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Space Traffic Management
The new comprehensive approach for regulating the use of outer space

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October 2007 brings us two anniversaries: 50 years ago, Sputnik was launched and 40 years ago, the Outer Space Treaty entered into force. The first satellite and the foundation of the legal regime governing outer space mark the two decisive points for the use of outer space and its international regulation. During the past decades, space activities have taken a tremendous development in quantity and scope. Regulation has, however, not been able to keep pace with technology, so that today the legal environment shows more and more shortcomings. This paper argues that the growing problems of space law can not be solved by "piecemeal engineering" any more but can only be overcome through a "big bang" comprehensive approach for regulating space activities: Space Traffic Management.

"Traffic" in outer space

Compared with road traffic or air traffic, it seems to be bold to use the term "space traffic". On the first view there are no congested roads, where a variety of traffic participants fight for their rights and there are no take-offs and landings by the minute. In fact, since the beginning of the space age, only 30.000 man-made objects larger than 10 cm have been observed and registered. Today there are 12.000 objects in earth orbits, 1.100 of these in the Geostationary Satellite Orbit (GSO). This means that there are only 10^{-7} objects per cubic km. This does not sound very dramatic, indeed.

But this is only the dry calculation. Regarding "space traffic" from another angle might change this initial evaluation. The first aspect to be considered in more detail is the distribution of space objects. In fact, there are areas with a particularly high density of activities. These are the low orbits of up to 400 km, the polar orbits at around 800 to 1.000 km and the GSO at 35.800 km above sea level. With some notable exceptions (like Medium Earth Orbits where navigation satellites can be found), these orbits host the largest number of the main application satellites, like for Earth observation and telecommunication. This uneven distribution has already led to types of congestion, which has been known for years with regard to the GSO.

There already exist highly congested areas in outer space.

Currently, at least 600 active satellites are in orbit (300 of these in GSO). They move with a typical velocity of around 7.500 meter per second. Only few of them have manoeuvring capabilities. They are surrounded by a growing number of space debris. Currently only objects larger than 10 cm can be tracked (their number is larger than 10.000) but the millions of smaller objects can still do harm to satellites (or humans in outer space) if they are larger than 1 cm. This debris population is constantly rising, in particular through explosions of upper stages, which happen on average at the rate of five per year). The Chinese anti-satellite test of January 2007 additionally created a population of more than 2.000 trackable pieces of debris, and this in a highly valuable orbit plain, where debris remains for decades or centuries. There have also been recorded three collisions between active satellites and space debris and the need to fly debris avoidance manoeuvres by the Space Shuttle and the International Space Station has become a routine. So, this second view draws a more urgent picture of the situation around the Earth. This is why for a couple of years, research on how to cope with the problem of maintaining space for safe use is on the rise. 2007, the year of anniversaries, might give this research another strong push.

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Findings from the study by the International Academy of Astronautics

Already in the early 1980s, the term of traffic has been used for space activities and the resulting need for regulation.[1] In a more comprehensive way, the American Institute of Aeronautics and Astronautics (AIAA) took up the issue at two workshops they organized at the turn of the century.[2] Emanating from these workshops, the International Academy of Astronautics (IAA) established a working group on the issue of Space Traffic Management (STM) in order to prepare an in-depth multi-disciplinary study (a "Cosmic Study" in the IAA's nomenclature). This study was published in 2006.[3] It is the first comprehensive work in this field.

The study defines STM as: "the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical and radio-frequency interference." The study acknowledges that today the need for STM is not yet so pressing that immediate action has to be taken. But it clearly identifies perspectives which make it seem reasonable to start already now with conceptualizing a future regime. The study refers to a slow and steady decline of launches since 1980 but on the other hand stresses the increase of countries with their own launching capacities and launch facilities. Due to space debris, the number of catalogued objects is also steadily rising, but the number of active satellites remains at 6 to 7% of the total catalogued objects. The precision of current space surveillance systems has to be improved and data sharing has to be developed further. Also, information on "space weather" is still limited and has to improve.

