Towards Long-term Sustainability of Space Activities: Overcoming the Challenges of Space Debris

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I. INTRODUCTION – PURPOSE

To briefly present the findings and recommendations of the International Interdisciplinary Congress on Space Debris that was

- organised in 2009 and 2010 by the IAASS in cooperation with
- my home institution, the Institute of Air and Space Law, McGill University, Canada, &
- the Institute of Air and Space Law of Cologne University, Germany
- co-sponsored by the United Nations Office for Outer Space Affairs
- financially supported by the Erin J. C. Arsenault Trust Fund at McGill, and the German Aerospace Center

- attended by over 60 invited experts who:
- experienced in various fields,
- came from several countries, space agencies and international organizations
- thoroughly analysed the problem and openly discussed the various solutions (*Chatham House Rules)*

The Report of the Congress seeks to:

(a) objectively demonstrate the current status of space debris,

(b) assess the effectiveness of current debris mitigation measures, particularly the 2007 COPUOS Space Debris Mitigation Guidelines, and

(c) offer recommendations to improve current and future space debris mitigation efforts.

The Report has been distributed: A/AC.105/C.1/2011/CRP.14 (3rd Feb. 2011)

II. THE PROBLEM - SPACE DEBRIS CAPSTONE

Space age has brought many technological, social, & economic benefits for all mankind

However, these benefits have not been achieved without negative consequences

Space activities have been & are causing environmental damage having lasting negative effect on long-term space safety & sustainable use of space by all States

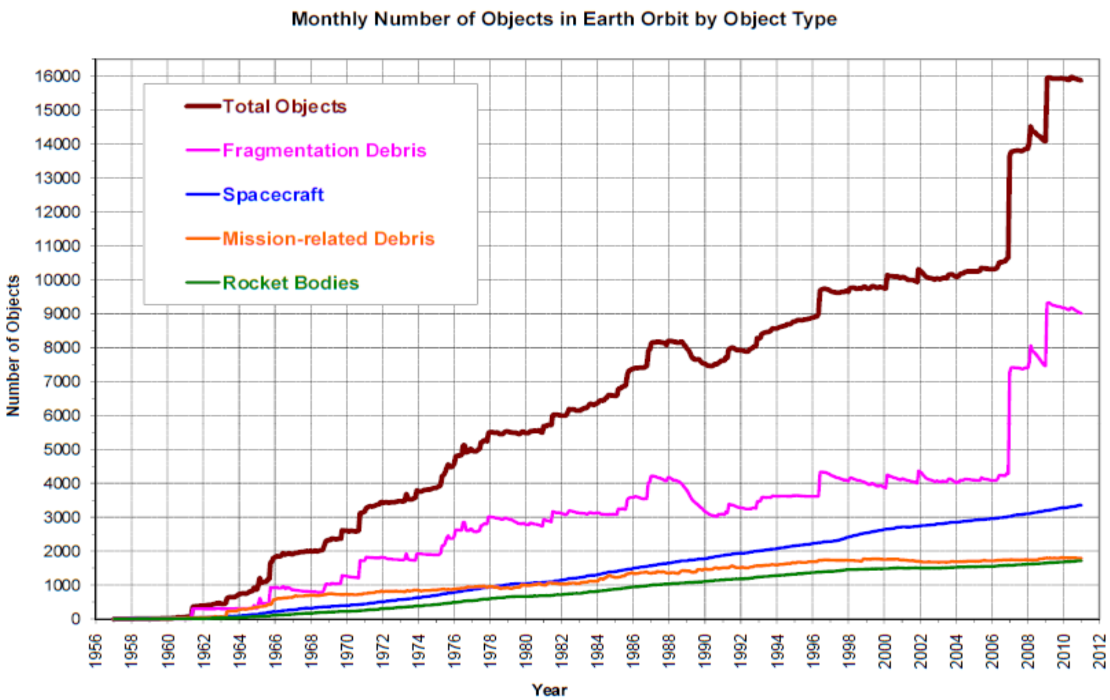
Most immediate & serious of these negative effects are the risks posed by space debris

The amount of space debris has been increasing, particularly debris generated by the intentional destruction of space objects, and by recent accidents, like the collision between Iridium 33 and Cosmos 2251.

