IAC-07-E6.3.07

COMMON BUT DIFFERENTIATED RESPONSIBILITY – A PRINCIPLE TO MAINTAIN SPACE ENVIRONMENT WITH RESPECT TO SPACE DEBRIS

M.Y.S. Prasad
Space Applications Centre, Indian Space Research Organisation, Ahmedabad, India
mys@sac.isro.gov.in

Rajeev Lochan
Indian Space Research Organisation, Bangalore, India
lochan@isro.gov.in

ABSTRACT

Space debris situation is in focus of all Space-faring countries for quite sometime. Many other non Space faring countries have also caught up with the awareness on the need to limit the Space debris and maintain the Space environment clean. Two proactive initiatives taken up were the studies by Inter-Agency Space debris Coordination Committee (IADC), and the debate on the Space debris Mitigation Guidelines in the UN Committee on Peaceful Uses of Outer Space (UNCOPUOS). The guidelines worked out cover a wide range of technical areas and actions to be taken for Space debris Mitigation. The effective approach in the long term would be a combination of technical solutions and arriving at a set of "Rules of the Game". These rules can be in the form of Principles, Agreement or can be an UN Treaty on Space debris depending on the level of consensus among various Nations. However, two aspects are very clear – limiting of Space debris is a part of broader strategy of maintaining Space Environment, and the contribution to the present level of Space debris is proportional to number of launches carried out by each country in the past. The UN Framework Convention on Climate Change (UN FCCC), dealing with a different subject, had introduced a very important category of responsibility called "Common but differentiated responsibilities". This was based on the largest share to the emissions of green house gases by developed countries, relatively low level of per capita emissions from developing countries, and the share of global emissions for the developing countries to be decided consistent with their social and developmental needs. It simply means the responsibility for maintaining and improving the environment is common to all countries, but at the same time major responsibility to limit emission of green house gases rests with the developed countries, who contributed maximum to the present state of environmental pollution. This principle of "Common but differentiated responsibility" applies equally well for the Space debris situation, in the view of the authors. Similarly, certain innovative mechanisms which were introduced in the UN FCCC and Kyoto Protocol can also be adopted for Space debris area. This paper describes the principle of 'Common but differentiated responsibility', its possible application to Space debris Mitigation in future, various mechanisms which can be innovatively brought in to motivate the countries to maintain Space clean and with relatively low level of debris. The aim of the paper is to introduce new ideas, which can be considered in future by the Legal Experts as and when they examine and develop Space debris Legal Regime.

1. INTRODUCTION

The launch of man made artificial satellite took place for the first time successfully on 4th October, 1957 and the Sputnik-I satellite was orbited around Earth. This historical event had opened the Space Exploration to mankind. It proved the theories projected till then that the Earth-orbiting velocity could be attained with multi-stage rocket propulsion systems based on principle of reaction. It also proved the precise engineering which went into planning and realization of Satellite and Launch Vehicle

This historic breakthrough was followed up by some of the Space-faring countries. Since 1957, mankind has performed more than 4000 Space launches into Earth orbit – orbiting successfully the remote sensing, communications, navigation, science exploration, and inter-planetary exploration Spacecrafts. These Spacecrafts were orbited into Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geo-Stationary Earth Orbit (GEO) around the planet Earth. All the inter-planetary exploration satellites escape Earth's gravity and travel to their destinations. These Spacecrafts and associated services brought in significant benefits to the society, and also a great wealth of a new knowledge on the Outer Space and Universe.

These launches and the Spacecrafts also resulted in a side effect which is popularly called as Space debris today. Space debris consists of the Spacecrafts and rocket stages which had completed their missions but still in the orbits, the parts of Spacecrafts and launch vehicles which were released during the mission operations, and the small fragments created due to explosion of satellite and spent rocket stages which are in the orbits. These Space debris vary from small millimeter size specks to large multi-tonne sized systems. These Space debris will eventually either reenter the Earth's atmosphere, escape from the Earth orbit into deep Space, or remain in the Earth orbit for a long period.