New technologies and new types of actors require a new regulatory approach.

The study also shows that the prospects for re-usable space transportation systems are still open, that human space flight will roughly remain at the amount of 10 to 15% of all launches (a number which it has held during the past 20 years) and that following the successful flight of Spaceship One there might be – if safety is guaranteed – a growing number of sub-orbital commercial human flights. The picture is supplemented with a view on novel technologies like tethers, stratospheric platforms or space elevators, which might be introduced in the future and which will have to be taken into account as well. This enumeration of perspectives shows the variety of trends and developments that will make space activities more diverse, regarding technologies as well as actors. This does not only poses technological challenges but also challenges in the regulatory field.

STM as a challenge to current space law

While the space technologies rapidly change, space law has not left the basis which has been set by the Outer Space Treaty 40 years ago. Current space law still shows the strong traces of its emergence in the East-versus-West era. It is still characterized by a primary focus on States as actors in outer space. This has lead to a situation where the recently growing need for effective mechanisms to regulate the activities of non-governmental, private actors is not met any more. The cases where this has become apparent have been the reviews of the concept of the "launching State" and the registration practice, in particular with regard to private actors.[4] While problems have been highlighted through these agenda items and proposals for remedies have been worked out, these deliberations again proved that UNCOPUOS is a forum which is characterized by an extremely slow decision-making process and a hardly imaginable reluctance of its member States to accept any changes in the current regulatory framework.

This extreme fear of the member States in UNCOPUOS has lead to results during the past 15 years that did not add any new binding provisions to international space law. They didn't even produce authoritative interpretations of existing provisions, which urgently need to be re-evaluated in the light of new developments. The consequence has been that on the one hand, other international organizations like the International Telecommunication Union (ITU) started to regulate areas of space activities and that on the other hand, soft law (regulations, standards etc.) instead of binding international law has been developed in technical fora like the Inter-Agency Space Debris Coordination Committee (IADC) or the Committee on Earth Observation Satellites (CEOS) or through initiatives like the Hague Code of Conduct Against Ballistic Missile Proliferation (HCOC). Through this, UNCOPUOS is slowly loosing control over the regulation of outer space activities.

[1] See Perek, Lubos. Traffic Rules for Outer Space. International Colloquium on the Law of Outer Space by the International Institute of Space Law (IISL), 1982, 82-IISL-09.
[2] AIAA Workshop Proceedings: International Cooperation: Solving Global Problems. 1999: 35-39, and International Cooperation: Addressing Challenges for the New Millennium. 2001: 7-14.
[3] Contant-Jorgenson, Corinne (Secretary of the Study Group), Lala, Petr and Schrogl, Kai-Uwe (Coordinators of the Study Group), eds. "Cosmic Study on Space Traffic Management", Paris: IAA, 2006. The Study Group consisted of 16 contributors from numerous countries covering engineering, policy and legal aspects. Download at http://iaaweb.org/iaa/Studies/spacetraffic.pdf
[4] Both topics have recently been dealt with in working groups under multi-year work plans of the UNCOPUOS. See: Schrogl, Kai-Uwe, and Charles Davies. A New Look at the Concept of the "Launching State" - The Results of the UNCOPUOS Legal Subcommittee Working Group 2000-2002. German Journal of Air and Space Law (ZLW) 51,3 (2002): 359-381 and Schrogl, Kai-Uwe, and Niklas Hedman, The results of the UNCOPUOS Legal Subcommittee Working Group on "Practice of States and international organizations in registering space objects 2005-2007". International Colloquium on the Law of Outer Space by the International Institute of Space Law (IISL), 2007, IAC-07-E6.5.12. The author of this Flash Report has been the chairman of both these working groups.

STM is a comprehensive concept leading to a regulatory "big bang".

