worse. Space debris in lower-earth orbit poses hazards to spacecraft, astronauts' lives, and to the integrity of scientific experiments. Lives and property on earth are also endangered by dead satellites that re-enter the atmosphere. Space was free of man-made pollution until 1957, when the Russians launched Sputnik. Since that time 15,000 large objects have been discarded in orbit, including rocket boosters and fuel tanks,

dead satellites, tools and garbage jettisoned from manned spacecraft.[14] Forty thousand smaller objects (approximately 2.5 cm in size) and billions of tiny flakes of paint also float in space.[15] Space debris in near-earth orbit is particularly hazardous because it travels at approximately 17,500 miles (29,575 km) per hour.[16] At these velocities, even a tiny flake of paint 1/50 of an inch (0.51 mm) across could puncture an astronaut's spacesuit. A paint fleck that is 1/10 of an inch (2.54 mm) in diameter can damage a space-craft.[17]

Several unexplained failures of satellites have been attributed to possible collisions with space debris. Analysis of the Solar Maximum Mission Satellite shows that one hundred and fifty visible holes were found in a five-foot square area from its surface. About one-half of the holes were caused by micro meteors, which are objects naturally found in space. The other half were created by man-made garbage. Chemical analyses re-vealed that most of the man-made holes resulted from collisions with paint flakes. The international community is confronted with the serious question of whether present planning for space activities will bring about unacceptable probabilities of collision between active spacecraft and space debris. Chobotov recentlye stimated this probability to be as much as 50 percent for a 50-meter spacecraft in a 1,000-day, circular, low-altitude orbit.[18] This probability is clearly unacceptable and must be improved.

So considering the various incidents, orbiting debris is the main source of space pollution and adversely affecting the space environment. There is an increased risk of additional debris being generated due to collision between space objects, and such fragments remaining in space permanently. Every space actors, whether State-sponsored, civilians or commercial, are affected by the space debris population. Human lives are endangered: astronauts undertaking extra-vehicular activities or even the paying public enjoying commercial human spaceflights run the risk of colliding with pieces of debris. The continuing growth of debris in heavily used orbital regions, like Low Earth Orbit and Geostationary Earth Orbit, not causes minor or complete abruptions to space operations, but potentially could prevent launches of planned space vehicles; thus, denying future access to, and use of, outer space. There are several example which provide ample evidence regarding damage done by debris like:—

- In April 1984, the shuttle crew brought back to earth some malfunctioning electronics boxes on the Solar Max satellite. National Aeronautics and Space Administration (NASA) found the outer surface peppered with around 160 small holes created by fling paint chips.
- On its seventh moission in July in 1983,the shuttle orbiter Challenger was hit by something that chipped a window. NASA concluded that the damage was done by a tiny(0.2mm) flank of white paint, possibly the kind used on U.S. Delta rockets.
- In July 1981, the Soviet navigation satellite Kosmos 1275 broke up over Alaska in a pattern suggesting it had been hit by debris.

- The Soviet surveillance satellite Kosmos 954, with a nuclear reactor abroad, suddenly depressurised and fell to earth over northern Canada in January 1978, also in a way that suggested a collision had occurred.
- The European Earth observation satellite, GEOS-2, suffered injury to its solar panels in 1978, apparently when hit by debris.

The National Aeronautics and Space Administration Agency, moreover, had to take evasive measures to avoid colliding with debris which would otherwise have had affected its operations. NASA's Earth's observing System, as from May 2009, had been manoeuvred three times to avoid collision with orbital debris.[19] NASA tracked a large piece of debris from a spent European rocket which was launched in August 2006 to send two communications satellites in orbit.[20] The decision to steer the docked Shuttle and the International Space Station to dodge the debris was not executed as it passed at a safe distance.[21] A small piece of space litter from a derelict 2007 Chinese weather satellite, which was destroyed under a coordinated effort by the Chinese government with a military missile, was detected by NASA on September 7, 2007.[22] Although it was expected to head towards the ISS, the debris did not pose a threat as it passed the orbiting laboratory.[23] In November 2009, the Agency announced that a small piece of space debris approached some 1,640 feet from the ISS. Although the debris posed no threat to the Station or its crew, the six astronauts were informed that as a safety precaution they might have to evacuate the ISS to board their Russian Soyuz spacecrafts lifeboats. NASA further revealed that it had difficulty tracking the object because of its very small size, and that it was too late to steer the orbiting laboratory away from the close encounter.[24]

Sources of Space Debris

According to various scholors of space law, the main sources of space debris has been categorised into four parts as follows:—

Inactive payloads

These are launched space objects which have become derelict and cannot be controlled by their space operator for a re-entry to Earth.

