WHAT FUTURE FOR SPACE DEBRIS?

Luboš Perek
Astronomical Institute, Bocni 11 1401, 14131 Prague, Czech Republique
E-mail: perek@ig.cas.cz

INTRODUCTION

Even if the present population of space debris poses only acceptable risks, it is necessary to follow its future development. The number of debris is steadily increasing and most probably it will continue to increase even if the generation of new debris is restricted. It may happen that the risks will become unacceptable in the future and that active removal of debris will become a necessity. Only few debris possess devices for de-orbiting. The majority of objects is inactive not only in the sense that they terminated their intended activities but also in the sense of having no capability for initiating or speeding up their own decay.

Several methods have been proposed for removing inactive debris from orbit. All of them, however, require new technical developments. Also the cost of implementation is very high.

The UN Committee realized the importance of theoretical research into methods for removal of inactive objects from Earth orbit on the Peaceful Uses of Outer Space. The Committee has recently encouraged such studies [5].

SMALL OBJECTS

The necessity of removal may be different for different sizes of the objects. Up to 1 cm the collision risk may be minimal because of protective shields of active spacecraft.

Debris between 1 and 10 cm may destroy active spacecraft and may be the most risky group of inactive objects. A powerful ground-based laser has been proposed for reducing the lifetime of debris by repeated bursts of laser light [6]. The supporters of the project consider the study adequate but the opponents doubt the efficiency of the method. As of now, no experiment is being funded.

Objects larger than 10 cm can be tracked. They are mostly fragments originating from explosions and break-ups of spacecraft. The only way, known at present, to deal with the risk posed by such objects is to avoid them by maneuvering. The problem is to achieve sufficient precision in tracking to permit successful avoiding maneuvers.

LARGE OBJECTS

The largest and most massive space debris are inactive spacecraft, which are intact or almost intact. The main risk involved in these objects is – besides a collision in space - the possibility that some compact pieces could hit the ground when the object decays. Another risky possibility is in their eventual disintegration into large numbers of small debris. De-orbiting of some of these objects would markedly decrease the total mass of the debris population.

In this context, the planned decay of the MIR station by means of the Progress spacecraft is important because its success could prove the feasibility of active removal of inactive spacecraft by an unmanned vehicle. Another theoretical possibility of removing from orbit large objects is the application of tethers to transfer momentum between two objects [7].

How many and how massive are these largest inactive objects? The reply to that question can be found in the data provided by the DISCOS System of the ESA Operational Center in Darmstadt [8].

The DISCOS System recognizes two classes of objects: payloads and rocket bodies. The latter class can be assumed to refer to non-operational objects, but the former class may contain active objects as well as those which have already terminated their activities. The NASA Satellite Situation Report makes a similar distinction: payload and debris.

A printout of 200 heaviest payloads and 200 heaviest rockets with perigees below 2000 km is quite interesting. At the top of the list of payloads is, of course, the MIR complex of about 100 tons. Next comes the ISS and its component parts, then the Hubble Space Telescope and Cosmos 2372, all of them above 10 tons, all of them active. These objects are followed by payloads launched by several countries. The last payload on the list still has a mass of 1590kg. The heaviest inactive objects are second stages of the Zenit-2 rocket with masses between 8.2 and 9 tons. There are 19 such objects. Rocket bodies of many other systems follow. The last rocket on the list has a mass of 1430kg. The number of massive objects in space is surprisingly large.

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The Discos System lists also the expected lifetime of individual objects. This parameter is very useful in separating objects, which will decay within a relatively short period of time, from objects, which could be considered for de-orbiting, and from objects with very long lifetimes, not of imminent urgency.

PERMISSION TO REMOVE AN OBJECT FROM ORBIT

We have to revert to the difficulty of finding out which payloads are active and which are not, in other words, which are functional and which are non-functional, because these terms are the basis of defining space debris.

In the Position Paper on Orbital Debris [5], *orbital debris is defined as 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.*

The term "space debris", used in the UN, is more general. It includes also the decaying phase and the eventual impact on the ground. In space, the two terms are equivalent.