The third category of Space debris i.e. those objects and fragments which remain in Earth's orbits for a long time increased steadily in the last 50 years. The subject of Space debris became important in the early 1990s with the realization by several countries of its exponential growth. A number of initiatives were taken up to handle the subject of Space debris.

2. MULTI-LATERAL INITIATIVES

The initial focus on the subject of Space debris and their harmful effects came from the major Space-faring nations, who are worried about the safety of manned missions and Space Stations. Later, Inter-Agency Space debris Coordination Committee (IADC) was formed in 1993. Its membership was drawn from Space-faring countries to carry out the technical exchanges and to take up cooperative actions at international level. IADC had carried out many studies on the measurements, analysis, and mitigation aspects of Space debris.

The subject of Space debris was included in the Agenda of Scientific and Technical (S&T) sub-committee of United Nations Committee on Peaceful Uses of Outer Space (UN-COPOUS) in February 1994. The S&T sub-committee carried out the deliberations on the subject for three years and later prepared a technical report which was adopted as official UN document in 1999. This document laid down the

common understanding of all nations comprising of UN-COPUOS membership on the subject of Space debris [1].

International Academy of Astronautics (IAA) formed a Study Group to study and prepare a detailed technical report on the Space debris. The membership of the study group consisted of technical experts and academicians drawn from the IAA members. The report of the study group was published in the year 2000 as IAA Position Paper on Orbital Debris, after approval by the Board of Trustees of IAA [2].

The S&T sub-committee of UN-COPUOS took up the work of formulating Space debris mitigation guidelines in the year 2002 as a multi-year task plan. After detailed deliberations the guidelines were adopted, and formed part of the S&T sub-committee report of the year 2007. These guidelines are applicable to Mission Planning and Operation of newly designed Spacecraft and orbital stages, and if possible, to the existing ones. They are not legally binding under International Law. These Space debris mitigation guidelines are to be implemented by the Member States and International Organisations on a voluntary basis through national mechanisms [3].

Achieving a common technical understanding, and adopting Space debris mitigation guidelines are significant achievements at the multi-national level working purely on consensus basis. But still the problem of existing Space debris, and a potential accident and damage resulting from such Space debris exist. An international legal regime either in the form of Principles, or Agreement, or Rules of the Game, or in the form of UN Treaty on Space debris has to be formulated in the long run depending on the level of consensus among various nations.

The most significant achievement of various multi-lateral initiatives so far has been to raise the awareness on Space debris and to establish an understanding that limiting the Space debris is a part of broader strategy of maintaining Space environment clean and manageable for future generations.

3. ANALYSIS OF THE SPACE DEBRIS

Historically, the development of launch vehicles and orbiting of the satellites had been led by former Soviet Union (and present Russia), and USA. The reasons for such a leadership was because of their participation in the second World War, development of long range missiles for military purposes which matured into Space Launch Vehicles, and post-World War II military competition and race between these two countries. Both of them developed a number of launch vehicles, and spacecraft for wide ranging applications.

Figure-1 below gives a successful launches carried out by different countries worldwide. The figure shows the dominant role in the number of launches by USA and former Soviet Union (Russia). At the peak of the activities between 1965 and 1990, these two countries together were launching on average one launch vehicle every three days. Obviously such a high level of activity accrued large lead in the Space field to both these countries, but at the same time created large amount of Space debris.

