LEGAL ASPECTS OF INTERNATIONAL REGIME FOR SPACE TRAFFIC MANAGEMENT

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The views expressed in this thesis are solely those of the author in his personal capacity, and do not in any way represent those of the organization to which the author belongs or any other entity of the Japanese Government.

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ABSTRACT

The current "congested, contested, and competing" situation of outer space increases collision risks in space operations. The efforts of technology development to solve this situation have been well-developed, but regulatory issues still remain as challenges. Namely, the UN space treaties are not well-implemented into national legislation, the political will for new international legislation is consistently lacking, and the well-developed soft laws remain too abstract to resolve the problem. Hence, this thesis proposes to establish a new international regime for Space Traffic Management (STM), with a demonstration of its admissibility within the current international legal regime. Today, several initiatives show existing trajectory in the international community that can gradually turn the STM regime into reality. The core proposal is the establishment of the Space Traffic Rules, with a parallel thought of the Air Traffic Rules, and fair regulation for Space Situational Awareness data sharing. This thesis also discusses the problems of the current international space law in terms of re-capturing it into the context of STM: involving the delimitation of outer space, the scope of the definition of space objects, and the space responsibility and liability.

RÉSUMÉ

Un espace extra-atmosphérique congestionné, concurrentiel et en proie à des différends, tel qu'il est actuellement, augmente les risques de collision lors des opérations spatiales. Les efforts de développement technologique pour remédier à cette situation ont connu une belle progression, mais des problèmes de réglementation restent à résoudre. Ainsi, les traités des Nations Unies relatifs à l'espace ne sont pas correctement retranscrits en droit interne, la volonté politique d'élaborer de nouveaux traités est inexistante, et les mesures non-contraignantes appropriées demeurent trop abstraites pour solutionner les problèmes. Par conséquent, ce mémoire propose de créer un nouveau régime international pour la gestion du trafic spatial [STM (*Space Traffic Management*)], en démontrant sa faisabilité dans le cadre du régime juridique international actuel. À ce jour, plusieurs initiatives, nées au sein de la communauté internationale, indiquent la voie qui pourrait progressivement transformer le régime de STM en réalité. La principale proposition porte sur la mise en place d'une règlementation du trafic spatial, faisant écho à celle du trafic aérien, ainsi que sur des règles équitables régissant le partage de données de SSA. Ce mémoire traite également les problèmes actuels du droit spatial international et la manière de promouvoir celui-ci dans le cadre de la STM, s'agissant notamment de la délimitation de l'espace extra-atmosphérique, de la définition des objets spatiaux, et de la responsabilité des États.

ACRONYMS

ASAT	Anti-Satellite (weapon)
ATM	Air Traffic Management
ATS	Air Traffic Services
ESA	European Space Agency
EU	European Union
CD	Conference on Disarmament
CSLA	Commercial Space Launch Act (US)
CSM	Conjunction Summary Message
FAA	Federal Aviation Administration
FIR	Flight Information Region
FSOA	French Space Operations Act
GEO	Geostationary Earth Orbit
GGE	Group of Governmental Experts
IAA	International Academy of Astronautics
IADC	Inter-Agency Space Debris Coordination Committee
ICAO	International Civil Aviation Organization
ICJ	International Court of Justice
IMO	International Maritime Organization
ISON	International Scientific Optical Network
ISS	International Space Station
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
JSPOC	Joint Space Operation Center
ICOC	International Code of Conduct for Space Activities
LEO	Low Earth Orbit
LSC	Legal Subcommittee
LTSSA	Long-term Sustainability of Outer Space Activities
MTM	Maritime Traffic Management
NASA	National Aeronautics and Space Administration

SARPs	International Standards and Recommended Practices
SSA	Space Situational Awareness
SDA	Space Data Association Limited
SSN	Space Surveillance Network
STM	Space Traffic Management
STSC	Scientific and Technical Subcommittee
TCBM	Transparency and Confidence Building Measures
TT&C	Telecommunication, Tracking and Command
UNCLOS	United Nations Convention on the Law of the Sea
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNGA	United Nations General Assembly
UNOOSA	United Nations Office of Outer Space Affairs
USSTRATCOM	United States Strategic Command
VTS	Vessel Traffic Services

