SAFETY AND SECURITY IN SPACE TRAFFIC MANAGEMENT REGULATIONS

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Abstract. The Space Traffic Management (STM) is a new concept referring to the space activities. The highest priority is safety and security of outer space and all conducted operations. There is no definition of STM. There is an urgent need to regulate STM providing safety and security regulations at international, regional and national level. Due to the fact that there is no STM definition, the regulator might use the example of existing regulations of International Civil Aviation Organization on Air Traffic Management (ATM). There are many questions, still open, regarding specific regulations needed and at which level they should be made: globally or nationally.
Keywords: space safety, security, Space Traffic Management, national legislation.

Introduction

The Space Traffic Management (STM) is a new concept referring to the space activities. The highest priority here is safety and security of outer space and all operations. There is no definition of STM. It seems that due to the growing congestion of outer space there is an urgent need to regulate it at international, regional and national level. The regulator might also use the example of existing regulations on Air Traffic Management (ATM). The open question could be what kind of regulations would be needed and at which level: international, regional or national.

The Air Traffic Management – history and role

The Air Traffic Management systems are used for the guidance, separation, coordination and control of the aircraft movements. Traffic control is a critical element in the safe and efficient operation of any transportation system. The first attempt to develop air traffic control rules was in 1919 when the International Commission

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on Air Navigation (ICAN)[2], as mile step for ICAO (International Civil Aviation Organization)[3], was created. Today, the Air Traffic Management ensures the safety, regularity and efficiency of the aviation transport system. ATM consists of ground and air parts. It is composed of a number of complementary systems: airspace management, air traffic flow and capacity management (ATFCM) and air traffic control (ATC). It comprises the interactions among the different elements, including human operators, procedures and the technical systems that all together form the air traffic management system. The services provided by the ATM are integrated, and it is through this integrity that the system properly functions. ATM generally affects three areas: (1) safety, (2) efficiency and (3) environmental mitigation.

Today, air traffic management services in national airspace are usually provided and supervised nationally, with international standardization and coordination provided by ICAO. ICAO is a leader in standardization and regulation of ATM in order to ensure that flying on international air routes is carried out under uniform conditions and is safe and orderly (Art. 28 of the Chicago Convention), ICAO Technical Annexes (Annex 2-Rules of Air and Annex 11 – Air Traffic Services).[4]

The current challenge is the following: how Air Traffic Management and navigation systems can be integrated globally in order to achieve a more unified system. Are there any challenges for the safety and security in ATM?[5]

ATM challenges

The problem of delimitation of the boundary between airspace and outer space raises questions as to the extent of the existing ATM system. The issue is far from finding a common solution and is subject to extensive legal debate within the UN-COPUOS[6] Legal Sub-Committee. It has been suggested that 100 km (the Karman line) is the beginning of outer space but this has never been fully accepted as this is, in effect, determining a national boundary. Therefore the area of applicability of the existing Air Traffic Management system is uncertain. For the area above "airspace" no legal requirements yet exist for a "Space Traffic Management" system (STM).[7]

The need to regulate STM

Unlike the situation in Aviation, there is no comprehensive and unified set of regulations for Space Traffic Management (STM). It should be noticed that there

[2] La Convention Internationale de la Navigation Aérienne, Paris 1919.
[3] ICAO Doc. 7300 Convention on International Air Navigation, Chicago 1944.
[4] ICAO Doc. Annex 2 and Annex 11.
[5] S. Kaltenhäuser, F. Morlang, J. Hampe, D.-R. Schmitt, *Air Traffic Management and Space Transportation System Wide Information Management and Integration into European Airspace*, 2015.
[6] UNCOPUOS – The Committee on the Peaceful Uses of Outer Space (http://www.unoosa.org/oosa/en/ourwork/copuos/index.html)
[7] M. Griffin, *Integration of Aerospace Operations into the Global Air Traffic Management System*, 2014.

