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LEGAL ASPECTS OF SPACE DEBRIS:
a view from outside the legal profession

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Abstract

A brief summary of main areas of current research in space debris is followed by a discussion of the role of main actors on the international scene: the UN Committee on the Peaceful Uses of Outer Space, the emerging Inter-Agency Orbital Debris Coordinating Committee and the International Telecommunication Union. The concluding section on legal problems is meant rather as asking provoking questions than providing answers.

Areas of scientific developments

What are space debris?

The basic question which objects are to be understood under the term space debris and which objects do not fall into that category has been answered in the Position Paper on Space Debris prepared by the International Academy of Astronautics[1]. The distinction is based on physical, in particular dynamical, properties of space debris. In the first place, only artificial objects can become space debris. Natural objects, i.e. meteoroids, are not considered space debris because their origin, their velocities and their trajectories in the atmosphere are different from those of man-made objects. In the second place, in spite of the fact that "debris" suggests something like fragments, also intact objects may qualify as space debris. The condition is that they are non-functional and not likely to assume any function in the future. In the third place, scientific satellites whose only function is not to perform any activities but to move without any disturbance in the gravitational field of the Earth, are not considered space debris, although at first glance they cannot be distinguished from non-functional objects.

Another point has to be added: The IAA Position Paper deals with *orbital debris* which, as the term suggests, are those debris which are in an orbit around the Earth. *Space debris*, which are on the agenda of the

Scientific and Technical Subcommittee, however, may, but for a decision of the Subcommittee to the contrary, encompass debris during their decaying phase up to their impact on the ground or into the ocean.

Many scientific and technical papers on space debris have been published in the last years. Their number may have exceeded one thousand. Among the main results or directions of research let us mention the following:

Completeness of data.

The available catalogues are not complete. E.g., the NASA Satellite Situation Report[2], one of the most important catalogues of objects in space, has rather strict conditions for listing objects. Only those are included which have been repeatedly detected and which can be attributed to a specific launch. Thus, a certain percentage of debris, not meeting the criteria, does not appear in the catalogue.

Special observing programmes of unlisted objects, in particular of those which are too small to be detected with present day instrumentation, have been initiated. It seems that real population of small objects exceeds previous estimates.

Models of the debris population.

Important work[3] is going on at several research institutes on modelling of space debris environment. A space debris model is a mathematical description of the current and future distribution in space of debris of different sizes, of the distribution of their directions of motion, and of their average velocities. Such a model, if it is detailed enough, will permit a more accurate calculation of risks encountered by an active satellite in a specific orbit. Models of the debris population may become available soon.

Access to data.

Another recent development is the improved accessibility of orbital and other data. The NASA Satellite Situation Report, the NASA Two Line Elements, the Spacewarn Bulletin and other lists and data have become accessible through the INTERNET computer network. The access is much faster and the distribution of data much wider than it used to be with the previously used mailing of paper copies. We understand that also the data contained in the governmental launching announcements, submitted in conformity with the Registration Convention, will eventually become accessible through a computer network.

Removing orbiting debris.

The maximum of solar activity which occurs with a period of 11 years, cleans outer space of some 30% of space debris at altitudes of 200 – 500 km. This is, however, not sufficient and the number of debris at all altitudes is constantly growing. Therefore some scientists have become interested in methods of removing orbiting debris. Among the methods under consideration are the use of laser beams of high energy which could change the orbit of a debris. A suitable selection of direction and timing would result in reducing the lifetime of the object in question. Another method, suitable for large debris, requires a tether between the piece of debris to be removed and a scavenging spacecraft. A clever use of the tether would bring the debris into a lower orbit by reducing its momentum. And a lower orbit implies a shorter lifetime.

An important aspect in this connexion is the cost of the operation. Retrieval by a direct approach of the space shuttle may be justified for a valuable satellite, not for a worthless piece of debris. Also the use of a tether would be rather expensive, leaving the ground-based laser as the most promising — if as yet untested — method. Evidently, restricting the generation of debris and other preventive measures are relatively inexpensive if compared with methods of removing objects which already are in orbit.

Need for additional research.

It is frequently stressed that additional research of space debris is required. This is absolutely true because we still do not know the debris population which is below the limit of detection by available radars and telescopes. Even these small objects, in the range of 1-10 cm or proportionally larger at higher altitudes, can severely damage or destroy an active satellite in case of a collision. Moreover, average values of the collision probability are used. These may be considerably exceeded by actual collision probabilities in a specific orbit.