In this situation, STM challenges the current condition of space law and the way it is developed further. While the current state can be regarded as a "piecemeal engineering", STM would provide a regulatory "big bang". STM would not tackle single issues, but regard the regulation of space activities as a comprehensive concept. This concept is based on functionality, aiming at the provision of a complete set of rules of the road for the current and future way. Space activities have to be regarded as a traffic system and not as disconnected activities of States. This would require not only new, interacting levels and forms of regulation (binding treaty provisions/technical standards, international/national provisions) but also new ways of organizing the supervision and implementation.

It is clear that specific provisions of the current space law can and will find their way into such a regime. This shall certainly be the case for principles like the freedom of use, the non-appropriation or the peaceful uses. The comprehensive approach will also make it possible to integrate existing regimes for specific areas, like the ITU regulations on using the orbit/frequency spectrum of the GSO or the emerging space debris mitigation regime developed in IADC or even the rocket launch notification regime of the HCOC, one more area where UNCOPUOS with its post launch registration regime has been outpaced. But STM will be more than only the sum of these single parts. STM will develop all provisions - including a legal delimitation of airspace and outer space - in one coherent way from the overarching principle of guaranteeing safe operations in the space traffic system.

Elements of a future STM regime

A STM regime will comprise four areas: the securing of the information needs, a notification system, concrete traffic rules and mechanisms for implementation and control. The first area is the basis for any kind of traffic management in outer space. In order to manage traffic, a sound information basis regarding the Space Situational Awareness (SSA) has to be established. Today, only the US Strategic Command possesses such a capability and shares some of its information with external users. A global STM system has to be open and accessible to all actors. The task will be to exactly define the necessary data, to establish rules for data provision and data management as well as rules for an information system on space weather. Only on such a basis, a shared knowledge about what is going on in the Earth orbits, traffic rules can become meaningful.

The second area is a notification system. The current system of registration based on the Registration Convention of 1975 is by far insufficient. A pre-launch notification system together with a notification system on in-orbit manoeuvres has to be established. To this end, parameters for the notification of launches and operations of space objects have to be worked out. This has to be complemented by rules for the notification of orbital manoeuvres and for re-entries. In addition, provisions for the notification of the end-of-lifetime of space objects are necessary.

The third area comprises the concrete traffic rules, which come first into mind - in analogy to road traffic - when traffic management in outer space is mentioned. Here we will find actual analogies, but also completely different rules. It starts with safety provisions for launches, then turns to space operations with right-of-way rules (comparable to "sail before motor" in maritime traffic), priorization with regard to manoeuvres, specific rules for the protection of human spaceflight, zoning (e.g. keep-out zones, providing special safety to military space assets[5]), specific rules for the GSO, specific rules for satellite constellations, debris mitigation rules, safety rules for re-entry (e.g. descent corridors) and environmental provisions (e.g. the prevention of the pollution of the atmosphere and the troposphere).

The fourth area will have to deal with mechanisms for implementation and control. The "modern" way of law or rule making by international organizations like the ITU or the International Civil Aviation Organization (ICAO) can provide an example to be followed. Basic provisions can be laid down in an international treaty (either drafted by an ad hoc assembly of States or in the framework of an existing organization like ICAO or an existing forum like UNCOPUOS), and subsequent rules of the road and standards can be developed in a routine way in the format of soft law. Since space law making in UNCOPUOS is too traditional, such an innovation would be a real culture change.[6] Another innovation would be the introduction of enforcement and arbitration mechanisms ultimately leading to a kind of policing in outer space and sanctions like e.g. the renouncement of access to information or the use of frequencies. This might sound utopian to those who adhere to traditional space law, but it is part of the systemic approach taken by STM, which make it such a revolutionary concept.