is no one definition of STM. Thus Space Traffic Coordination (STC) is what is actually required. It is unclear how or under what authority any entity could manage/control space traffic. It is more likely that an entity could help to facilitate the coordination between operators. The concept of STM is of intense interest today, primarily due to the increase in space population and the ever-increasing quantity and complexity of space actors (both states and companies). There are continual and substantive collision risks in both LEO[8] and GEO[9] orbit regimes. Moreover, "mitigation of this risk requires satellite operators, space object tracking entities and flight dynamicists to be ever vigilant and expend considerable resources and attention to ensure safe and efficient use of space for current and future generations".[10]

There are different phases of a space flight which all need STM in order to ensure safety and orderly flow of traffic, both for spacecraft and aircraft. These phases include the launch, in-orbit and reentry phases. The question arising refers to the necessity of the STM regulations? The problematic issue is that the potential interference of launching objects with Air Traffic is unavoidable. Spacecraft's cannot reach outer space and return to earth except through the same airspace that aircrafts are using. Thus this physical interference of air flights and space flights needs to be handled by an effective traffic management system so that the safety of both aircraft and space objects is not jeopardized. There are high risks of collision between operating and non-operating objects in orbit and creation of more space debris. There is a need to guarantee the safety and sustainability of space while the space objects are in outer space. The most complete research conducted in regard to STM is reflected in a report called the Cosmic Study on Space Traffic Management of 2006, which was prepared by the International Academy of Astronautics (IAA) study group. This report 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 or radio-frequency interference." Another proposed definition is that "Space Traffic Management includes actions related to the oversight, coordination, regulation and promotion of space activities (including preservation of the space environment) at several distinct phases of the mission – launch, operations in space and return from space.

Space debris

There is a list of collisions in outer space producing debris (e.g. Cosmos 2251 and Iridium 33 in 2009; in this case, two satellites produced more than 1,600 pieces of debris). This can jeopardize safety and national security. International and regional efforts in space debris are the following: Space Debris Mitigation Guidelines

[8] LEO – Low Earth Orbit.
[9] GEO – Geostationary Orbit.
[10] D.L. Oltrogge, *The "We" Approach to Space Traffic Management*, 2018 SpaceOps Conference, https://arc.aiaa.org/doi/10.2514/6.2018-2668.

as developed by UN COPUOS (UN resolution (62/217 in 2008) or Inter-Agency Space Debris Coordination Committee – IADC (international governmental forum for the worldwide coordination of activities related to the issues of man-made and natural debris in space). The primary purposes of the IADC are to exchange information on space debris research activities between member space agencies, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options. The IADC serves a valuable function in suggesting and coordinating national research on space debris, mitigation and related topics. A key product of the IADC is its IADC Guidelines[11], which are non-binding guidelines for approaches to avoid creating space debris in both current and future space activities.[12] There are some ideas about founding the proper international fora for ATM. One of them is UN COPUOS, the others: ITU (International Telecommunication Union)[13] or ICAO. There is finally the third option with creating a new organization, such as International Space Management Organization. There is also an idea to bring STM activities into national activities level. Some states with strong policy on space, such as the US, in its strategies mentioned about STM.

Suborbital flights

The ATM and STM challenge is also the suborbital flights issue[14]. Commercial aerospace operations are a reality (as RPAS; delays in providing a global framework for them resulted in an extremely fragmented system). As technology has advanced the concept of different types of space launch vehicles other than the traditional rocket launch system are being exploited which are likely to lead to significantly reduced launch costs. These concepts include launches from "mother" aircraft (Swiss Space System S3), high altitude launch station (Dark Sky) and "traditional operations" from airports (Rocketplane US) / the questions of spaceports capabilities arise. If the sub-orbital aerospace industry is to grow, segregated operations cannot be the long term solution. However, to integrate into the existing ATM system will require the development of a new regulatory, operational and technical framework. This must ensure not only the safety of the sub-orbital passengers but also of the other users of the ATM system. No legal requirements exist for management of space traffic.[15]

[11] https://www.iadc-online.org/index.cgi?item=docs_pub

[12] https://www.iadc-online.org/; D.L. Oltrogge, *The "We" Approach to Space Traffic Management*, 2018 SpaceOps Conference, https://arc.aiaa.org/doi/10.2514/6.2018-2668.

[13] www.itu.int

[14] A/AC.105/C.2/2018/CRP.9, 29 March 2018, Suborbital flights and the delimitation of air space vis-à-vis outer space: functionalism, spatialism and state sovereignty a Submission by the Space Safety Law & Regulation Committee of the International Association for the Advancement of Space Safety Prepared by: P.S. Dempsey and M. Manoli.

