THE ROLE OF THE SCIENTIFIC AND TECHNICAL SUBCOMMITTE OF UN-COPUOS FOR THE SPACE DEBRIS WORK OF THE UNITED NATIONS.

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1. THE HISTORICAL TASK

1.1 Space Utilization and the Threat of Orbital Overcrowding

The dimension and the historical importance of the task before us can only be fully understood when we put it in wider context. 37 years ago, when the first satellites were launched, mankind made its initial steps into near Earth space, and by now this new technology has already changed the world at a breathtaking speed.

Worldwide and low cost communication by telephone, by numerous television-channels, telefax, electronic mail and other data links has brought the people and the countries of the world together in a way not anticipated. The detection of extremely far-away galaxies, of x-ray sources, quasars and of black holes from orbiting telescopes has enlarged our scope of the universe and even helped to understand its creation. The global and detailed knowledge of the Earth´s surface, of its oceans, of the atmosphere, of the climate and weather dynamics has led to very practical applications and benefits. But it has also helped to fully realize, that mankind lives together on the surface of a comparatively small sphere, our Earth, on which we are drifting alone, as its seems, through the universe like on a space ship and that we feel a common responsibility to preserve that precious sphere.

All this has been brought about by a few hundred satellites orbiting the Earth and being operated for communications, earth observation and astronomical investigation. All this is only a beginning, and further achievements are waiting. Now, since our every-day life is intensively and frequently influenced by the utilization of satellites, it is indeed justified to speak of the "space age", - a term which was premature when it was coined at the time of the first launches of tiny satellites. Having understood this context, it is then more clear what we are going to lose if congestion, increasing risks of impacts and collisions, and rising mission insurance costs would gradually hamper or even stop the utilization of orbital regions.
To continue spaceflight and allow for further space achievements in such a way that this is not accompanied by overcrowding, by collision- and impact-risks, - this is the historical task before us, of which I am sure that mankind will solve it.

1.2 The Threat of Overcrowding

In the past, the number of tracked space objects contained in the US radar catalogue has risen more or less linearly with time to the present well known number of ~ 8300 objects. Also the untrackable population, as described by all major models of the world, has risen linearly in time to a present value of typically 100 000 objects larger then 1 cm, depending on which model is used. Among these two population classes the present collision risk seems fairly low but finite. Impacts on satellites by man-made objects smaller than 1 cm, however, are frequent and pose a risk already now.

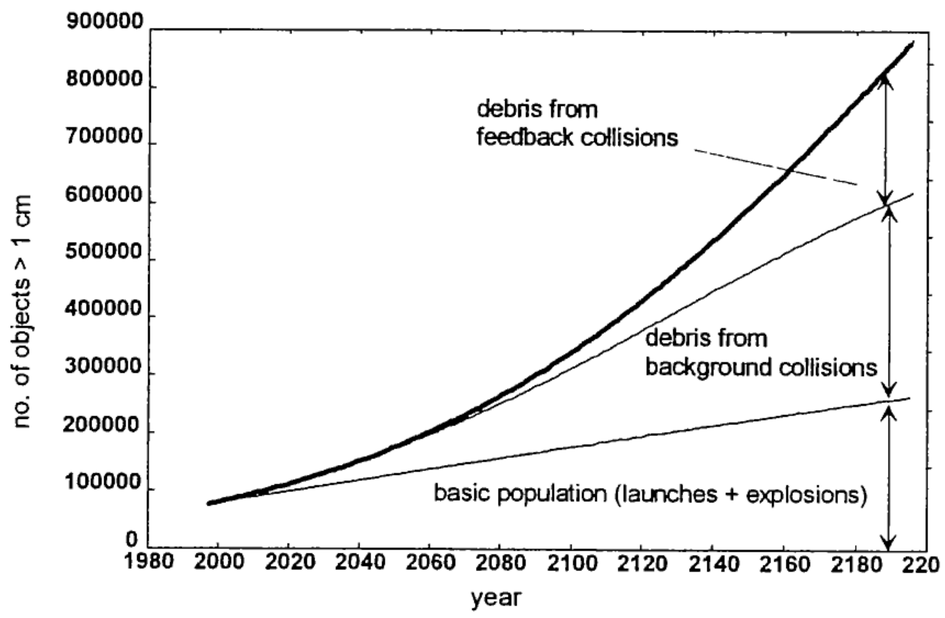

Figure 1. Predicted increase of the number of space debris objects (larger than 1 cm) over 200 years.

