

EXECUTIVE SUMMARY

Space traffic already takes place. It seems, however, minuscule with regard to the dimension of near-Earth outer space. Around 10,000 man-made objects larger than 10 cm are currently tracked out of which only 650 are operational spacecraft. On the surface, it does not look, as if the management of space traffic was a pressing problem. Investigated further, this judgement has to be challenged. A high level or even growing number of launches from more and more launch sites and space ports, the entering of non-governmental entities, the positioning of satellite constellations, an increase in space debris and the advent of reusable launch vehicles supports this judgement. Considering this scenario, conceptualizing space traffic management will turn out to become a relevant task during the next two decades. Space traffic management will, however, limit the freedom of use of outer space. Therefore an international consensus on internationally binding regulations will only be achieved, if States identify a certain urgency and expect a specific as well as collective benefit from this.

Space traffic touches two dimensions: the scientific and technical area, and the regulatory field that are both analyzed in this study. Then, those two dimensions of space traffic are applied to analyzing the three phases of space traffic: the launch phase, the in-orbit operation phase, and the re-entry phase. Below are the findings.

Space Traffic: Current Status and Prospects for 2010 and 2020

- The motion of space objects is influenced by different forces, which cannot be accounted for precisely. Errors in predictions of space object motion are primarily caused by variations of atmospheric density, and the error in predicted position in orbit increases with the square of elapsed time. For this reason, positions of all objects should be monitored systematically and precisely.
- The large majority of active satellites have no maneuver capability and most others have only a limited capacity to change their trajectory.
- There is a slow but steady decline of launch activities since 1980.
- There is a rise in the number of launch vehicles (today 18). There is also a rise in the number of launch centers (today 11).
- The prospects for the introduction of full/partly RLV are still open. In any case, by 2020 they would probably still be limited to supporting missions below 1000 km.
- Human spaceflight has been accounting for 13% of launches during the past 20 years. It might rise with the emergence of new actors in this field but dramatically only beyond 2020.
- Technologies like tethers, stratospheric platforms or space elevators, which might be introduced in the future, will have to be taken into account, when rules in particular for the launch and re-entry phase are developed.
- The population of space debris is continuously growing in number (today around 100,000 objects larger than 1 cm, most of them not catalogued).
- The number of catalogued objects is steadily rising (today 13,000 objects larger than approximately 10 cm).
- The number of active satellites remains at 6-7% of total catalogued objects.
- Capabilities for space surveillance rest with the US (and to a smaller extent to Russia and some singular capabilities in Europe); the US provides data and processed information on a voluntary basis.
- The capacity and accuracy of current space monitoring systems is not sufficient to cover small objects and provide for orbital avoidance service for all space assets.

- There are two major catalogues of space population, which is a far cry from the needed unified system of monitoring space traffic.
- Information on space weather is still limited but important for the operation of space objects as well as the prediction of the debris environment.
- The constant monitoring and information of space weather would be a useful tool for implementing a space traffic management system.

The Current Legal and Regulatory Framework

- The general principles of space law provide for a basis and rationale to establish a space traffic management regime.
- There exist some singular rules in international space law as well as in international telecommunication law, which constitute elements for a space traffic management system (especially for the GEO through the ITU). They are, however neither complete nor are they harmonized. ITU rules, aiming at the avoidance of radio-frequency interference are far more advanced than rules, aiming at the avoidance of physical interference.
- In this context, the IADC space debris mitigation guidelines of 2002 (non-binding soft law) encompass elements of space traffic management (use of disposal orbits, notification in case of controlled re-entry; but so far no provisions on the environment, i.e. avoidance of polluting the atmosphere/troposphere).
- Space law is, however, lacking numerous provisions, which are essential for a comprehensive traffic management regime (i.e. pre-launch notification).
- A space traffic management regime has to touch also the question of harmonizing national space legislation (mostly to be established) and its consequential licensing standards and procedures, since they provide the building blocks for assuring technical safety.
- In the context of arms control/disarmament negotiations notification practices (prior to launch) are currently discussed, thus surpassing the status of civilian space law and negotiations in UNCOPUOS.
- The implementation of a comprehensive space traffic management regime would require additional regulation (with regard to information and the execution of space missions), which would further limit the freedom of use of outer space; in order to achieve a consensus on this, States have to perceive a certain urgency and have to expect a specific as well as collective benefit (as they receive from existing regulation).
- There are interfering factors, in particular military doctrines, which might hinder the establishment and working of a space traffic management regime.

Comparable Traffic Regimes

In international spaces such as high sea—and outer space—no territorial jurisdiction applies. Only personal jurisdiction does. When rules such as traffic management are concerned, this system is far from being efficient. It is the reason why in the high sea, the exclusivity of the flag State is due to be overruled by an extension of the territorial jurisdiction of one or some States. This solution is not acceptable for space activities as there is no territorial jurisdiction involved. The solution of the port State is not usable as, for the time being a satellite does not fly back to Earth, the solution of extension of "coastal" jurisdiction is also impossible for obvious technical reasons. These difficulties should be taken into consideration if and when Space Traffic Management will be set in force.

The Launch Phase

- There is a rise in the number of launch vehicles (today 18).
- There is also a rise in the number of launch centers (today 11).
- The prospects for the inauguration of full/partly RLV are still open. In any case, by 2020 they would still be limited to supporting missions below 1000 km.
- Human space flight might only change dramatically beyond 2020.
- Safety certifications should be introduced.
- A clarification of the term "space object" is needed.
- The question of delimitation of air space and outer space should be revisited.
- The concept of the "launching State" has to be clarified.
- A pre-launch notification is necessary.
- Obligatory information in cases of damage is relevant.
- An international level playing field for transport services should be aimed for with a balance of public and private/economic interest.

The In-Orbit Operation Phase

- Maneuvering and in-orbit collision avoidance (with regard to other operational space objects as well as with regard to space debris) is growing in number and importance.
- Maneuvering in the GEO is intensely applied but with little consideration of possible collisions.
- Reliable collision probabilities can be estimated only when reliable information exists, which currently is not guaranteed.
- There is no prioritization with regard to maneuvers.
- There is no prioritization of certain space activities, no "right-of-way-rules", nor is any kind of utilization of space ruled out (except it is against the peaceful uses).
- There is no traffic separation ("one-way-traffic").
- There are no "zoning" rules (restriction of certain activities in certain areas).
- There are no communication rules (advance notification and communication if orbits of other operators are passed).
- The ITU system of nominal orbital positions finds application only to satellites in the GEO.
- Private/commercial actors have started (i.e. through SUIRG and ITU) coordinating against radio-frequency interference.

The Re-Entry Phase

- Intentional (RLVs as well as active debris mitigation) and un-intentional de-orbiting (natural debris mitigation through decay) is now more frequent but care should be taken that large debris structures will be de-orbited in fragments.
- Responsibilities and liabilities for damages caused by space objects or its components ensue not only from international space law but also from the general provisions of national (tort) civil and administrative law.
- The generally shared wish to reduce space debris raises the question, whether regulation should also set a standard under which conditions a re-entry activity is in general legitimate and under which conditions it is not.

- Notification of, and coordination with, local and downrange air traffic, maritime authorities, and local government officials are already considered a best practice in coordinating launch activities.
- Space Law and Air Law have to solve the open issue of passage of space objects through airspace (the Chicago Convention does not apply to space objects in air space).
- The question is posed to introduce certain internationally recognized descent corridors and possibly even impact areas which are not frequently used by other traffic and which might be dedicated to space traffic.