[15] M. Polkowska, *Sub-orbital traffic: A new regulatory or non-regulatory discipline*, [in:] ed. J. Walulik, *Harmonising Regulatory and Antitrust Regimes for International Air Transport*, p. 189, Routledge 2018.

There are no global regulations relating to traffic management between aircraft and space flights. In some national space legislation there exist some procedures ensuring (as far as practical) safe operations of space activities and separation assurance. However they were not developed for providing an integrated Air Traffic Management system. There is no definition of suborbital operations, legal constraints (if there is a Sub-orbital airplane operations, deriving support from the atmosphere for the largest part of their flight, are considered as aircraft therefore the legal framework of ICAO also applies to these vehicles). Sub-orbital safety standards will be expected to have no negative impact on the safety of other aircraft. Passengers on board the Sub-orbital vehicle will increasingly demand higher standards of safety than is presently proved. Target levels of safety will need to be established for Sub-orbital operations. Is there any idea of a separate traffic management system specifically for suborbital flights?

There are some negative aspects: different traffic management systems for these giant flying birds might endanger safety, the most important concern of the regulators of air and space activities. Suborbital vehicles share the airspace with aircraft and spacecraft, and it is therefore important to consider the notion of 'integrity' while regulating the traffic management aspects of different types of flying vehicles so as to prevent collisions and ensure the optimum use of airspace. The best scenario – one integrated traffic management system that would render services for all types of aircraft, spacecraft and suborbital vehicles at all altitudes. However, bearing in mind all the legal hurdles in the existing international legal frameworks of air and space, as well as the technical complications, this might be too optimistic, at least in the near future. ICAO and its Learning group of Suborbital flights can achieve the most in legislation (step by step) having much experience with ATM (annexes). The group cooperates with UNOOSA[16]; an idea of creating a new technical annex or amending the existing ones.[17]

STM in national legislation

Due to the fact that the space activities are growing and international existing rules are not updated, there is a need to create the national legislation referred to the space activities. In all the safety and security regulations are provided. National law is generally easier to amend than international law[18]. Definitions may be included in national law which are lacking in international law. It is also characteristic of the case law of the European Court of Justice (ECJ) which, in one of its documents[19]

[16] UNOOSA – the United Nations Office for Outer Space Affairs; www.unoosa.org

[17] T. Cheney & L. Napier, Journal of Science Policy & Governance Policy Memorandum: Air Versus Space, *Policy Analysis: Air versus Space, Where do Suborbital Flights Fit Into International Regulation?* JSPG, Vol. 7, Issue 1, August 2015; Seyedeh Mahboubeh Mousavi Sameh, *Suborbital Flights: Selected Legal Issues*, IASL, McGill, 2013.

[18] K. Kocel, *Institutional and legal framework of Poland's space activities*, [in:] Ch. Brünner, E. Walter, *National Space Law (development in Europe – challenges for small countries)*, Böhlan 2008, p. 129-132.

[19] ECJ, Analir and others, C-205/99, 20 II 2001.

on the interpretation of Articles 1, 2 and 4 of Council Regulation No 3577/1992 of 7 December 1992[20], recognized, inter alia, that the possibility of applying restrictive national law exists only when it is justified by urgent needs in the general interest. This ruling can therefore be used as a basis for either opening the way for national space regulations in the absence of such regulations at international level or, conversely, for assuming that, in the absence of treaty regulations, the activities of operators in the space market are not restricted in any way[21]. Many authors point to the urgent need for national space legislation, especially in view of the privatization of the telecommunications sector. The following factors may be taken into account when legislating is a system of private licensing for space activities; general requirements concerning, on the one hand, the facilitation of private licensing while, on the other hand, maintaining the principle of State interest (national and international), the liability issues, include the obligation to take out insurance and other financial guarantees.[22]

In 2001, the so-called Cologne Project on National Space Legislation (Project 2001 Working Group on National Space Legislation) demonstrated the need for harmonization of space regulations and for equal and fair rights for space actors. National legislations of states vary depending on the policy pursued by the state, its wealth, and access to technology, geographical location, security and environmental concerns. The draft, while pointing out the need to harmonize the rules of international law, inter alia as regards the principles of liability, attaches greater importance to national law.[23]