Space objects are protected by international law, irrespective of their state of repair. Their owners are launching states or launching agencies. Moreover, there are agreements not to use "anti-satellite weapons". Consequently, any attempt to remove a space object from orbit may be perceived as an action against a satellite. Relevant international law was adopted in the form of international treaties at a time when the protection of spacecraft against foreign intervention was considered the most important principle. The real situation has changed in the course of years when inactive objects vastly outnumbered active spacecraft. The legal position has not as yet, followed suit. Consequently, useless inactive objects, if they are considered "space objects" in the sense of the space law treaties, enjoy the same protection as valuable active satellites.

Launching countries appreciate the international protection of their active spacecraft. Moreover, they may wish to keep also some of their inactive objects under the protection of the space treaties, such as spacecraft which had served as "technical means for the verification of international agreements", as well as objects having on board advanced technology not open to unauthorized inspection.

The technical aspect of space debris deals with the distinction active – inactive. The legal aspect of space debris deals, moreover, deals with the distinction "objects of property or interest" as opposed to "junk", if we wish to avoid the technical term "debris". Two more remarks:

Firstly, launching states are liable for damage caused by a space object while in outer space as well as by its impact on the ground. Let us just recall the case of Cosmos 954, which disintegrated over northern Canada on 14 February 1978.

Secondly, space law knows the terms "parts" or "component parts" but it does not know the concept of a fragment.

INTERNATIONAL RECOGNITION

International recognition of the fact that an object of no interest to the launching state does not need to be protected in the same way as an active object, is a matter for future development of space law. The international community will have to introduce the concept of abandoning a space object without renouncing its liability.

The first step in clearing up the situation and providing information on the status of space objects, could be a statement by the launching state that the object in question had terminated its functions. There is a way to use provisions of existing space law for this purpose. Let us first explain a few points about the Registration Convention.

The Registration Convention

The Registration Convention is one of the treaties on outer space. Its Article III requires the Secretary-General of the UN to maintain a Register of objects launched into outer space and its Article IV requires the launching States to register their space objects with the United Nations:

Article IV

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry:

(a) Name of launching State or States;
(b) An appropriate designator of the space object or its registration number;
(c) Date and territory or location of launch;

(d) Basic orbital parameters, including the nodal period, inclination, apogee and perigee;
(e) General function of the space object.

2. *In addition, each State of registry may, from time to time, provide the Secretary-General of the UN with additional information concerning a space object carried on its registry.*

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

The UN Register consists of hundreds of announcements by launching states published in the UN documents.

The governmental launching announcements, regrettably, are not uniform. Each launching state uses its own format and its own designations of space objects, making thus a correlation of objects quite difficult. Moreover, the Registration Convention does not give a fixed deadline for registering new objects. It merely requires launching states to submit the announcements "as soon as practicable". This phrase is interpreted by launching states quite liberally: Some register within weeks, some within months, some within years. Under these circumstances it is very difficult to find out relevant data on a specific object in the hundreds of announcements.

Table 1
Formats of registrations

Launching State	Name of spacecraft	COSPAR designation	General function	Delay and UN document	Termination of activities	Decay	Space debris
Argentina	Yes	No	Yes	2 mo E/351		Yes	
Australia	Yes	No	Yes	15mo E/348			
Canada	Yes	No	Yes	7mo E/309			
China	Yes	No	Yes	1mo E/365			
Chile	Yes	No	Yes	1mo E/342			
Czech R.	Yes	Yes	Yes	1 y E/361			
ESA	Yes	No	Yes	10mo E/375			
EUMETSAT	Yes	Yes	Yes	8mo E/338			
France	Yes	No	Yes	19-9moE/374		Yes	
Germany	Yes	No	Yes	1mo E/345			
India	Yes	No	Yes	2 mo E/357			
Japan	Yes	Yes	Yes	15mo E/371		Yes	
Mexico	Yes	No	Yes	3 y E/184			
R.of Korea	Yes	No	Yes	1mo E/368	Yes E/364		
Russian Fed	Yes	No	Yes	5-3mo E/372		Yes	
Spain	Yes	No	Yes	8 mo E/376			
Sweden	Yes	Yes	Yes	2 mo E/352			
Ukraine	Yes	No	Yes	2 mo E/291			
UK	Yes	Yes	Some	6y,1m E/378			
USA	No	Yes	Yes	7-3 moE/369		Yes	Yes
Brazil	Yes	No	Yes	1mo INF.397			
Israel	Yes	No	Yes	1mo INF.399			
Italy	Yes	No	Yes	7mo INF.403			
Luxemburg	Yes	No	Yes	yearsINF.402			