I don't intend to describe the problem in details; however, **here are a few important and simple facts:**

Historical Growth of Catalogued Objects

FROM: *Orbital Debris Quarterly,* (January 2011), NASA Orbital Debris Program Office



This Figure shows that the amount of debris has grown at a faster rate than the number of active spacecraft. What little gains were achieved by debris mitigation measures or natural decay were cancelled out by major events which added large amounts of debris

Top Ten Satellite Breakups

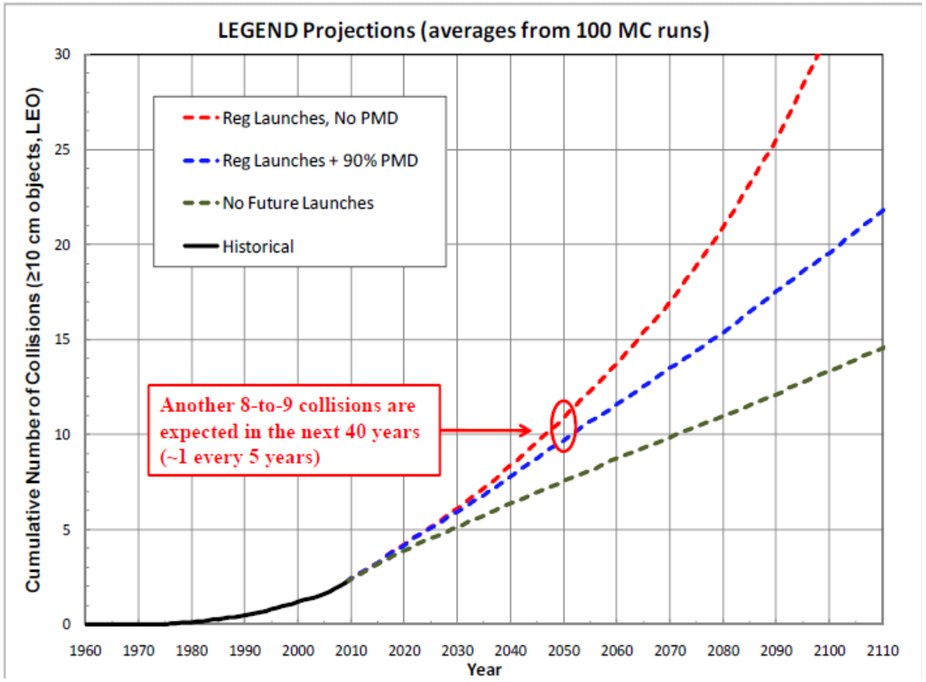
FROM: “*Orbital Debris Quarterly* (July 2010), NASA Orbital Debris Program Office

Common Name	Year of Breakup	Altitude of Breakup	Cataloged Debris*	Debris in Orbit*	Cause of Breakup
Fengyun-1C	2007	850 km	2841	2756	Intentional Collision
Cosmos 2251	2009	790 km	1267	1215	Accidental Collision
STEP 2 Rocket Body	1996	625 km	713	63	Accidental Explosion
Iridium 33	2009	790 km	521	498	Accidental Collision
Cosmos 2421	2008	410 km	509	18	Unknown
SPOT 1 Rocket Body	1986	805 km	492	33	Accidental Explosion
OV 2-1 / LCS 2 Rocket Body	1965	740 km	473	36	Accidental Explosion
Nimbus 4 Rocket Body	1970	1075 km	374	248	Accidental Explosion
TES Rocket Body	2001	670 km	370	116	Accidental Explosion
CBERS 1 Rocket Body	2000	740 km	343	189	Accidental Explosion
			Total: 7903	Total: 5172	

* As of May 2010

This Figure lists the top ten breakups that generated space debris. Note that the most recent breakups have added a proportionally significant amount of debris that will remain in orbit for an extended period of time

Future Prediction of Collisions in LEO using NASA LEGEND Model (FROM: J.-C. Liou and N.L. Johnson, *Acta Astronautica*, (March-April 2010).



This Figure shows three scenarios: (a) no future space launches, (b) future launches continue at historical rates but there is no post-mission disposal (PMD) of space objects, and (c) future launches at historical rates with 90% PMD compliance. The projections show that even without any new launches, the growth in the amount of space debris will result in eight to nine more collisions in LEO by 2050.