International treaties do not provide guidance on how states should implement their rules. When rules are directly applicable, a country may extend a rule and clarify it by national legislation. States should establish a legal framework for space activities, including those carried out by private entities; national rules should contain standards for registration and licensing rules.[24] Many authors point out that existing space conventions lack adequate provisions adapted to the current needs of space activities. This is due to the reluctance of richer countries, whose practice has become accustomed to doing what they want. The proposals are different:

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[20] Council Regulation (EEC) No 3577/92 of 7 December 1992 applying the principle of freedom to provide services to maritime transport within Member States (maritime cabotage). Official Journal L 364, 12/12/1992, p. 000-0010.

[21] L. Rapp, *When France puts its own stamp on The Space Law Landscape…*, op. cit., p. 90.

[22] F.G. von der Dunk, *Implementing the United Nations outer space treaties…*, op. cit., p. 139-144; M. Koster, *Legal problems related to a combined use of airspace by air- and spacecraft*, [w:] *Space law – general principles…*, op. cit., t. I, p. 454-457.

[23] S. Hobe, J.K. Hettling, *Challenges to space law in the 21st Century – Project 2001 plus*, Proceeding of the forty fifth colloquium on the law of outer space, International Institute of Space Law of the International Astronautical Federation, 10-19 X 2002, Houston, Texas; S. Hobe, Project 2001 *Plus…*, op. cit., p. 327-334; K.-H. Böckstiegel, *Project 2001 – final report conclusions*, [w:] K.-H. Böckstiegel, *„Project 2001" – Legal framework for the commercial use of outer space, recommendations and conclusions to develop the present state of the law*, Köln 2002, *Space law – general principles…*, op. cit., t. I, p. 609-617; M. Koster, *Legal problems related to a combined use…*, op. cit., p. 454; J. Hermida, *Legal basis…*, op. cit., p. 173-183.

[24] E. Gouesse, *Responsibility in International Law for Commercial Space Activities*, IASL McGill, Montreal 2000, p. 127-128.

do nothing and rely on natural mechanisms, or establish specific standards and an international regime.[25]

The only way out of the lack of international rules is through national legislation. A stable legal environment will help to recoup economic costs and increase confidence in potential investors. National legislation can liberalize legislation to maximize the benefits of space exploration.

It is worth noting the activities of European Space Agency (ESA) and the European Union (EU), whose extensive space legislation, especially in the areas of telecommunications and data protection, unifies the European market. Undoubtedly, in most of the presented space legislation (usually in the form of laws, constitutions, decrees and the like), space bodies have been established. There are agencies that have more or less extensive competences. Comparing the legislation in the world with that in Europe, one can see liberalizing tendencies (most visible in the telecommunications sector); in defense matters, states always retain their sovereignty.

The commercial activity of the state in space has also evolved; hence much internal legislation increasingly encourages the private sector (domestic and foreign) to invest in space activities. States are therefore trying, as the USA has done, to enable space operators to carry out their activities without unnecessary administrative barriers. However, in spite of these activities, space activities have still not been included in a separate space regulation in most countries (including Poland). This is, of course, linked to the scale of use of airspace and space. Even though there is no special regulation referring to STM, but all regulations may be useful in traffic management area as well.

STM policy

As was seen above, the special STM regulations are still missing. There are also calls for an internationally-accepted space traffic management (STM) regime. At present, there is no overarching international STM regime that seamlessly incorporates launch, reentry, and on-orbit activities, and many nations are still independently developing their own standards for these processes. This has also led to questions as to whether private space entities globally are being provided continuing supervision in accordance with international treaty obligations, in particular Article VI of the 1967 Outer Space Treaty.