All predictions by space debris models, which extend the linear increase of orbiting space objects into the future, predict a more than linear increase of object numbers if one also accounts for debris from collisions. Fig. 1 is a general representation of this fact. This dominance of collisional debris in the future (whereas its contribution at present is only minor) is a general result of all researchers in the field. The results only differ in how steep and in which time frame the actual dominance of collisional debris will occur: in two

decades or in hundred years.
Such a situation is typical for the decision makers to take action: decision must be taken despite considerable ignorance regarding the medium-term risks. The feasible counter-measure strategies involve long term technology implementation. The classical approach of immediate profit from the actions taken, rejecting any actions not based on absolutely certain forcecasts, can no longer be sustained.
Regardless of which precise countermeasures have to be taken at what time, it becomes clear in general that the situation urgently requires investigation, that the effictiveness, feasibility and cost of countermeasures has to be analyzed and political decisions on their implementation have to be prepared.

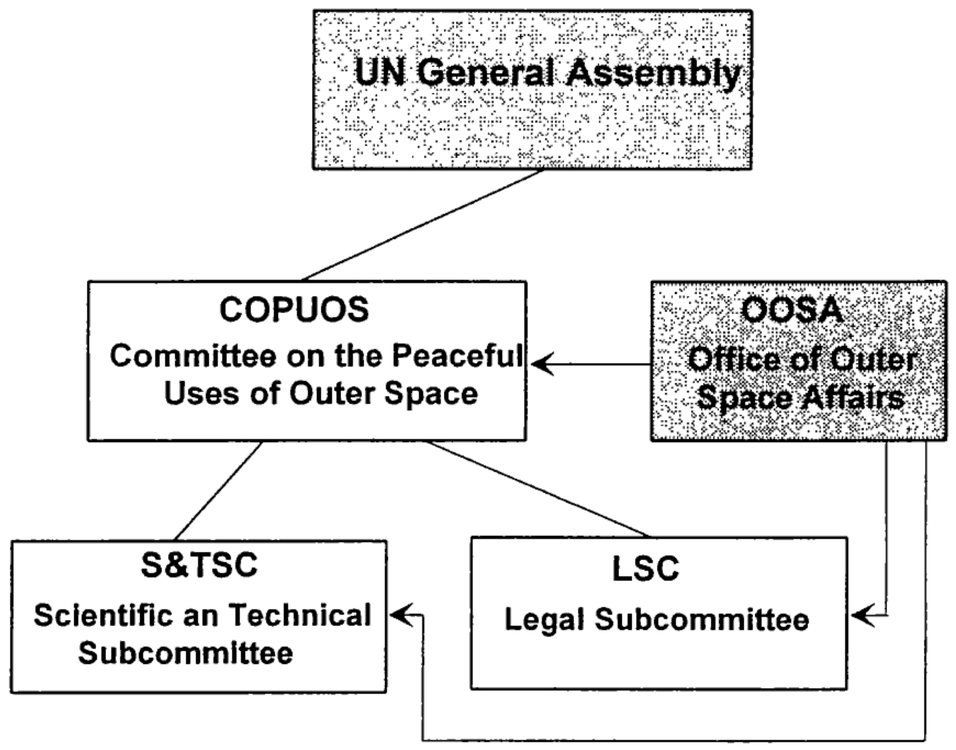

Figure 2. Structure of the three outer space committees in the U.N.

1.3 Involvement of the United Nations

The question can be discussed, which international/ intergovernmental organization is most suited to tackle and possibly find a final solution for the space debris problem. Space debris was, for a long time already, on the scientific program of the IAF-congresses and COSPAR-general assemblies. The IAF debris sessions were organized by the Committee On Safety and Rescue of the International Astronautical Academy. The Academy also, via its committee on Safety, Rescue and Quality, issued the "Position Paper on Space Debris" in 1995. Since 1993, there is the Interagency Space Debris Coordination Committee, IADC, put together by researchers from all of the bigger space agencies. This group assembles presently the biggest number of space debris experts and so resembles the largest expertise in the field. Also, on the legal side, the International Law Association, ILA, and the International Institute of Space Law, ISSL, have been working in the field.