Chapter 1
Introduction

Transportation has always been part of the dreams and dynamic powers in the history of human beings. All roads led to Rome in the Roman Empire, the development of modern America was connected to the construction of railroads,[1] and aviation revolutionary changed economic circumstances.[2] Transportation to space started with the first launch of Sputnik in 1957 under the space race of the United States (US) and the former Soviet Union. During the last couple of decades, usable orbits within outer space have become congested by the increase of space activities and the domination policies by sovereign States over outer space. The increasing number of space actors raised the amount of space vehicles, as well as space debris.[3] Calculations show that the amount of space debris large enough to affect satellite missions in usable orbits includes more than one hundred million pieces. The anti-satellite (ASAT) weapon test conducted by China in 2007 heavily impacted space security as well as its environment, and was an example of the non-transparent nature of Chinese space policy.[4] The first collision between large satellites, which occurred in 2009, also generated similar amounts of space debris.[5] The scientific scenario known as Kessler Syndrome illustrates how possible space debris growth is generated as fragments from random collisions rapidly create additional hazards. Based on the current volume of space debris, the catastrophic reality of unusable space could become real in a couple of decades if we do not start reducing space debris and controlling space

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[1] Paul Stephen Dempsey & Laurence E. Gesell, *Public Policy and the Regulation of Commercial Aviation* (Chandler: Coast Aire Publications, 2013) at 131-172.
[2] *Ibid* at 48-63.
[3] Cesar Jaramillo, ed, *Space Security Index 2013*, 10th ed (Waterloo, Canada: Project Ploughshares, 2013) at 23-30.
[4] "Concern over China's missile test", *BBC News* (19 January 2007) online: BBC News <http://news.bbc.co.uk>.
[5] "Russian and US Satellites Collide", *BBC News* (12 February 2009) online: BBC News <http://news.bbc.co.uk>.

activities.[6] In other words, we have almost reached the critical limit for the sustainable development of outer space. The status of laws governing outer space, however, remains at its original inception in the 1960s and 1970s when the UN space treaties were adopted. The international community is attempting to supplement the old system by adopting various "soft laws". However, to date, there is no single rule with a binding legal obligation to regulate the movement of objects in outer space.

The purpose of this thesis is to propose a consolidated set of rules for the establishment of an appropriate and practical space traffic management international regime.[7] The concept of Space Traffic Management (STM) was first proposed by American Institute of Aeronautics and Astronautics in the early 1990s, and formalized in a report by International Academy of Astronautics (IAA) in 2006.[8] Although the report mainly showed technical necessity and feasibility, the whole proposal also introduced a new regulatory perspective as a necessity of STM regarding current space activities. Following the IAA STM Report and previous relevant studies, this thesis will further describe the legal aspects and tackle some potential legal challenges behind the implementation of STM. As a result, it will lead the way for a new regulatory regime, and hopefully provide solution to the current contested and congested nature of space activities.[9]

This thesis will use a theoretical approach and a comparative approach. The theoretical approach involves developing the form of the STM regulatory regime as a legal theory and obligation. This would include theoretical discussions of current concepts of international

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[6] Donald J. Kessler & Burton G. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt" (1978) 83:A6 Journal of Geophysical Research: Space Physics 2637.

[7] International regime is defined as "a set of implicit or explicit principles, norms, rules and decision-making procedures around which actors' expectations converge in a given area of international relations": Stephen D. Krasner, *International Regimes* (Ithaca: Cornell University Press, 1983) at 2.

[8] Kai-Uwe Schrogl, Petr Lála & Corinne Contant-Jorgenson, *Cosmic Study on Space Traffic Management* (Paris: International Academy of Astronautics (IAA), 2006) [Schrogl, Lála & Contant-Jorgenson, "IAA STM Report"].