Given the world's growing dependence on space for critical national security, economic and societal services, and infrastructure (and the resultant growing vulnerabilities to any disruptions), there is mounting concern globally to ensure

[25] T.C. Brisibe, M.E. Davis, *The regulation of commercial space launches: the differences between the national systems*, Proceeding of the forty fourth colloquium on the law of outer space, International Institute of Space Law of the International Astronautical Federation, 1-5 X 2001, Toulouse, France, p. 43-48; C. Guillotte, *Nouvelles perspectives pour le droit de l'espace*, IASL McGill, Montreal 2003.

that space assets perform as planned. Additionally, capabilities to track objects in space have not grown at the same rate as the increased use of space. Accurate and precise awareness of the location of satellites and spacecraft and the environment around them, as well as ensuring radiofrequency interference-free operation, are key components of this interest. There is also growing agreement in the SSA community that data sharing alone across countries and organizations is not enough, and there is a need to collaborate to ensure the safety and sustainability of space activities (for example, ensuring that there is no radiofrequency interference across satellites, or that objects move out of each other's way if there is risk of collision) that is both domestically and internationally coordinated.[26]

SMT can be also regulated at national level. The only example is in the US. There is a national legislation on STM (e.g. US concept of the Space and Air Traffic Management System (SATMS). It represents, according "a conceptual "aerospace" environment in which space and aviation operations are seamless and fully integrated in a modernized, efficient National Airspace System (NAS)." In June 2018 the US President Donald Trump signed the Space Policy Directive 3 about monitoring objects in orbit and sharing the information so spacecraft can avoid collisions. Space Policy Directive – 3 provides guidelines and direction to ensure that the United States is a leader in providing a safe and secure environment as commercial and civil space traffic increases. As space becomes increasingly contested, the demand for the Department of Defense to focus on protecting U.S. space assets and interests also increases (security). At the same time, the rapid commercialization of space requires a traffic management framework that protects U.S. interests and considers the private sector's needs (safety). The new Directive seeks to reduce the growing threat of orbital debris to the common interest of all nations. According to this directive, the United States should continue to provide basic Space Situational Awareness (SSA) data and basic STM services free of direct user fees. According to the Directive, STM shall mean the planning, coordination, and on-orbit synchronization of activities to enhance the safety, stability, and sustainability of operations in the space environment. The United States recognizes that spaceflight safety is a global challenge and will continue to encourage safe and responsible behavior in space while emphasizing the need for international transparency and STM data sharing. Through this national policy for STM and other national space strategies and policies, the United States will enhance safety and ensure continued leadership, preeminence, and freedom of action in space[27].

[26] B. Lal, A. Balakrishnan, B.M. Caldwell, R.S. Buenconsejo, S.A. Carioscia, *Global Trends in Space Situational Awareness (SSA) and Space Traffic Management (STM)*, Science and Technology Policy Institute, April 2018, IDA Document D-9074, p. 1-81.

[27] The Daily Journal of the United States, Government Presidential Document, National Space Traffic Management Policy. A Presidential Document by the Executive Office of the President on 06/21/2018; Remarks of Richard H. Buenneke, U.S. Department of State Panel on "Balancing national security and economic security in a contested and congested space domain", "Greater Security Through International Space Collaboration" Seminar George Washington University Space Policy Institute The Aerospace Corporation's Center for Space Policy & Strategy, July 19, 2018.

The US STM policy aims to tackle a number of security challenges related to the expected boom in space traffic, especially related to the deployment of mega-constellations and of non-manoeuvrable spacecraft e.g. cubeSats. STM can be characterized by the development of a normative approach through best practices, technical standards, pre-launch risk assessments and on-orbit collision avoidance services. STM involves the supervision of a complex chain of information/data to support operational decision making. Development of STM raises the following issues, such as SSA data enhancement, SSA data policy and specification of STM best practices and norms.[28]