It seems natural, however, to entrust the final discussion and solution of the space debris problem to the United Nations. They are a world-wide Organization not limited to some countries and at the same time have an intergovernmental composition, i.e. agreements found there have already the support of the governments. Also, the United Nations have helped already in the past to coordinate space activties of all countries by introducing space related treaties, conventions and General Assembly resolutions, so that they have already created an area of space law. The United Nations Organization has a well established structure for its work on space issues, see Fig. 2. The S&T SC normally serves as the entrance to the system, i.e. a new item is first treated there to clarify its technical implications. Each year, a report of the considerations before the S&T SC is adopted by consensus (non consensus paragraphs can also be included in the report as "views of some delegations"). The S&T SC´s report is later each year endorsed by COPUOS. If the subject requires legal considerations it is then also put on the agenda of the LSC, and its consensus report together with draft legal instruments as appropriate finds its way again to COPUOS and to the General Assembly as appropriate. It is of course up to the national delegations in COPUOS, whether or not they wish to create a legal instrument on space debris by consensus. However, in the frame-work of the UN that opportunity would exist and all decisions to use it or not to use it can be taken. Also, it should be mentioned, that the three committees of the UN are supported by OOSA, the Office of Outer Space Affairs, the expertise and manpower of which for preparing and drafting documents in all languages and for organizing and documenting meetings is invaluable. All this for me is a clear indication, that the final solution to the space debris problems, perhaps its continued consideration as appropriate, should be entrusted to COPUOS and its Subcommittees. In this space debris work, COPUOS, especially the S&T SC, should of course draw on all expertise in the world.

2. THE UN SPACE DEBRIS WORK UP TO PRESENT.

2.1 How did Space Debris become an Agenda Item at the S&T Subcommittee.

Since 1979, the application and safety of nuclear power sources in space, NPS, was on the agenda of the S&T SC, later also on the agenda of the legal SC, which finally, in 1992, led to the adoption by the General Assembly of the 11 Principles Relevant to the Use of Nuclear Power Sources in Outer Space. In the final phase of the technical considerations of this issue in the S&T SC it became evident, that nuclear reactors, stored

as a safety measure in long-lifetime circular orbits around 950 km altitude, would be subject to collisions with space debris. This risk became non negligible due to the debris density peak at that altitude and due to the long orbital lifetime of more than 300 years. So, in this context, space debris and collision risks for the first time had to be considered in the S&T SC.

Also at that time, many delegations were of the view, that the emerging space debris problem should be put officially on the agenda to clarify it more thoroughly. Space debris statements by delegations were made under the agenda "other matters", reviewing the national space debris work done in many countries and advocating a separate agenda item. Other delegations being reluctant in that question, it lasted until 1994, when space debris became a seperate agenda item in COPUOS in the S&T SC, but not in the Legal Subcommittee. By that time, numerous countries had also submitted working papers on space debris for distribution in the S&T SC.

2.2 Space Debris Considerations in the S&T SC 1994-1997, Work plan.

In the first year, all delegations welcomed the new agenda item and emphasized its importance. Although being one out of 16 items, it was considered to be among the most important issues on the agenda. To cover the broad and complicate field, a multi-year work plan was adopted in 1995:

1st year	Measurements of space debris
2nd year	modelling the space debris environment and risk assessment
3rd year	space debris mitigation.

Since work on this work plan started in 1996, it would last until 1998. In 1996, the work focused on debris measurement techniques. National and space agency experts briefed the Subcommittee on dedicated debris radars and their resolution limits, on optical measurements and on the evaluation of the impacts on retrieved surfaces. In 1996, it was agreed to invite the IADC to present a technical paper in 1997. So for the first time, in 1997 representatives of the IADC appeared before the Subcommittee presenting a paper, and it was agreed that this cooperation shall be continued in 1998. Together in 1996 and 1997, 14 technical presentations by experts on space debris were given, which ensures that all relevant technical expertise is included in the space debris considerations at the UN.