A closer look shows, however, that research has been lately providing mainly quantitative improvements. Most of the general features of risks, required for legal considerations, have been known for many years, some dating back to the 1970's. Thus the first transfer of a geostationary satellite into a disposal orbit was carried out by INTELSAT in May 1977, the reduction of the number of mission-related debris and the decreasing of lifetimes of inactive satellites were discussed at the IAF Congress in Munich in 1979[4] and at almost all subsequent IAF Congresses. The cause of Delta second stage explosions has been recognized as early as 1981[5].

Authoritative studies of debris

Several authoritative studies on space debris appeared in the last years. They have been reviewed at past congresses of the IAF and/or put before the UN Committee on the Peaceful Uses of Outer Space[6].

The most recent study of Orbital Debris[7], prepared by an international team of experts for the US National Research Council, presents the most recent and very detailed information. It puts its authority behind previously recommended measures, in general confirming the conclusions of the IAA Position Paper. It makes several recommendations for improving knowledge of the debris environment, for improving spacecraft protection against debris, and for reducing the future debris hazard. In the last area, it advocates:

- Reduction of debris *on a multilateral basis* in order not to penalize those engaging in mitigation measures,
- Prevention of explosions;
- Minimizing of mission-related debris,
- Minimizing the unintentional release of surface materials, such as paint,
- Avoiding intentional breakups, in particular those producing debris with long lifetimes,
- Reorbiting of spacecraft and rocket bodies in LEO after their functional lifetime and achieving an international consensus on the magnitude of such maneuvers, and
- Until a verifiably superior strategy is produced, reorbiting spacecraft and rocket bodies in the geostationary orbit to disposal orbits at least 300 km beyond that orbit.

Space Debris at the UN

In 1989, a proposal was put forward, at a session of the UN Committee on the Peaceful Uses of Outer Space (COPUOS), by a group of states to consider space debris as an agenda item. A consensus was reached a few years later and in 1994 the Scientific and Technical Subcommittee of the COPUOS started the consideration of the item. It was agreed that a work plan should be prepared which would cover scientific and technical aspects of space debris and would extend over a number of years. The Subcommittee, at its meeting last February adopted a concrete work plan, extending over three years, from 1996 to 1998. The measurements of space debris, understanding of data and effects of the debris environment on space systems would be discussed in 1996. The following year would be devoted to a critical review of models of the debris environment, to its evolution and to risk assessment. Finally, in 1998, mitigation measures would be addressed. Mitigation comprises reduction of the space debris population growth and protection against particulate impact. Important aspects are debris prevention, debris removal, physical protection of spacecraft with shielding and protection through collision avoidance.

The UN Committee on the Peaceful Uses of Outer Space, at its 38th Session in June 1995, expressed its satisfaction at having the subject of space debris as priority item on the agenda of its Scientific and Technical Subcommittee. It approved the Work Plan which would form a firm scientific and technical basis for future action. It also stressed the importance of national research into space debris and of information on various steps being taken by space agencies and international organizations for reducing the growth of space debris. Some delegations proposed to start the discussions on space debris also in the Legal Subcommittee but other delegations considered it premature at present time. The view was also expressed that space debris is only a part of a larger problem of preservation and protection of the space environment, or even of the rather wide question of management of outer space. The latter subject would encompass also ways how to maintain peaceful, reasonable and beneficial outer space activities.

The ambitious Work Plan will lead to a thorough discussion of all important scientific and technical aspects of space debris. We may anticipate that the Scientific and Technical Subcommittee will present its findings to the Legal Subcommittee after the completion of its work plan. But, it appears that the UN COPUOS is not the only actor on the stage.

The Inter-Agency Orbital Debris Coordination Committee

Leading space agencies such as NASA, ESA, NASDA of Japan and RKA of Russia formed in 1993 the Inter-Agency Orbital Debris Coordination Committee (IADC) for exchange of information on space debris activities, for creating opportunities for cooperation in space debris research and for the identification of debris mitigation measures. The Committee, being composed of launching agencies, will be in a good position to suggest technical steps for the implementation of mitigation measures, while keeping an eye on their cost, technical feasibility, and compatibility with the planned functions of space missions. The Committee might come up with important initiatives and with concrete recommendations to the COPUOS.