It seems there is a need to reinforce the US-EU cooperation from SST to STM. There is a need to recognize the severity of issues at stake and the urgency of setting up a framework to prevent and mitigate space security threats. Is certain that future space operations number will be increased; the same will be with the number of space objects. So it's sure that the current and limited traffic management activity and architecture will become inadequate. The objective of the task should be to develop a new approach to space traffic management that addresses current and future operational risks. It can be done only in the situation of clear political willingness to accelerate activities through national engagements. The challenges are the following: limited progress at international level, besides the policy does not necessarily challenge the relevance of multilateral efforts in space security. As it was said before, Space Policy Directive 3 calls for reorganization of responsibilities across military and civil branches, top-down approach to SSA data sharing, SSA data enhancement (to reach the appropriate accuracy required to safely plan, coordinate, and synchronize in-orbit activities and mitigate collision risks), SSA data policy (to set up appropriate information management structures (collection, fusion, distribution) safeguarding data integrity, reliance and confidentiality and for specification of STM best practices and norms (to enhance the safety, stability, and sustainability of operations in the space environment across different stakeholders (military, civil, commercial). STM seems to progress from informative to normative STM (specification of norms of behavior encompassing preventive, operative, and curative measures across the lifecycle of space systems (best practices, standards, regulations). There is an urgent need of coordination at international level of multiple, possibly divergent, regional/national approaches to STM. As some observers noted there is a need to prepare a European approach to Space Traffic Management by setting up a dedicated forum to coordinate the views, needs and possible contributions of European stakeholders.[29] Transatlantic cooperation between US and EU can bring a lot of benefits in this case.

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[28] ESPI report in collaboration with the Space Policy Institute, Security in Outer Space: perspectives on transatlantic relations, report 66, October 2018, p. 58-60.

[29] S. Moranta, *Towards a reinforced transatlantic cooperation: from SST to STM, presentation at the conference Space security in the 2020's: Transatlantic Perspectives*, IFRI (Institut Français des Relations Internationales) conference, 27th of November 2018.

Code of Conduct for Space

The Code of Conduct was initiated by the American Stimson Centre. The Code was named "Rules of the Road" and dealt with internationally agreed space operations. The most important elements of the Code include the following principles: collision avoidance the prevention of space debris, the exchange of information and consultation on space activities which could give rise to debris, the coordination of spectrum use and the allocation of orbital slots, as well as STM (Space Traffic Management). Discussions and consultations on the Code have not been finalised and the European Union has taken over the role of mediator.[30]

The opposition of the US to treaty solutions has made the idea of a code more and more important. The Code was intended to be a non-binding legal instrument – where acceding countries voluntarily agreed to certain rules of conduct. Moreover, the Code, as a soft law, is easier to agree on and avoid lengthy discussions on definitions and sends an important signal to political processes, both at home and abroad. But there is also a risk that such codes will divert attention from efforts to conclude international agreements.

In December 2008 The Council of the EU formally presented a draft space code. The Code, which was created at the initiative of the European Union, is an international instrument which is binding on States which accede to it on a voluntary basis (with the exception of standards which are codified and which are of a customary nature – they are applied even by States which are not signatories to the Code). The Code is open only to States and applies to their activities in the framework of intergovernmental organisations.

The Code applies to both military and civil aspects of the operation: security and safety. The Code can bring practical benefits to space safety and influence civil operations in space. The regulatory issues of the Code, including defence issues, are an integral part of the European Space Policy and are being implemented. The aim of the Code is for future states operating in space to be responsible for its implementation and application to their own activities. The Code does not give the EU any specific role or responsibility.

The objectives of the Code are twofold. On the one hand, it helps to strengthen existing treaties, principles and other arrangements, to encourage countries to join these initiatives, to implement their provisions and to promote their universality. On the other hand, it complements the UN treaty system by codifying good practices in space operations, including notifications and consultations. This will strengthen trust and transparency between states and contribute to the development of activities in the space.[31]

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[30] Draft International Code of conduct for Outer Space Activities, version 31 March 2014, p. 1-13; https://eeas.europa.eu (16.11.2017).

[31] M. Polkowska, *Prawo bezpieczeństwa w Kosmosie*, Warszawa 2018, p. 173-176; N. Hedman, *Space safety, security, sustainability at the global level*, IFRI conference "Space security in the 2020's: transatlantic perspectives", 27th of November 2018.