Finally, STM touches upon an issue which has been on the agenda for decades now and sheds a

[5] Such keep-out zones could also be a topic for the blocked negotiations in the Geneva Conference on Disarmament's Committee on the Prevention of an Arms Race in Outer Space (PAROS). Since the threat to military space assets is one of the drivers for a possible weaponization of outer space, STM could through such specific means also contribute to arms control and in that way receive particular promotion by the military users of outer space (this might be an analogy to space debris regulation where decisive progress was initiated by the US military realizing their assets being threatened).

[6] Early ideas on such an approach by Jasentuliyana, Nandasiri. Strengthening International Space Law. Proceedings of the Third ECSL Colloquium on "International Organisations and Space Law", Paris: ESA, 1999 (esa SP-442): 87-96.

completely new light on it: While the idea for a World Space Organization (WSO) has been around for more than thirty years, so far no convincing answer has been provided of what role such an organization should play. STM requires a strong operative oversight. This could be such a WSO but the authors of the IAA study have made it clear that it might be more adequate to broaden the mandate of the already existing and efficiently operating ICAO than establishing a new big bureaucracy. The philosophy behind this proposal is that space traffic might ultimately (but only in some decades) evolve into air traffic in another dimension where States and private actors with their "spacelines" operate side by side under one regulatory umbrella. But even without this optimistic vision, STM is an idea, whose time has come to shape the debate on how to overcome the regulatory deadlock we are facing today.

Perspectives

The IAA study was the first comprehensive approach to shape a space traffic management system. Its results have been presented at conferences, published in articles and have been brought to the attention of UNCOPUOS. Dedicated sessions on STM are starting to be held at symposia and an institution like the International Space University (ISU) has been conducting a student project on this issue in 2007.[7] In the US, the Center for Defense Information (CDI) – a Washington based think tank – also is concerned with STM in its research on space security.[8] The most notable initiative in this field is the establishment of the International Association for the Advancement of Space Safety (IAASS) some years ago, which in May 2007 published a thorough and detailed report, where STM is also reflected as a cornerstone for space safety.[9] ^

ESPI has been involved in most of these initiatives of ISU, CDI and ISSAA, and will continue to play a leading role in the research related to the conceptual approach of STM but also with research on specific related topics.[10]

The debate on STM is seriously on.

In the inter-governmental field, there is visible movement as well. The current Chairman of UNCOPUOS has suggested to make STM an agenda item in the Committee referring to the results from the IAA study.[11] Already in 2000, the then president of the ICAO Council, Assad Kotaite, proposed that the organization should think about the issue and start to play a role in regulating space activities.[12] An initial area for action might be Space Situational Awareness, where civilian and military actors outside the US increasingly get interested in. This field also shows that a future STM regime will not only have to comprise governmental as well as private space activities but also will inherently be of a dual use nature.

All these follow-ups and initiatives show that the concept of STM has its place in the framework of commemorating the anniversaries of the first space flight and the entering into force of the Outer Space Treaty. Its mission, however, is to show that we have already entered a new era of using outer space. It is an era that is characterized by new technologies and, even more important, by a growing number and type of actors. Preparing for the regulatory "big bang", leading to an effective framework for safe and equitable use of outer space, may take more than a decade. Therefore, it is encouraging to note that the debate is seriously on.

[7] See http://www.isunet.edu/index.php?option=com_content&task=blogcategory&id=93&Itemid=232
[8] See the activities of the CDI's Space Security Program, led by Theresa Hitchens, at http://www.cdi.org/program/index.cfm?programid=68
[9] IAASS, "An ICAO For Space?", 2007. Download at http://www.iaass.org/pdf/ICAO%20for%20Space%20-%20White%20Paper%20-%20draft%2029%20May%202007.pdf
[10] Currently, ESPI is conducting a study on data policy for Space Situational Awareness.
[11] Brachet, Gerard. Future role and activities of the COPUOS. Working paper submitted by the Chairman. UN Doc.A/AC.105/L.268, 10 May 2007: para. 28.
[12] See van Fenema, Peter. Suborbital Flights and ICAO. Air and Space Law 30,6 (2005): 396-411, 403.