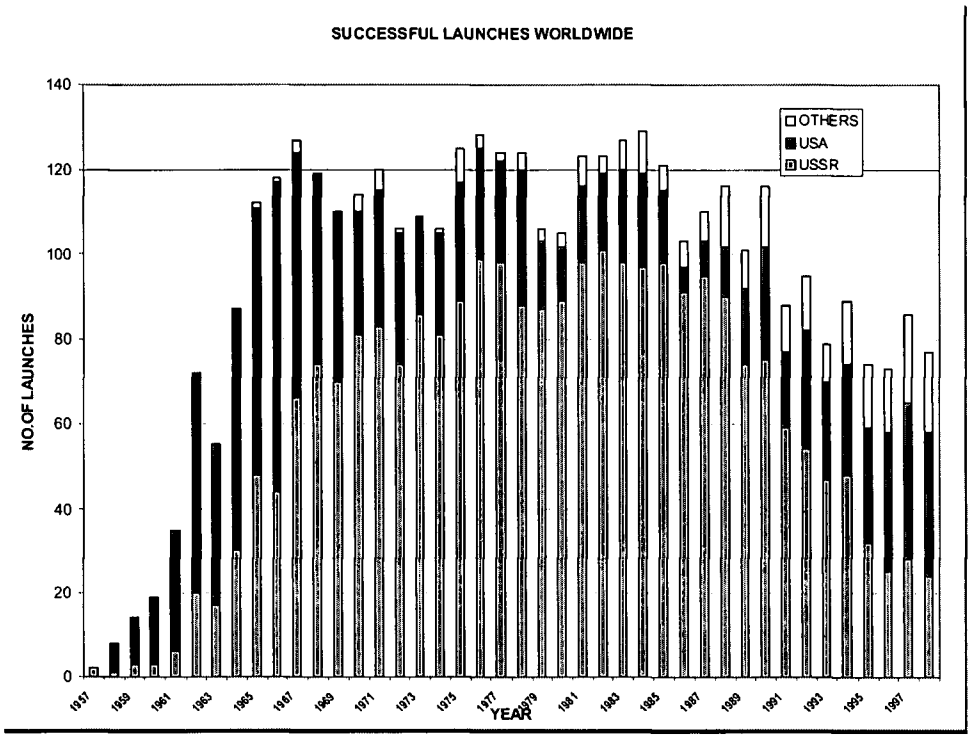

Fig. 1 : Successful Space Launches worldwide (Source : "Space Log" issues of TRW)

In the meantime slowly a few more countries have acquired and mastered the technology of launch vehicle development and launching satellites with their own launch vehicles. Table-1 provides the launch of first satellite by such countries. It may be noted that in the later period the European countries came together as European Space Agency. It should also be noted that the Space-faring nations – i.e. countries which have got independent capability for access to Space are only 7, considering all European Countries as one entity.

COUNTRY	DATE	SATELLITE	SATELLITE Wt. (kg)	LAUNCH VEHICLE
USSR	4.10.1957	Sputnik-I	83.6	Vostok
USA	31.1.1958	Explorer-I	14	Jupiter-C
France	26.11.1965	Asterix	38	Diamant-A
Japan	11.4.1970	Oshumi	23.8	Lambda-4S
China	24.4.1970	China-I	173	Long March-I
UK	28.10.1971	Prospero	66	Black Arrow
India	18.7.1980	Rohini E-2	40	SLV-3
Israel	17.9.1988	Offek I	156	Shavit

Table 1 : First Satellite Launches of Countries with their own Vehicles. (Compiled from the launch details of various countries)

Table-2 gives World wide successful Space launches between 1957 and 2002 by all these countries put together. This table also lists one each successful launch carried out by Australia and U.K., who discontinued the development of their launch vehicles later. The table also lists the launches of a multi-lateral private company called Sea Launch.

Country	No. of Launches
USSR/Russia	2674
USA	1235
France	10
Australia	1
UK	1
Europe	144
China	68
Japan	57
India	11
Israel	4
Sea Launch	3

Table 2 : World wide successful Space Launches 1957 – 2002
(Source : "Space Log" issues of TRW)

Space objects today consist of approximately 9000 objects monitored and catalogued by US Space Surveillance Network which are bigger than 10 cms. in diameter in LEO and bigger than 1 mtr. diameter in higher orbits. The composition of these objects is [2] :-

- Remains of Satellite and rocket stage fragmentation – 40%
- Pieces of hardware released during payload deployment – 12%
- Non-operational payloads – 20%
- Operational satellites – 6%

Table-3 below gives the country-wise listing of Space objects combining the type of objects and the origin / launching state. The Space objects belonging to former USSR, and later Russia and other countries which emerged from former USSR are listed under CIS countries. The dominant contribution of USA and CIS countries in total Space objects can be inferred from this table. [4]