Table 1 shows that not all countries give the names of their space objects. Also a wider use of the international COSPAR designation would make the correlation between announcements much easier.

Most of the table is self-explanatory. In column 5, E refers to a series of documents ST/SG.SER.E listing registrations according to the Registration Convention. In the lower part of the Table countries are listed which register according to a 1961 Resolution 1721(XVI) of the UN General Assembly. Some intergovernmental organizations, such as INTELSAT, ARABSAT and INMARSAT do not register their satellites at all.

The wide variety of formats and delays is due to the fact, that the Office for Outer space Affairs has not been authorized to invite registering states to reach at least some degree of conformity and to remind countries to register in case the delay grows out of proportion.

THE PROPOSAL

If launching states and agencies used the possibility suggested in Article IV, 2 of the registration convention of providing additional information, the termination of functions of spacecraft could appear in the announcements and the knowledge of inactive objects would become authoritative on this point. One country already used this possibility: Sweden announced the termination of activities of several of its satellites[1]. This example, if followed by other countries, could soon become a common practice. The initiative must come from the scientific and technical community, which realizes the need to know which space objects really are space debris. Two organizations have the necessary qualification: the Inter-Agency Coordinating Committee on Space Debris and the Committee on Space Debris of the International Academy of Astronautics.

Many launching states and agencies, as well as Members of the above two committees, are represented at this conference. Why not recommend, upon our return home, and unless already done, to relevant authorities:

- to consider this problem,
- to keep submitting the announcements "as soon as practicable" in the real sense of the word, in order to increase the efficiency of the Convention, and
- to keep announcing also the termination of activities of individual spacecraft.

Why not try to make one of the existing treaties a useful tool for authoritative announcements of the true status of space objects which cannot be established in any other way?

Just now is a good opportunity to start using the Registration Convention to its full capacity. The UN Office of Outer Space Affairs has made an important effort in correlating the available information into an Online Index of Objects Launched into Outer Space. It was presented at the recent session of the Scientific and Technical Subcommittee (February 2001). It can be accessed directly using the following url address <**registry.oosa.unvienna.org/index/index.stm**> or through the United Nations Office for Outer Space Affairs website <www.oosa.unvienna.org>.

Once the information relevant to the search has been selected, the programme sends the information to the secure database server, which is searched. Matching records are organized chronologically and returned to the requester. The Index presently contains information on about 3450 objects launched since 1976 and makes a color distinction between information contained in the governmental announcements and information provided by other sources.

Good and authoritative information on space objects is an important basis for mitigation measures as far as objects already in orbit are concerned.

[1] The termination of activities of Freja, 1992-064A, was announced in E/318, on 21 Jan 1997, of Tele-X, 1989-027A, was announced in E/335, on 28 Apr 1998, and of Astrid 2, 1998-072B, was announced in E/364, on 29 Nov 1999.

REFERENCES:

[1] Report of the COPUOS, Fifty-fifth Session, Vienna 2000, UN Doc. A/55/20, para 107.

[2] J.W. Campbell: Project Orion: Orbital Debris Removal Using Ground-Based Sensors and Lasers. NASA Technical Memorandum 108522, Marshall Space Flight Center

[3] A. Bade: Seilsysteme zur Entfernung von inaktiven Raketenoberstufen und Satelliten aus Erdumlaufbahnen, Dissertation, Verlag Shaker, Aachen, 1993.

[4] We are indebted to Dr. H. Klinkrad and his colleagues at the ESA/ESOC Centre for the courtesy.

[5] Position Paper on Orbital Debris, published by the International Academy of Astronautics, Paris, 1995.