



# Space Traffic Management

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DEFENCE AND SPACE

ROYAL AERONAUTICAL SOCIETY  
YOUNG PERSONS' LECTURE COMPETITION



**AIRBUS**

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National N E Rowe Lecture Competition

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June 2017

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## Synopsis

Space Traffic Management (STM) was not an issue in international space activities until the threat to space assets has become prevalent. It is only in recent years that the earth orbits are considered as limited resources which should be properly used and managed. In 2006, the International Academy of Astronautics defined Space Traffic Management as "*the set of regulatory rules to ensure safe access to outer space, safe operations in outer space and safe return from outer space.*" As a result, STM has to cover the entire life (BOL-EOL) of a spacecraft and even more: its launch, its in-orbit phase of course but also its pre-mission phase and its re-entry on earth to ensure a limitation of space debris.

In particular in Low Earth Orbit and Geostationary Earth Orbit, the issue of increased space traffic represents an emerging problem, as these orbits are the most frequented in space. On top of the particular constraints which apply to the outer space environment, space is facing new challenges mainly due to the entry of new actors and space activities such as suborbital tourism and orbital spaceflight.

This rapid evolution calls for a new set of rules and strong inter-state relations. Discussions have already started at intergovernmental level. As a matter of fact, in June 2016 the Committee on the Peaceful Uses of Outer Space agreed to a first set of guidelines for the long-term sustainability of outer space activities. Poor management of space traffic could render space activities and the use of orbits impossible for future generations. Therefore, a sustainable Space Traffic Management will depend on the extent of such intergovernmental cooperation and its outcome.

Convinced that this situation needs to be resolved as soon as possible to eschew long-lasting severe obstacles for the future of spaceflight and the peaceful exploration and use of outer space, I thought that presenting Space Traffic Management for the Royal Aeronautical Society Young Lectures Competition would be an appropriate way to raise awareness.

## Background

As space enthusiasts you probably all have watched Gravity and George Clooney saving the world. Let me remind you how it starts. During a spacewalk, mission Control in Houston warns the International Space Station about a Russian strike on their own satellite. This strike caused a chain reaction forming a cloud of debris in space. Surprisingly enough destroying its own satellite is not science fiction and it has already occurred.

Indeed, in 2007, the Chinese Government conducted an anti-missile test on their own satellite, Fengyun 1C, in space. They wanted to demonstrate, in particular to the United States, that they had the capability to strike in Space. This event was the largest recorded creation of space debris in history with more than an estimated 150,000 debris particles.

The worst is that the density of objects in Low Earth Orbit is high enough that collisions could cause a cascade exactly like in Gravity. This is called the Kessler syndrome named after Donald. J. Kessler who first explained this scenario in 1978. It means that each collision generates space debris that increases the likelihood of further collisions. As a result, in 2011, debris from the Chinese test forced the International Space Station to change course to avoid a collision.

Former head of NASA's Orbital Debris Program Office declared recently that "*more than 10% of functioning satellites have likely experienced a sudden shock due to impact by debris too small to be tracked by ground sensors*"<sup>1</sup>. It could be more because a few operators actually divulgate this information. There are two main problems. On the one hand, one hundred and fifty million particles of debris are too small to be tracked. On the other hand, they travel too fast; up to sixteen kilometres per second. As a point of comparison, the muzzle velocity, which is the speed reached by a bullet when it comes out of the muzzle of a gun, ranges from approximately one hundred twenty meters per second to more than one thousand and two hundred meters per second. As a consequence, space junks are approximately ten times faster than any gun projectiles on earth.

Uncontrollable and untraceable objects in space are a real threat. They can potentially cripple a satellite. As a matter of fact, not so long ago, Sentinel 1-A was struck by one centimetre debris which created a forty centimetre crater. On the top of that, as of December 2016 there were five satellite collisions with space waste.

STM has become a relevant topic because the orbits around Earth, in particular, the near-Earth orbit, are quickly reaching a critical capacity due to spacecraft and debris owned by an increasing number of private and national actors. What was once an expensive pursuit, traditionally

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<sup>1</sup> <https://www.spaceintelreport.com/study-suggests-10-of-satellites-suffer-debris-impacts/>

reserved to governments and their space agencies begins to thaw. Even as corporations turn their eyes upwards, space grows ever more accessible—through the reach of DIY instruments, experiments, sensors and cubesats, and soon through space tourism and space mining. The increasing importance of commercial, private sector (such as Virgin Galactic, Space X or Deep Industries) driven space activity impacts many aspects of how space projects are conducted and requires new ways of managing the different associated risks, including Space Traffic Management. Thanks to the university space programme a student can now send a cubesat into space.

Currently, space actors need to undertake more and more avoidance manoeuvres of their spacecraft to prevent fatal collisions with each other or with debris. Collision may lead to mission failure, the loss of valuable economic assets, or in the case of human spaceflight even the loss of life. Furthermore, it could make space travel impossible. These new ways of using Outer Space are really exciting but we have to take all of these activities into consideration when we talk about regulating and managing the space traffic.

## Definition of Space Traffic Management

You were probably waiting for a definition of Space Traffic and here it comes. To be honest I have done this on purpose. It is generally admitted that the beginning of space activities started with the launch of Sputnik on the 4<sup>th</sup> October 1957. However, STM was conceptualized in the eighties and defined by the International Academy of Astronautics - almost thirty years later!- as the set of technical and regulatory rules to ensure:

- (1) safe access to outer space,
- (2) safe operation in outer space and
- (3) safe return from outer space.