Space debris poses risk in two major ways:

First, it is a navigation hazard to operational satellites of all space-faring nations. A collision between a piece of debris and a satellite poses the risk of damage to, or even loss of, the satellite. For example, the destruction of Iridium 33 during its collision with Cosmos 2251 in 2009.

The second major risk from space debris is to humans, property and environment on the surface of the Earth. For example, the re-entry of COSMOS 954 in 1978 that scattered radioactive debris over a large area of Northern Canada.

It is beloved that in the absence of appropriate and effective regulatory and technical measures, the safe and sustainable access to and use of outer space will continue being increasingly threatened.

III. SOLTUIONS – PAST AND CURRENT EFFORTS

Existing Regulatory Measures Related to Space Debris

The existing international legal framework governing space activities must be considered both with regard *to legal obligations and rights* to take preventive measures that address the risks posed by space debris, as well as to the *legal consequences* should such a risk materialize.

The former aspect addresses prevention and/or minimization of the risk to damage spacecraft and/or damage on the ground. The latter aspect primarily raises questions of responsibility and liability for damage caused by space debris and the allocation of risks.

How does space law address the question of space debris? The existing international treaties do not include a definition of space debris. Thus there is a controversy whether or not they apply and regulate the problems caused by space debris.

What is the (il)legality of space debris generation? The generation of space debris is not *per se* illegal. However, creation of space debris can be illegal in certain contexts (e.g. purposeful debris generation intended to interfere with the peaceful use and exploration of outer space).

Is there an international legal obligation to mitigate risks associated with space debris? There is no explicit international legal obligation to mitigate risks associated with space debris. The international legal principle of due regard (under Article IX of the Outer Space Treaty) may be considered to oblige space-faring nations to take appropriate measures to prevent harm to other States. However, this obligation is broad and vague, thus controversial.

Is there an international legal obligation to exchange information for the purposes of collision avoidance? While there is a general duty of due regard, there is no clear legal obligation to exchange information with other space actors for the purposes of collision avoidance.

Materialization of risk and allocation of financial burden? States bear international responsibility for their national activities and are liable for damage caused by their space objects. Each State is individually burdened with the costs for measures related to “its” space debris. This allocation of costs does not, however, reflect the community interest in preserving the space environment, especially where space debris can no longer be attributed to a certain source or a State.

Does space law need clarification and further development to become a fully operational rule-based framework? In view of the above-mentioned points, the answer to this question would be in the affirmative.

In brief, currently applicable international space law (in the form of various space treaties) does not establish a sufficient and appropriate legal regime to internationally regulate the serious risks created by space debris. It needs clarification and further development to become a fully operational rule-based and effective regulatory framework**.**

Therefore, several regulatory efforts have been and are being made at international, regional and inational levels.

COPUOS Guidelines: Analysis and Implementation

At the international level, regulatory efforts have essentially been limited to technical discussions at the IADC and the Scientific and Technical Subcommittee of the COPUOS, which adopted their respective guidelines. It may be noted that the 2007 COPUOS Space Debris Mitigation Guidelines (hereinafter referred to as COPUOS Guidelines) are based on, and consistent with, the IADC Guidelines.

These Guidelines are a first and important step towards long-term sustainable use of outer space.

The COPUOS Guidelines constitute fundamental guiding principles, recognizing the problem of space debris, and expressing political commitment to address and mitigate the problem.

The purpose of the COPUOS Guidelines is to limit the generation of space debris. While observance of the COPUOS Guidelines themselves is voluntary, some States have adopted domestic policies, legislations, and/or regulations that implement the COPUOS Guidelines to commercial, civilian, and/or military space actors.

COPUOS Guidelines apply only to mission planning and operation of newly designed spacecraft and orbital stages and, if possible, to existing ones. They are future-oriented, not retroactive, and operational, as opposed to regulatory. The COPUOS Guidelines are executed during the certification processes at the design and manufacturing stage, exerting a substantive influence for these spacecraft to operate within the COPUOS Guidelines.