Operational debris

It relates to all associated material used to carry out the space endeavour which remains in space. Such debris includes spent and discarded upper rocket stages to provide the necessary thrust for the launched space vehicle to enter space.

Fragmentation debris

It is the third source, and is produced when there is a break up of a space object as a result of an explosion, collision or for some other cause.

Microparticulate matter

Microparticulate matter, which consists of particles, gases and space glow64. Such debris is generated from different sources, including solid-propellants rocket motors, surfaces of in-orbit objects and manned spacecrafts.

Space debris has emerged as a chief pollutant in the outer space in the last century and shows its presence through various accidents as above mentioned. So the appropriate measures should be adopted within the reasonable time by the international community.

Space Debris Mitigation and International Approach

What should be the limit of pollution in the outer space or how much pollution should society be willing to permit in outer space? Generally it is argued that the less space pollution is the better. The less pollution there is, the smaller the chance is that accidents will occur. But this assertion is incorrect. The issue is not total pollution free environment in outer space, but rather how much pollution is optimal. It is not possible to maintain total pollution free environment in the outer space with its exploring mindset. The world's resources are limited and the gains from reducing space pollution must be weighed against the costs, in terms of other goods and services that could be produced with the resources being devoted to pollution abatement activities.[25]

The international community should devote resources to limiting space pollution until the marginal gain from reducing space debris is exactly equal to the marginal cost of reducing the pollution. There can be too little space debris.

In opening statement before the US House of Representatives Committee on Science and Technology's Subcommittee on Space and Aeronautics on '*Keeping the Space Environment Safe for Civil and Commercial Users*', Chairwoman Gabrielle Giffords described the 'relentless growth of space debris', which has been a continuous concern for policymakers and interested bodies.[26] These sentiments were later echoed by Al Gore who indicated that problems with orbital debris and nuclear contamination polluting the space environment warrant international concern and coordinated action in order to sustain access to, and use of, outer space.[27]

Many space-faring nations have started to realize the problem posed by space debris and have adopted various measures to mitigate it. Today, there is a wide interest in the problem from the scientific community and various initiatives and organizations have been set up to debate andpromote various guidelines or codes of conduct. Now I will try to analyse the various measurres adopted by the state and non state entities,

United States

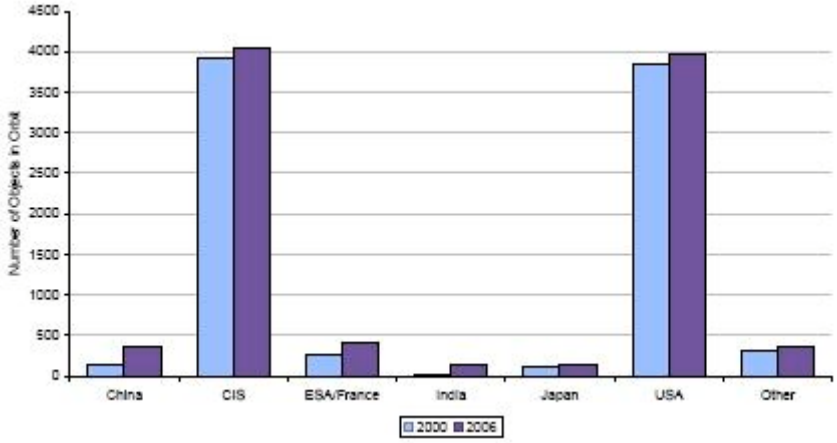
It is worth noting that the debris problem has its origin in the space competition between the former USSR and the U.S. Since 2000, the number of in-orbit objects larger than a bowling ball has increased by nearly 10 percent, with the United States and Russia each contributing approximately 40 percent of the total debris. The following graph illustrates the origin of space debris and clearly it becomes obvious that the role of the U.S. in dealing with this problem cannot be marginal.

Although at this time the U.S. Government does not see the need or benefit for a new legal regime to address the topic of space debris, the U.S. has played a

crucial role in tracking, cataloguing, and modeling space debris. NASA has been at the forefront of orbital debris mitigation efforts in the U.S. government. With authority over all civil government space missions, the agency has developed a policy and specific procedural requirements for orbital debris mitigation.

A NASA Orbital Debris Program Office, located at the Johnson Space Center, is recognized worldwide for its leadership in addressing orbital debris issues. Researchers at the center develop an improved understanding of the orbital debris environment and devise measures that can be taken to control its growth. The Office plays a key role within the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space in promoting mitigation guidelines.