2.3 Technical Report

In 1996, with the beginning of my chairmanship, it was also agreed to reflect the technical substance of the considerations in the Subcommittee and of the technical presentations given by experts before the Subcommittee in a comprehensive technical report, which would be carried forward according to the work plan each year and updated and finalized at the end. The following structure of the report was drafted in 1996:

1. Measurements of Space Debris
   - 1.1 Ground based measurements
     - 1.1.1 Radar measurements
     - 1.1.2 Optical measurements
   - 1.2 Space based measurements
     - 1.2.1 Retrieved Surfaces and impact detectors
     - 1.2.2 Space-based debris measurements
   - 1.3 Cataloguing and databases
   - 1.4 Effects of the space debris environment on the operation of space systems
     - 1.4.1 Effects of large debris
     - 1.4.2 Effects of small debris
   - 1.5 Other effects of space debris

2. Modelling of the Space Debris Environment and risk assessment
   - 2.1 Modelling of the space debris environment
     - 2.1.1 Introduction and methodology
     - 2.1.2 Short term models
     - 2.1.3 Long term models
   - 2.2 Orbital debris risk assessment
     - 2.2.1 Introduction
     - 2.2.2 Collision risk assessment in LEO
     - 2.2.3 Collision risk assessment in GEO
     - 2.3.4 Risk assessments for re-entering orbital debris

3. Space Debris Mitigation Measures
   - 3.1 Reduction of the debris increase in time
     - 3.1.1 Avoidance of mission related objects
     - 3.1.2 Improved structural integrity of space objects (explosion prevention etc.)
     - 3.1.3 De-orbiting and re-orbiting of space debris
   - 3.2 Protection strategies
     - 3.2.1 Shielding
     - 3.2.2 Collision avoidance
   - 3.3 Effectiveness of mitigation measures

Chapter 1 and 2 of the report have been written in 1996 and 1997 respectively but are subject to amendments and changes in the next two years. The report will be accompanied by a number of diagrams and graphs, the preliminary first set of which has been drafted this year.

3. MITIGATION AND OUTLOOK

It is expected that the consideration of mitigation measures next year will be somewhat more problematic than the discussions of measurements and modelling in the past. Explosion prevention, de- and re-orbiting can give rise to a financial burden on space missions and all space faring entities will watch closely that their share in the burden is not going to be heavier than others'. The S&T SC will strictly adhere to its mandate of dealing with technical issues. However, technical efforts necessary (e.g. amount of propellant for lifetime reduction) are an indicator of cost, and also the effectiveness of certain mitigation measures to limit the future increase of space debris will be studied. So the balance of positive effects of mitigation measures and the economic drawback inevitably comes into sight. "What are we willing to pay now for the preservation of unhampered space use in the future ?" Is already a political question and goes beyond the mandate of the S&T SC, but the future decision in the political field requires strong support from the technical side: what are the alternatives, what are the consequences ? On the other hand, examples for mitigation measures developed in national efforts such as the US NASA Safety Standard "Guidelines and Assessment Procedures for Limiting Orbital Debris", the ESA "Handbook on Space Debris Mitigation", and the NASDA "Debris Mitigation Standard" can be used to ease the discussions.

So I am sure that the S&T SC, also next year will produce and agree upon a substantive report chapter on mitigation.

Following consensus on that chapter, the whole Technical Report will need some final editorial work, adding introduction, conclusions etc. It is expected that this finalized report is ready for adoption in 1999.

It is not clear at present, what is the intention of the delegations in COPUOS with respect to the further procedure concerning that report. Presently, there is no consensus to introduce "Space debris" in the Legal Subcommittee, where then the report could be used as a basis. In the view of many delegations, who have suggested this, the involvement of the Legal Sub-committe would be the normal procedure, which has been followed in previous cases, for the last time in the NPS case. If, however, an agreement in this procedural question will not be reached, then perhaps a set of technical recommendations adopted by COPUOS would be the lowest level result, which anyhow, would have some moral effect.

In view of the paramount importance of the preservation of near Earth space for future space flight, as emphasized at the outset of this paper, a final legal instrument on space debris mitigation would be commensurate. Such legal instrument needs to be either sufficiently general, avoiding much technical detail, or it would have to be organized in a framework structure which accommodates supplements to reflect future technical developments.