Important input could come also from still another side which is deeply involved in space communications and which has recently become fully aware of the risks posed by space debris:

The International Telecommunication Union

The mandate of the ITU is the *improvement and rational use of telecommunications of all kinds.* An object in space constitutes, in the ITU terminology, a *space station* if it transmits radio signals. All other aspects, such as the fate of a satellite after it has terminated its transmissions, were rarely considered in the past, if at all. However, the growing risk of collision of a communication satellite in the geostationary orbit with a piece of debris prompted the ITU to deal with the problem. It is also possible that the recent reorganization of the ITU[8] speeded up its response. The ITU Radiocommunication Assembly adopted a recommendation[9] in 1993 on debris in the geostationary orbit. Specifically, it was recommended:

1. that as little debris as possible should be released into the geostationary orbit (GSO) during the placement of a satellite in orbit;

2. that every reasonable effort should be made to shorten the lifetime of debris in the transfer orbit;

3. that a geostationary satellite at the end of its life should be transferred, before complete exhaustion of its propellant, to a supresynchronous graveyard (=disposal) orbit that does not intersect the GSO;

4. that the transfer to the disposal orbit should be carried out with particular caution in order to avoid radiofrequency interference with active satellites.

The document also stated that further studies were required to define what constitutes an effective disposal orbit. That question, i.,e. the minimum distance of a disposal orbit beyond the geostationary orbit, was dealt with in the IAA Position Paper (see reference 1). It was concluded that, depending on spacecraft characteristics, 300 to 400 km are necessary to remove a chance of an object in the disposal orbit to cross the geostationary belt even at distant future times.

An annex to the above recommendation, entitled "Environmental protection of the geostationary-satellite orbit", deals with physical aspects of objects in the geostationary orbit. It contains also a definition of the GSO: "For purposes of considering environmental measures, the GSO may be defined as the mean Earth radius of 42,164 km $\pm$ 300 km and extending to 15° N/S latitude or a distance of approximately 10,000 km".

Even if that recommendation, as well as the definition of the geostationary orbit, are not binding, they will probably be widely adopted. They have to be studied and considered carefully. In fact, such a document could have been expected to come from the COPUOS after the conclusion of discussions in both subcommittees. It shows that the ITU realized that there was a danger in delay and that the COPUOS, as at previous occasions, needs a long time to come to a concrete result.

And this may not be the end of the story. Proposals have been put forward to use low Earth orbits for communication satellites such as the Iridium project[10] or the MEGA-LEO satellite system[11] calling for large numbers of satellites in low orbits. And if the ITU is prepared to act fast and to deal with the safety of communication satellite systems, we should not be surprised to see one day another recommendation dealing with space debris at low Earth orbits. This development may affect the relative roles of the UN and of the ITU in making space law.

The International Law Association

The activities of the International Law Association have been covered by another paper in this session.

Legal questions

Space Debris and Space Object.

One of the first questions to be asked, may be the establishment of a relation between *space debris* and related legal terms which appear in one or other of the instruments of space law. The term, nearest at hand, is *space object*. Space objects, however, are protected by the Outer Space Treaty[12], Article VIII, in the sense that a State on whose registry an object launched into outer space is carried retains jurisdiction, control and ownership of such an object.

This makes sense for intact objects or their valuable parts which can be identified from inscriptions or markings or from orbital elements in case they are still in flight. But what about space debris? Even if the legal community decides that they are to be considered as space objects, it may not be possible to recover and inspect them. Even if recovered, it may not be possible to identify them if they contain no markings. And their orbital elements — a good guideline for identification of objects in orbit — may not be available after a collision.

The well documented, well observed collisions with no doubt which objects participated in the collision will be rather exceptions. The typical case of a collision may be a damaged satellite with the time of the collision known only approximately, caused by a piece of debris of unknown origin and the piece of debris not available for examination. What legal provisions would be useful in such a case?

The task which lies before space lawyers is not simple and is not an easy one.

Abandonment of Space Debris.

As Professor Martin[13] noted, it would be useful to create a procedure regulating the act of abandonment of a space object by the State which retains jurisdiction and control over it. Without attempting to solve this legal problem, a practical difficulty needs to be pointed out. There are many thousands of objects which States might like to abandon, many of them unlisted or unidentified, smaller ones unknown. Moreover, their number is constantly changing. There is no such thing as an up-to-date list of all space debris that might cause damage. It is not likely that our knowledge will ever be as detailed as to allow the setting up of such a list.

On the other hand, the number of objects which are of value and interest is relatively short. The total number of active or otherwise interesting satellites is estimated at about 5% of the total amount of space objects which is currently 7800. Thus lists of objects of interest of all launching states would have a total of only 350 to 400 entries.

The setting up of a list of satellites of interest and value should not be difficult. It would contain quotations from governmental launching announcements made in conformity with the Registration Convention[14]. In addition, it would have to contain updated orbital elements to make the identification and protection against scavenging or disposal possible. For a vast majority of satellites and trackable space debris these elements are accessible through computer networks. Difficulties, hopefully surmountable, might arise in the case of a few special objects, whose orbital elements are not accessible, such as the "national means of verification".