STM in Europe

STM is important for Single European Sky. Europe is very interested in satellite communications, so they invest a lot for governments and institutions. There is a great interest in Europe to provide secure, reliable satellite communications at much lower prices than for military satellites. One of the key areas of concern is resilience and reliability. Hence space traffic management is very important. There is an urgent need to create a code of conduct establishing common standards for behavior, based firmly upon empirical data and evidence, which will help satellite operators avoid misunderstandings, conform to safety constraints and anticipate and practice procedures for dealing with normal and emergency situations. Establishment of a body or organization responsible for monitoring, oversight, coordination, and enforcement (including incident management) will benefit design and operation of a successful and sustainable space traffic management system. This body must incorporate the concerns of the affected parties while balancing the need for effective control as policies and procedures are developed. A space traffic management program could involve a large number of agencies, companies, universities, and technologies. The efficient and secure sharing of information amongst this group will be vital for managing traffic in a congested space. As such, a communication strategy that includes policies and procedures for who to contact, when to initiate, how to format, how to assess and assign urgency, and expected responses will be required. In addition, communications have to be secure and reliable.[32]

For STM the Space Situational Awareness is important. SSA in Europe consists of three separate segments: SST (Space Surveillance Tracking), especially in the context of Space Debris, Space Weather and Near Earth Orbit (NEO) observation. Participants in European Space Agency (ESA) SSA programs are 19 participating states. The European SSA system has dual-use civilian and military applications. Additional components to the SSA system may be added in the near future. They are built on the basis of military requirements and compiled by the European Defense Agency (EDA). The good progress in the development of a SSA system in Europe with many actors: Member States, ESA, EU may be observed. There are still some challenges of European SSA referring to the development and exploitation.

Ensuring security in space requires a variety of measures targeted to: monitor the space environment, mitigate threats to space infrastructure, and reduce vulnerability of space infrastructure. According to ESPI report from 2018

SSA encompasses all means and measures to monitor, detect, predict and inform about man-made and natural, intentional and unintentional, threats to operations in space (i.e. threats originating from the space environment).

[32] R. Heron, *Security in Outer Space: Rising Stakes for Civilian Space Programs*; https://www.federalregister.gov/documents/2018/06/21/2018-13521/national-space-traffic-management-policy; The Daily Journal of the United States Government Presidential Document: National Space Traffic Management Policy – A Presidential Document by the Executive Office of the President on 06/21/2018.

The introduction of a SSA component within the EU space programme with a dedicated budget (corresponding to a share of the 500M€ allocated to GOVSATCOM/SSA) represents a substantial step towards a more ambitious and integrated capacity-building effort. This new SSA component will build on past activities in the field of SST[33] and in the fields of Space Weather and NEOs. The SST component shall, now, "support the establishment, development and operation of a network of ground- and/or space-based sensors of the Member States, including sensors developed through ESA and EU sensors nationally operated".

Space Data Association

In next generation of STM systems and capabilities data sharing is a priority. Formed in 2009, the Space Data Association (SDA)[34] is a formal, non-profit association of civil, commercial and military spacecraft operators that support the controlled, reliable and efficient sharing of data that is critical to the safety and integrity of satellite operations. SDA has a legal structure and agreements that provide protections and enforcement mechanisms to ensure data is only used for intended purposes, The Space Data Association relies on the Space Data Center (SDC) developed and operated by the technology partner AGI, for flight safety data exchange and processing. The objectives are: to promote responsible behaviors from operators in all orbital domains to ensure the protection of key assets and the space environment, to provide members with a system (SDC) to enhance safety of flight, to improve the accuracy of collision avoidance predictions, to take advantage of other opportunities for data sharing. SDA is uniquely positioned to provide inputs in discussions on future STM. The SDA members have been studying the requirements for the next generation STM systems. The highlighted limitation clearly demonstrates the need to have new capabilities to ensure the long term protection of the space environment and provide actionable operational products. Working with all stakeholders: governments, agencies, operators and industry are extremely important.[35]

STM next steps

Based on the above experiences, the STM problem needs to be approached in "holistic way", as a system-of systems that incorporates contributions and participation from all spacefaring nations, entities (governmental, commercial,

[33] EU (European Union), Decision No 541/2014/EU of the European Parliament and of the Council of 16 April 2014 establishing a Framework for Space Surveillance and Tracking Support, "L 158/227, 2014; EC (European Commission)", "Report from the Commission to the European Parliament and the Council on the implementation of the Space Surveillance and Tracking (SST) support framework (2014-2017)", COM (2018) 256 final, 3.5.2018, 2018.