COUNTRY/ ORGANISATION	PAYLOADS	ROCKET BODIES & DEBRIS	TOTAL
CHINA	51	310	361
CIS	1359	2680	4039
ESA	36	33	69
FRANCE	43	300	343
INDIA	31	111	142
JAPAN	89	55	144
US	1015	2949	3964
OTHERS	346	20	366
Total	2970	6458	9428

Table 3 : Orbital Box Score (as of JAN 2006, as cataloged by US Space Surveillance Networks)

The analysis on Space debris by various specialist fora indicated that the population of Space debris will increase significantly in future unless proper corrective measures and mitigation measures are taken by all concerned. This is where the relevance of the Space debris mitigation guidelines developed by UN-COPUOS lies. When some sort of legal regime has to be evolved and Space debris has to be treated as an essential Space environment problem, we have to look around for guidance on similar issues tackled earlier.

4. THE KYOTO PROTOCOL

The issue of Climate Change was one of the issues having significant effect on the Earth and its environment. An International Treaty on climate change was worked out under the United Nations Framework Convention on Climate Change (UN FCCC). The Kyoto Protocol is an agreement made under UN FCCC with the object of stabilizing the atmospheric concentrations of green house gases at a level that would prevent dangerous anthropogenic interference in the climate system [5]. The targets of the Kyoto Protocol cover six main green house gases namely carbon dioxide, methane, nitrus oxide, hydroflurocarbons, perfluorocarbons and sulphur hexafluoride. The Kyoto Protocol separates the governments into the two general categories – developed countries referred to as Annexe-1 countries and others which are called non-Annexe-1 countries. The main agreement of the Kyoto Protocol is that the Annexe-1 countries will reduce their collective emissions of green house gases by 5.2 % compared to the level of year 1990, calculated as an average over the 5 year-period of 2008-12. The Kyoto Protocol also created the concept of any group of Annexe-1 countries join together and form a cluster. Such a cluster of countries can be given over all emission cap and can be treated as single entity. The European Union works under such a system. The non-Annexe-1 countries are having no obligations for emission caps.

The above differentiation into Annexe-1 and non-Annexe-1 countries is achieved by the United Nations Framework Convention on Climate Change by agreeing to a Principle of "Common but differentiated responsibilities". The principles agreed under this common but differentiated responsibilities are :-

- The largest share of historical and current global emissions of green house gases has originated in developed countries.
- Per capita emissions in developing countries are still relatively low.
- The share of global emissions originated in developing countries will grow to meet their social and development needs.

In other words, developing countries were exempt from requirement of Kyoto Protocol because they were not the main contributors to the green house gas emissions during the industralisation period that is believed to be cause of today's Climate Change. The Protocol also affirmed the principle that the developed countries have to pay the cost and supply technology to other countries for climate related studies and projects (which was originally agreed in UN-FCCC). The Kyoto Protocol also brought in very innovative system for the non-Annexe-1 economies to take up green house gas emission reduction projects through the Clean Development Mechanism (CDM) and Joint Implementation (JI) mechanism. Through these CDM and JI projects, the

developing countries can implement clean projects with reduced emission green house gases. For such efforts they gain credits called Carbon Credits.

The Annexe-1 countries, who are not able to meet the annual caps on green house gas emission, can buy the carbon credits from the developing countries and use it as a offset against their inability to meet green house emission limits.

These innovative mechanisms (differential caps, cluster of countries as single entity, CDM, JI mechanism, and Carbon Credits & trading) can be taken as a queue to develop concepts for Space debris legal regime to tackle the debris population growth, implementation of mitigation measures, and liability responsibilities in case of accidents involving Space debris. Such possibilities are examined in the next section.

5. COMMON BUT DIFFERENTIATED RESPONSIBILITY FOR SPACE DEBRIS MITIGATION

Space debris will be a concern for future for all the countries. Especially the developing countries which have limited Space assets will face serious consequences if any of their satellites is involved with incidents / accidents with Space debris. The manned missions of advanced countries requires absolutely high level of crew safety, and hence Space debris is a serious concern to them also. Even a close approach of the debris to the operational satellites may pose problems if the cloud of debris occupies larger volume. From these considerations, it is definitely essential to evolve strategies to limit the growth of Space debris, and also to evolve debris mitigation measures.