The main purpose of the abandonment procedure would be to legalize scavenging or other disposal of space debris, i.e. of objects not on the list of satellites of value and interest. As a consequence, it would stimulate the scientific and technical development of methods for removing debris from orbit and thus contribute significantly to reducing the number of space debris. The abandonment procedure would, of course, have to retain the liability of launching states for possible damage caused by space objects as far as it is covered by the Liability Convention[15].

Are there any perspectives for this or a similar procedure?

Level of Generality.

Compared with the Radio Regulations of the ITU — which contain a large number of very detailed provisions and of numerical values depending on the state of technology — the instruments of space law are very brief and general. A similar level of generality is shown, e.g., by the ITU recommendation on the disposal orbits (see reference 9). The question arises what level of generality can be expected of an instrument resulting from future deliberations of the COPUOS. It may be assumed that such a document, if and when it sees the light of the day, will be of a general character and will hardly contain too many technical details dependent on the actual state of technology. On the other hand, technical guidelines and numerical values of some parameters will be highly important for designers of spacecraft. The design of spacecraft becomes more and more sophisticated in order to meet the requirements for performance and cost effectiveness. It will have to meet an additional requirement for generating few debris and no explosions. In order to remain competitive, the designer will need good and detailed guidelines which would apply to all countries. These guidelines and recommendations, let us call them Debris Regulations, will have to be set up by some international authority and will have to be periodically updated. The COPUOS will have to establish for this purpose a new body or to entrust the work to some existing body. Would the Scientific and Technical Subcommittee or the Inter-Agency Space Debris Coordination Committee be among the candidates for such a role?

Conclusion

In any case, the years up to the end of the millenium will be very important for the future fate of space activities. The task before us is to preserve the outer space environment – not perhaps quite unchanged – but still fit for successful activities of many satellites and probes. Outer space has become indispensable for research, for many practical activities and finally for the ultimate goal, for the survival of homo sapiens.

References

1. IAA Position Paper on Orbital Debris, Acta Astronautica, Vol. 31, October 1993, p. 169. Appeared also in the UN documents A/AC.105/570, A/AC.105/593, p.22-43, and was distributed as a brochure at the session of the Scientific and Technical Subcommittee in February 1995.

2. NASA Satellite Situation Report, Goddard Space Flight Center.

3. E.g., at ESA-ESOC in Darmstadt, Germany, at CNUCE-CNR and the University of Pisa, Italy, at the Technical University, Braunschweig, Germany, at the ISRO Satellite Centre, Bangalore, India, at the NASA Johnson Space Center, Houston TX, USA, at the Aerospace Corporation, El Segundo CA, USA, at the Orion International Technologies, Inc., Albuquerque NM, USA, etc.

4. L. Perek, Outer Space Activities versus Outer Space, Journal of Space Law, Vol. 7, p.115, 1979.

5. D.S.F. Portree and J.P. Loftus Jr.:Orbital debris and Near-Earth Environmental Management: A Chronology. NASA Reference Publication 1320, December 1993.

6. Environmental Effects of Space Activities. Study by IAF and COSPAR, UN doc. A/AC.105/420, 1988,
Space Debris, ESA-SP-1109, 1988,
Orbiting Debris: A space environmental problem. US Congress, OTA-BP-ISC-72, 1990,
IAA Position Paper on Orbital Debris (ref. 1).

7. Orbital debris: A Technical Assessment. US National Research Council. National Academy Press, Washington, D.C. 1995 (ISBN 0-309-05125-8).

8. See, e.g., the article by K.-U. Schrogl, The new structure of the ITU – responses to rapid technological and political change, Space Communications, Vol. 12, No. 1, p. 29, 1994.

9. Recommendation ITU-R S.1003. See UN document A/AC.105/C.1/CRP.4 of 9 February 1995.

10. See, e.g., R.E. Penny and P.A. Swan, Orbital Debris Mitigation the Iridium Way, Paper B.8-M3.06 at the World Space Congress, Washington DC, 1992.

11. Space Communications, Vol. 12, p.1, 1994.

12. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, UN General Assembly Resolution 2222(XXI) of December 19, 1966.

13. P.M. Martin: Liability Issues on Space Debris, IAA 7.193-760, presented at the IAF Congress in Graz, Austria, 1993.

14. Convention on Registration of Objects Launched into Outer Space, UN General Assembly Resolution 3235(XXIX) of November 12, 1974.

15. Convention on International Liability for Damage Caused by Space Objects. UN General Assembly Resolution 2777(XXVI) of November 29, 1971.