[34] https://www.space-data.org/sda/

[35] M. Dickinson, *Future STM capabilities*, ESPI conference, September 2018.

academic etc.), vehicle types (satellites, launch, hypersonic, sub-orbital). Founding principles of a better framework are: no single organization has best data on everything; the STM system must collect and process authoritative data to obtain the best result, this collected data needs to be "normalized" and quality-controlled inside. The STM system should be compatible with both internal data and data collected from other sources. Biases in tracking observations and satellite operations must be identified and removed. STM must cover all phases of flight, to include orbital operations, suborbital flight, hypersonic, launch/ascent and end-of-life deorbit/reentry/descent. Recognizing that classified operators cannot directly participate, the ideal candidate STM system should forward all sharable operator and SSA data to the classified communities, in the hope that that data would be used to exercise due diligence and prevent collision with classified objects.[36]

Conclusion

ATM and STM have some common ground. They refer to safety and security of navigation. ATM and STM refer to measures taken to minimize or mitigate the negative impacts of the increasing physical congestion in air and space.

As the number of active satellites and amount of space debris in space increases, particularly in highly used orbits and altitudes, physical congestion has become a growing problem. To date, there have been several confirmed, unintentional collisions between a functional satellite and another space object that have either damaged the satellite or completely destroyed both objects and created thousands of new pieces of space debris, which may jeopardize the aircrafts safety.

The goal of STM is to try to eliminate future collisions and other incidents in space that could create additional debris or other safety risks for space activities, and to increase the safety and efficiency of space activities. Space Situational Awareness (SSA) is an important element of STM. SSA refers to the ability to characterize the space environment and activities in space. A key component of SSA is using ground- or space-based sensors, such as radars or optical telescopes, to track space objects. The tracking data from multiple sensors is combined to estimate orbits for space objects and predictions of their trajectories in the future.

There is a need from government side to consider national legislation in which they can determine where outer space legally begins, in the absence of an international definition. Likewise, a space start-up should be aware of the different regimes of air and space law, and the lack of international legal certainty between them.

While some states currently engage in practices that could be considered to be part of STM, there currently is no widespread state practice or established international regime. There have also been international political initiatives to discuss voluntary guidelines or norms for improving the safety and sustain-

[36] D.L. Oltrogge, *The "We" Approach to Space Traffic Management…*

ability of space activities, and studies to examine the interactions between space and air traffic and possible safety concerns. There is ongoing debate over whether an international STM regime should begin internally or at international level (as a multilateral treaty).

Some have also made comparisons between STM and Air Traffic Management, and called for a new treaty to establish an international body that would set standards for STM and be similar to the function of the International Civil Aviation Organization (ICAO) for Air Traffic Management. However, ICAO was created to resolve differences between previously existing national airspace regulations. Furthermore, the air traffic standards that are set by ICAO require implementation by national regulative and administrative bodies, which many states don't' have for space activities. As a result, others are pushing for major spacefaring states to establish national STM regimes that may evolve into an international regime in the future.[37]

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BEZPIECZEŃSTWO W PRZEPISACH REGULUJĄCYCH ZARZĄDZANIE RUCHEM KOSMICZNYM

Streszczenie. Zarządzanie ruchem kosmicznym to nowe pojęcie odnoszące się do działań kosmicznych. Dużą rolę przywiązuje się w nim do zasad bezpieczeństwa podejmowanej w przestrzeni kosmicznej działalności operacyjnej. Z uwagi na zwiększającą się aktywność państw w Kosmosie i coraz więcej obiektów tam umieszczanych, ważne jest, aby uregulować zasady korzystania z przestrzeni kosmicznej, na zasadzie analogii do zarządzania ruchem lotniczym w przestrzeni powietrznej państw. Artykuł podejmuje ten problem i rozważa się w nim m.in. kwestie dotyczące regulacji na szczeblu międzynarodowym, europejskim i krajowym. Można tu skorzystać z rozwiązań aneksów do konwencji chicagowskiej z 1944 r. i doświadczeń Organizacji Międzynarodowego Lotnictwa Cywilnego w tym zakresie.
Słowa kluczowe: bezpieczeństwo kosmiczne, ochrona w Kosmosie, zarządzanie ruchem kosmicznym, narodowa legislacja.