The Guidelines have limitations – some observations:

- The COPUOS Guidelines are not legally binding under international law. This means there is no legal obligation for States and their nationals to comply. It is also recognized that exceptions to the implementation of individual Guidelines or elements thereof may be justified, for example by provisions of the "United Nations Treaties and Principles on Outer Space".

- The COPUOS Guidelines are general recommendations to be implemented by States primarily through national legislation, regulations, and/or policy directives. Nonetheless, humankind recently witnessed two intentional destructions of satellites and one unintentional collision, which indicated serious limitation of the Guidelines and further emphasized the seriousness and urgency of the space debris problem.

The Guidelines do not outlaw a certain space debris creation activity, nor do they impose sanctions on the violators. The Guidelines simply provide guidance on how to conduct space activities in principle in order to prevent, or at least to minimize, harmful by-products of space activities.

The Guidelines are not designed as a comprehensive approach for the space debris problem.

The Guidelines do not deal with the disposal of the debris currently orbiting in space (e.g. remediation).

The Guidelines cannot stabilize the space debris environment and do not give guidance to liability and insurance.

Safety and security considerations, particularly visible under Guideline 4, imply the attempt to avoid intentional destruction of space objects but do not fully ban ASAT tests.

The Guidelines do not address the generation of space debris in a non-peaceful context.

The Guidelines do not establish legally binding requirements. As a result, a “tragedy of the commons” situation may arise wherein actors adhering to the measures are at a competitive disadvantage when foreign competitors do not have to comply with them.

The Guidelines may be applied to the commercial/private activities through national licensing mechanisms. In contrast, government sponsored military and civilian space activities are generally not subject to the licensing regime, as they are typically carried out by governmental agencies.

National policies dictate whether and to what extent the Guidelines are to be followed. Internal government decisions often deal with conflicting policy goals, including national security. Consequently, incorporation of the Guidelines into domestic policy and/or regulatory procedures, mechanisms varies according to each State, its level and type of space activity.

Effectiveness of COPUOS Guidelines

There are mixed signs about how well the COPUOS Guidelines are working in practice. There is evidence that standard practices are getting better, which is important given the increased level of space activity. From the mid-90s until 2006, there was a gradual decline in the growth rate of the space debris population, suggesting a possible relationship between mitigation efforts and slowing growth rates.

Unfortunately, a series of significant debris-creating events involving both the intentional and unintentional breakup of large space objects have occurred since 2006. With the inclusion of these recent events, there has been no reduction in the growth rate of space debris: these intentional and accidental fragmentations have effectively reversed any debris population reductions achieved by the COPUOS Guidelines. Years of successful mitigation can be negated by a single large event. Overall, we are not doing as well as necessary.

IV. SOLUTIONS - FUTURE STRATEGIES AND RECOMMENDATIONS

If the COPOUS Guidelines are to become effective States must adopt (and enforce) them through their respective domestic policies, laws and regulations, in active coordination with other States, following uniform standards.

As described earlier, the Guidelines are limited in scope and application. It is therefore imperative that States and other stakeholders explore and adopt complementary and alternative initiatives to mitigate (and eventually remove) space debris.

There are a variety of mechanisms that can be implemented to control space debris and ensure long-term sustainability of the use of space. They fall within a continuum of law and policy and include technical measures.

Here are some of the specific measures-options that can be considered in this regard:

Transforming the COPUOS Guidelines into a set of Principles adopted by the UN General Assembly with mandatory wording obliging States to adopt the COPUOS Guidelines in national legislation. The rationale would be to simply transform the current Guidelines into a set of Principles in the same way as, for example, the Nuclear Power Sources Principles. Such a declaration should also make provision for the creation of an appropriate expert body (or preferably to additionally mandate a existing one, like the United Nations Office for Outer Space affairs), with the task of (a) regularly collecting information, (b) coordinating national efforts towards implementation of the COPUOS Guidelines and other space debris mitigation mechanisms, and (c) making suggestions for achieving their uniformity.

Adopting a Space Debris Code of Conduct: A Code of Conduct whose membership is generally limited to a small group of States and includes some accountability as to non-implementation is more likely to succeed in implementation and adherence. In addition, such a Code of Conduct could be nationally binding when implemented through domestic law (e.g. Missile Technology Control Regime - MTCR – is being implemented through export control legislation and/or regulations) and thus could prove to be a good option for facilitating the implementation of the COPUOS Guidelines.