However the analysis of the Space debris presented in section 4 clearly brought out that the debris population is proportional to the number of launches carried out by each country in the past. Hence larger responsibility lies with the countries which carried out a number of launches in the past. So the maintenance of Space environment from the Space debris point of view is a case well suited for "Common but differentiated responsibility" . In this context this principle means that all countries capable of taking actions are responsible to maintain the Space environment relatively clean with respect to Space debris. Also the countries, which are responsible for the present level of the debris population, should take higher responsibility in respect of limiting the future growth of Space debris, and also in providing knowledge and technology in the areas of Space debris monitoring and mitigation to all countries.

In this context various measures can be contemplated for future. One of them had been achieved when UN-COPUOS adopted Space debris mitigation guidelines to be implemented by all countries on voluntary basis through national mechanisms. Different countries have evolved their own national Space debris mitigation standards and regulations to be implemented by the companies involved in aerospace activities in their countries. Still many countries feel that an appropriate legal regime at a global level is essential to tackle the Space debris issue. This is where the models evolved in the Kyoto Protocol can be considered to be tailored and used with appropriate modifications for Space debris legal regime.

Some of the new mechanisms which can be derived from the principles of Kyoto Protocol are :-

- To limit the future Space debris generation, launch quota caps for each Space-faring country can be evolved linked to their past generation of the Space debris.
- The countries can be rewarded with "debris credits" in case they implement Space debris mitigation measures in their missions.
- Some advanced Space-faring nations may have pressing commitments to carry out larger number of launches. They can be enabled to carry out such missions through purchase of "debris credits" from the other countries, who have earned "debris credits" through application of Space debris mitigation measures.
- The countries which do not have any Space activity for the present, but who have plans to develop either Space transportation or deploy satellites in orbit can be given fixed quota of "debris credits". These credits can lapse after a certain period if they do not realize their Space missions. These countries can also be enabled to market their "debris credits" to the other countries, and benefit by acquiring Space technologies.
- A Trust Fund can be created to compensate the victims involved in the accidents with Space debris, to which the contributions can be linked to the debris generated in the past by different countries. This can be a part of larger aspect of Space debris damage liability regime.
- Special treatment can be considered for the countries willing to share their knowledge and technology in the area of Space debris with other countries, to take up the research and development to a higher level. Such cooperative ventures can be given special treatment as Joint Implementation Mechanisms to earn "Debris credits".

These are some of the ideas which are derived from the Kyoto Protocol with application to Space debris area. They are not exhaustive but only indicative for future legal experts to examine while developing Space debris legal regime.

6. CONCLUSIONS

This paper describes various multi-lateral initiatives in the area of analysis, and mitigation of Space debris. The specific features related to type of debris and the level of launches and other activities of Space-faring nations are detailed. The innovative mechanisms evolved in the Kyoto Protocol of UN FCCC are described and their applicability for Space debris case is argued. Possible measures which can be fashioned after the Kyoto Protocol are suggested to deal with the Space debris and maintenance of Outer Space environment. All the analysis is based on the conviction that 'Common but Differentiated Responsibility' is very well suited for the present Space debris scenario.

7. ACKNOWLEDGEMENT

Authors sincerely thank the encouragement and support provided by Director, SAC and Chairman-ISRO in the preparation and approval of this paper. The applicability of the principle of Common but differentiated responsibility to Space debris area was first proposed in an informal discussion with the authors by Mr. T.P. Srinivasan, Former Ambassador of India to UN, New York and Vienna, Austria. Authors sincerely thank Mr. T.P. Srinivasan for this important contribution. Dr. G. Madhavan Nair, presently Chairman-ISRO, was the Head of the Indian Delegation to UN-COPUOS meetings wherein this proposal was first

delivered as Indian Statement on Space Debris in February 2002. Authors are thankful to Dr. Madhavan Nair for his policy guidance in this area.

Dr. Rajeev Lochan was Assistant Scientific Secretary, ISRO when the Abstract was submitted and when it was accepted for IAC-2007. Unfortunately he passed away before submission of final paper, but after providing all his inputs for the paper.

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