As a result, STM is a very broad definition covering a lot of aspects. Moreover, everyone is involved: from industries for designing and manufacturing satellites to launching states. And yet, something is missing. Currently, we do not have any international organisations to track and monitor space objects. Added to that, there is no legal consensus on what is considered to be a space object (are we talking about a manned space object or should it also cover celestial bodies?).

We do have some provisions though in the Outer Space Treaty and the Liability and Registration Convention. These legal texts are holding space actors responsible for their activities into, in and back from space. Despite these pieces of legislation, the regulation today is incomplete. Overall, up to now, there is no reliable mechanism in place and we do not have another set of regulations tackling STM in a more comprehensive manner. So we need new regulatory requirements. It is actually really hard to reach an international agreement and this can be explained with two main reasons.

The first one is related to disparity. New spacefaring nations do not want to pay for space junks left by the US, Russia and Europe before they had access to space.

The second one is linked to sensitivity. States and operators do not want to divulgate the information they have regarding space traffic which might include the location of their military satellites.

Nevertheless, some initiatives, researchers and think tank groups are trying to reach and propose some solutions. I am proud to say that I participated to one of those during the second European Space Generation Workshop organized by the Space Generation Advisory Council (SGAC) and the European Space Agency (ESA).

## Recommendations

The SGAC is a non-governmental organisation aiming to bring the views of students and young space professionals to the United Nations, Space industry and other organisations. I chose to contribute to the Diplomacy Working Group which was one of four working groups in the Second European Space Generation Workshop, held at the European Space Agency HQ in Paris, France, on the 24-25th of March 2017. This Working Group (hereinafter the “Group”) was kindly sponsored by ESA.

Inside this Group, we were twenty four delegates coming from eighteen different countries with different backgrounds. In support of the United Nations Programme on Space Application, we had to provide forward, new-thinking and practical recommendations to the following three interconnected set of questions (regulatory focus) that the future of space is highly dependent on:

- (1) Is the legal framework of Space Traffic Management (STM) sufficient? How can it be improved?
- (2) What should be the role of all (private and public) entities in STM?
- (3) What are the currently proposed technical solutions? Which might work best? How can they be implemented/enhanced?

We presented a ten page report with more than twenty recommendations. I have attempted to underscore three main recommendations in this presentation.

The first one is raising awareness to all members of society. This includes but is not limited to governments, industries, academia and citizens. Awareness can be achieved both by the use of diplomacy (both traditional and digital) and media. One form of diplomacy is unofficial diplomacy between citizens and groups of individuals, also known as Track II Diplomacy, which can be effective when official measures do not work. Advisory groups such as the SGAC, the Secure World Foundation and others can be influential in informing industry representatives and politicians on STM issues. Informed citizens can form grassroot movements and bring awareness through dialogue with policy makers, in businesses and schools. Another form of diplomacy is Digital Diplomacy. STM proponents may reach out to influential politicians, entrepreneurs and opinion makers with large numbers of followers on Twitter, Facebook, Instagram and Snapchat and invite them to help make a buzz around space traffic management by using existing hashtags like #spacedebris or creating a new hashtag such as #STM. Finally, STM proponents can use the traditional media by using creative storytelling to capture the stakeholder’s attention on an emotional level.

Following excellent input by experts in the field (Kai-Uwe Schrogl, Marco Ferrazzani and Alexander Soucek), the Group established that an enforceable international agreement on STM needs to be put into place. Reaching an international agreement with legal enforcement mechanisms, potentially to be additionally implemented into domestic law by each signatory, is the second main recommendation I decided to pick up. Until STM is in place, irresponsible actors will undermine long-term progress for short-term technical solutions, deferring the problem unto future generations in a manner similar to climate change. This agreement should approach spaceflight as a comprehensive traffic regime similar to car, ship and aviation regulation but taking into account particular constraints which apply to the outer space environment. I already mentioned the Kessler syndrome and high velocities but we also have to bear in mind that space causes limited manoeuvring capabilities and it offers limited visibility on ongoing operations. We all agree on the fact that this agreement will have to determine which spacecraft/mission and zones will be subject to controls. We also thought that establishing mandatory pre-launch notifications was necessary to assess potential collision and other unfortunate consequences. A preliminary solution and inspiration might also be found in the success of the International Charter Space and Major Disasters (the Disaster Charter). Thanks to this Charter, agencies members share information to prevent environmental disasters. Since it was issued, it has been triggered more than two thousand times so this demonstrates that even in space, collaboration can be reached and that it can work in an effective manner. The Group argues that a global summit should be initiated by major spacefaring nations and key stakeholders (states and private entities) willing to reach an international regulatory agreement (e.g. model treaty) on STM. This could happen in the context of UNISPACE+50 and its High - Level Forums to give it a greater international audience and to highlight its openness to all.

The third and last recommendation is creating a global civil agency to ensure that this agreement is applied. This agency should gather all current space actors (both governmental and private) and push them to provide updated information on their spaceflight activities and share their Space Situational Awareness (SSA) data. The International Telecommunication Union (ITU) appears as a perfect model for the purpose of this establishment. The ITU is a specialised agency of the United Nations responsible for issues related to information and communications technologies. Since it was formed in 1865, it has been successfully coordinating the shared global use of the radio spectrum and assigning satellite orbits. For the common funding, the Group proposed several solutions. One of them was setting up a deposit system in order to incentivize deorbit. This deposit could be returned to space actors as soon as they successfully comply with deorbit regulations. It was generally agreed that this funding should be proportionate to Member States resources and their space activities. Besides, it can be adjusted downwards depending on the level of members' involvement in sharing information related to Space Situational Awareness data.

## Conclusion

Space Traffic Management is one of these topics that does not warrant for short-term solutions but needs the collective effort of all participants in the space sector which even includes you, dear reader.

*Total number of words: 2,479*

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