States could enter into binding international legal agreements (i.e. bilateral, regional, or multilateral treaties): Elevating prevention, mitigation and remediation commitments to the international level could be politically acceptable, but it will depend significantly on the circumstances surrounding the nature of the agreement In the long-term, it is anticipated that internationally legally binding general commitments to prevention, mitigation, and remediation, coupled with monitoring and enforcement mechanisms, will have to be adopted. This is particularly true in order to establish binding universal and uniform requirements, standards, and procedures for space debris mitigation and remediation to ensure long-term sustainability of use of space by all States. For example, the adoption of binding technical standards and procedures for civil aviation by ICAO in the form of Annexes to the Chicago Convention.

End-of-Life Disposal: Technical implementation of de-orbiting guidelines needs to be improved. The best end-of-life solution for GEO spacecraft, as of today, is to dispose them of in a graveyard orbit above the nominal GEO altitude. The corresponding IADC and COPUOS Guidelines are followed more and more, but still about half of all satellites in orbit are not properly re-orbited at the end of their lives. Such a requirement should be somehow made compulsory.

Setting up of a Space Situational Awareness (SSA) and Space Traffic Management (STM) system: Today, there are several SSA/STM service providers. It should be understood that each service provider has been developed with different objectives, capabilities, and clients. However, a coordinated global SSA/STM is needed to provide accurate and timely data on active and inactive space objects and debris, as well as collision/conjunction alerts. The rationale for this global coordination is that the safety of commercial space activities can be ensured only if there is a commitment from governments to monitor uncontrolled space objects and satellite operators to provide the locations and manoeuvre plans for their satellites.

It is recognised that several issues need to be considered concerning the feasibility of an international SSA system. These include national security concerns, data sources, financing, liability, public access, and participation.

Expanding Space Data Center of the Space Data Association (SDA): The Space Data Center is an interactive repository for commercial satellite orbit, manoeuvre, and frequency information. It provides and shares information among fellow operators regarding satellites under their control. As of January, 2011, the Space Data Center has twenty participating operators and provides safety services for almost 1200 satellites in GEO and 114 satellites in LEO. However, one major shortcoming of the Space Data Center is that its operators must still rely on governments, and primarily the U.S. Government, to monitor dead satellites and other objects drifting in GEO that could collide with active satellites. This issue needs to be addressed to make the Space Data Center more independent and neutral. In addition, its membership should be expanded to include more countries, space actors and space objects.

These strategies and proposals are not mutually exclusive and can be implemented as complementary initiatives. It is clear that maintaining the status quo is not a viable option as space debris poses a risk to the long-term sustainable use of outer space for human benefit on Earth. Action must be taken to prevent and/or mitigate space debris generation, as soon as possible. In the medium-term, stronger international arrangements can be implemented amongst government and non-government space stakeholders. In the long-term, binding international legal agreements, and perhaps even an international organization that provides Space Situational Awareness-Space Traffic Management, can be achieved.

FINAL REMARKS:

The Report of the Congress contains some other recommendations, some of which are:

(1) States should make safe and sustainable use of outer space a policy priority and should preserve access to and use of this unique environment for future generations.

(2) States should establish mechanisms for:

(a) the promulgation and regular review of binding international uniform technical standards for debris mitigation based on evolving technical developments;

(b) remediation based on evolving technical developments; and

(c) an appropriate means for their national implementation.

The Congress believed that the principle of common but differentiated responsibility, as enabling all States to fulfil their obligations associated with current international efforts in preserving the terrestrial environment, is an important precedent to guide current and future space debris mitigation and remediation efforts.

Finally, continuous growth in the amount of space debris will likely result in more collisions. This indicates looming danger and a sense of urgency in finding viable solution(s) to the space debris problem. The risks posed by space debris are a global problem requiring global solutions, which could be implemented internationally, regionally, and nationally. This can be best achieved through active efforts by space technologists and policy and law makers, in concert with spacecraft manufacturers, operators, and insurers, to establish regulatory solutions and assure a sustainable space environment for present and future generations.

!!! THANK YOU FOR YOUR ATTENTION !!!