FIGURE 1: GROWTH IN NUMBER OF OBJECTS IN ORBIT, BY COUNTRY/ORGANIZATION, FROM 2000 TO 2006



Source: Futron Corporation, 2006.

National Space Policy document of U.S.flagged the progress made both nationally and internationally regarding proliferation of orbital debris over the past decade but also underscored the worrisome nature of space junk. The White House document stated:Orbital debris poses a risk to continued reliable use of space-based services and operations and to the safety of persons and property in space and on Earth. The United States shall seek to minimize the creation of orbital debris by government and non-government operations in space in order to preserve the space environment for future generations.[28]

This is a major step but the intentions have to be followed by actions. For instance, NASA guidelines known as the U.S. Government Orbital Debris Mitigation Standard Practices have been issued in 2000 for mitigating the growth of orbital debris. However, they are not considered binding regulations and responsibility and accountability is not legally enforceable. More importantly,

national security and other government programs can be granted orbital debris waivers today, demonstrating that the current regulatory regime contains loopholes in terms of applicability of standards.[29]

European Union

European Space Agency (ESA) has a long history in tracking space debris. In 1986, the Director General of ESA created a Space Debris Working Group with the mandate to assess the various issues of space debris. The findings and conclusions are contained in ESA's Report on Space Debris, issued in 1988. In 1989, the ESA Council passed a resolution on space debris where the Agency's objectives were formulated as follows:

(1) Minimize the creation of space debris;

(2) reduce the risk for manned space flight,

(3) reduce the risk on ground due to re entry of space objects,

(4) reduce the risk for geostationary satellites. ESA's Launcher Directorate at ESA Headquarters in Paris also coordinates the implementation of debris mitigation measures for the Arianespace launcher.

Over the last few years, ESA developed debris warning systems and mitigation guidelines. Following the publication of NASA mitigation guidelines for orbital debris in 1995, ESA Published a Space Debris Mitigation Handbook, issued in 1999, in order to provide technical support to projects in the following areas: Description of the current space debris and meteoroid environment, risk assessment due to debris and meteoroid impacts, future evolution of the space debris population, hyper-velocity impacts and shielding, cost-efficient debris mitigation measures.

Inter-Agency Space Debris Coordination Committee (IADC)

The Inter-Agency Space Debris Coordination Committee (IADC) is one of the world's leading technical organizations dealing with space debris. ESA is a founding member of IADC, together with NASA, the Russian Aviation and Space Agency, and Japan. IADC is today an in forum of governmental bodies for the coordination of activities related to the issues of man-made and natural debris in space. The primary purpose of the IADC is to exchange information on space debris research activities between member space agencies, to facilitate opportunities for co-operation in space debris research, to review the progress of ongoing co-operative activities and to identify debris mitigation options. Generally speaking, the organizations reached a consensus of adopting the mitigation guidelines as proposed by the IADC. The IADC Space Debris Mitigation Guidelines was drafted in 2002 as the first international document that is specialized in field of space debris mitigation and based on a consensus among the IADC members. In February 2003, at the fortieth session of the Scientific and Technical Subcommittee of the UNCOPUOS, the IADC presented

the IADC Guidelines as its proposals on debris mitigation. This document serves as the baseline for the debris mitigation in two directions:

(1) toward a no binding policy document, and

(2) toward applicable implementation standards.[30]

One criticism of the IADC Space Debris Mitigation Guidelines is that they remain voluntary and are not legally binding under international law. Still, IADC is an ideal forum on space debris due to its wide membership among the leading space agencies and provides a basis for further international cooperation when elaborating a space debris convention. Indeed, IADC standards have facilitated the discussion on space debris mitigation guidelines and opened the door to further research related to the cost of mitigation measures. Thus, recently, various studies have been conducted on the effectiveness and the costs of debris mitigation measures. These studiesexamine a number of important problems: prevention of on-orbit explosions and operational debris release, reduction of slag debris ejected from solid rocket motor firings, de-orbiting of space systems in LEO with various limitations on the post-mission lifetime, and re-orbiting ofspace systems to above the LEO & GEO protection zones (graveyard orbiting).

United Nations

Over the past years, the United Nations On Peaceful Use of Outer Space (UNCOPUOS) and its Scientific and Technical Subcommittee (STSC) have played an important role in debating space debris issues. UNCOPUOS was set up by the General Assembly in 1959 in resolution 1472 (XIV). At that time, the Committee had 24 members. Since then, it has grown to 67 members—one of the largest Committees in the United Nations. In addition to states, a number of international organizations, including both intergovernmental and non-governmental, have been granted observer status with UNCOPUOS and its Subcommittees. The Committee has the following goals:

(1) review the scope of international cooperation inpeaceful uses of outer space,

(2) devise programs in this field to be undertaken under United Nations auspices,

(3) encourage continued research and the dissemination of information on outer space matters, and

(4) study legal problems arising from the exploration of outer space.

The resolution establishing UNCOPUOS also requested the UN Secretary-General to maintain a public registry of launchings based on the information supplied by states launching objects into orbit or beyond. Those terms of reference have since provided the general guidance for the activities of the Committee in promoting international cooperation in the peaceful uses and exploration of outer space. The Committee is divided in two standing subcommittees: the Scientific and

Technical Subcommittee and the Legal Subcommittee. The Committee and its two Subcommittees meet annually to consider questions put before them by the General Assembly, reports and issues raised by the Member States.

The United Nations Office for Outer Space Affairs (UNOOSA) implements the decisions of the General Assembly and of UNCOPUOS. The office has the dual objective of supporting the intergovernmental discussions in UNCOPUOS and of assisting developing countries in using space technology for development. The Office is the focus of expertise within the United Nations Secretariat. It serves as the secretariat for the intergovernmental Committee (UNCOPUSOS), and implements the recommendations of the Committee and the United Nations General Assembly. The Office is also responsible for organization and implementation of the United Nations Programme on Space Applications (UNPSA).

International Obligation and Its Acceptance

There is a critical weakness in the international law on space debris. Existing space law is related to the use of space and not to debris regulation. Most of existing treaties have been overtaken by technology advancement. While the rules developed by the Outer Space Treaty or the Registration Convention is useful, it does not apply to the space debris issue. This means that commercial and government-sponsored space launches can still create more debris without limits. Today, any country or corporation can launch a rocket and/or place equipment into orbit without permit. The only constraint is that they are required to record the launching as stipulated under the Registration Convention.

Furthermore, nothing is said about the destruction of satellites in space and the creation of space debris resulting from it. In international law, nothing can prevent a nation from destroying one of its own satellites. The arms control provisions of the Outer Space Treaty forbids the placing of nuclear weapons or any other kinds of weapons of mass destruction in orbit. The treaty also forbids establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on the Moon and other celestial bodies. However, nothing is mentioned about spacecraft destruction and space debris thus created. Recently, in February 2007, the UN reached a consensus on the draft of space debris mitigation Guidelines and adopted them. However, all of the existing guidelines remain voluntary and are not legally binding under international law. At the UN level, some nations have expressed the view that a legally non-binding set of guidelines was not sufficient. Some delegations at the Scientific and Technical Subcommittee (UNCOPUOS) expressed the view that the Subcommittee should consider submitting the space debris mitigation guidelines as a draft resolution of the General Assembly rather than as an addendum to the report of the Committee. At the meeting of UNCOPUOS on February 2007 in Vienna, the view was also expressed that the states largely responsible for the creation of the present situation and those having the capability to take action on space debris mitigation should contribute to space debris mitigation efforts in a more significant manner than other States.

Conclusion and Suggestions

In 21st century, where chance of space exploration is unlimited, orbital debris are great threat for government and commercial satellite operators and manufacturers. Orbital debris are bound to grow as long as there are launches of satellites and other spacecraft. However, the greatest challenge is about our ability to successfully coordinate and implement, a set of measures to deal with space debris in the coming years. There is requirement of a global norm in form of a convention, which must be developed through common conciousness to get a cosistant practice by nations. Furthermore, the convention would cast in stone some of the principles for dispute resolution and liability damage. The convention is to be organized around the following objectives:

Independent Tracking of space debris by states and its Cataloguing—A similar pattern database should be maintained by United Nations Office for Outer Space Affairs secretariat. Specific procedures will need to be drafted and enforced to ensure that information and data must be collected in a timely and exhaustive manner.

- Laying down the standered for Space Debris Mitigation and Disposal Standards—There is urgent requirment for internationally agreed standards that can enforce appropriate debris mitigation and disposal measures.
- There must be Space Preservation Provision—The convention must secure the protection of some orbital regions because of their scientific and economical importance: the Low Earth Orbit ranging from 200 km to 2000 km altitude, and the Geostationary Earth Orbit between 33000 and 36000 km altitude.

Space debris pollution problem is giving a negative effect on, space tourism, space commerce, the exploration of space, the use of raw materials from space and celestial bodies like moon and mars. A new space debris convention is thus *sine qua non* for fearless exploitation of space now.

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