[9] For defining STM, this thesis uses the definition of the IAA STM Report: "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." (*Ibid* at 10.).

space law, the establishment of the legal regulatory regime of STM, and the addressing of potential legal challenges to the implementation and use of STM. The comparative approach involves comparing and contrasting similar regimes of traffic management used today in other fields, such as maritime and aviation. The most affordable and practical system used today is Air Traffic Management (ATM) over aviation: therefore, a comparison of potential STM regime and the existing ATM regime will be conducted.

In the last half-century's history of space activities, the configurations of these activities have changed and new issues have actualized while technology developed. Currently, outer space is becoming increasingly "congested, contested, and competitive".[10] By a concrete description of these three circumstances of outer space, the remaining pages of this chapter will illustrate the actual problems lying in the current circumstances of space operations for illuminating the exacerbating practical problems of space operations. This description will also serve to provide an overview of actual space activities as a subject matter of the topic throughout this thesis.

In the early 21st Century, human beings experienced several major events regarding space activities. Most of them, especially the collision events occurred on the spacecraft were becoming observable by virtue of technological advancement.[11] This advancement of technology has also brought new political and legal issues in the international community, which will be discussed below. The number of space objects has been growing constantly from the beginning of the space age, and it was recognized as a universal problem around the 1990s.[12] Despite global recognition by the space community, a major accident occurred in 2009, which established a historical case.

In February 2009, the Iridium 33 satellite belonging to the private American company Iridium Satellite, and the Cosmos 2251 satellite belonging to the Russian military, collided

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[10] US Department of Defense & Office of the Director of National Intelligence, *National Security Space Strategy (Unclassified Summary)* (2011) [*US National Security Space Strategy*].

[11] Jaramillo, ed, *supra* note 3 at 23-30.

[12] US National Aeronautics and Space Administration [NASA], "Monthly Number of Cataloged Objects in Earth Orbit by Object Type", *Orbital Debris Quarterly News* (15 January 2014) 10 online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>, [NASA, "Debris by Object Type"].

at an altitude of about 800 km above Siberia.[13] It is reported that Cosmos 2251 had terminated its function and Iridium 33 was in operation at the time of collision. Statistics show that more than 3,000 pieces of space debris were created because of this collision.[14] This incident made a huge impact on the space community, since it was the first time it had happened among the major satellites. It served as one of the driving forces of the US space debris policy, such as the legislation to authorize the government to share space situational awareness (SSA) data with private entities and foreign governments in 2009. President Obama's space policy accelerates international cooperation in this area and the US government is positively promoting SSA sharing.[15] Despite these efforts, the actual situation has already become serious enough that a slight modification of a single policy cannot make drastic change.

Observations show that the amount of total catalogued debris counted around 17,000 pieces in 2013, and roughly 23,000 pieces of those 10 cm or larger are being tracked.[16] These numbers can be seen as a warning sign, if the behavior of international space actors in the near future continues as it is today. The famous scientific simulation pinpointed, in 1978, that if human beings continued space activities without space debris mitigation, fragments from random collisions between pieces of space debris might trigger hazardous populations of space debris around the year 2000.[17] However, human beings successfully managed to refrain from loosely generating space debris by establishing certain rules for mitigating it. Currently, the speed of our approach to the deadlocked situation is slower than it was 30 years ago, though it has not been stopped and will eventually reach an unsustainable situation.

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[13] *BBC News*, *supra* note 5.
[14] NASA, "Debris by Object Type", *supra* note 12.
[15] Davis Florick & Col. Lina Cashin, "Space Situational Awareness Sharing for the 21st Century", *Space News* (27 May 2013) online: Space News <http://www.spacenews.com>.
[16] NASA, "Debris by Object Type", *supra* note 12; Jaramillo, ed, *supra* note 3 at 24-25.
[17] Donald J. Kessler et al, "The Kessler Syndrome: Implications to Future Space Operations", (Paper delivered at the 33rd Annual American Astronautical Society Guidance and Control Conference, Breckenridge, Colorado, 6-10 February 2010) at 1-2, [unpublished].

Although this hazardous situation is still a prophetical study, actual risks are becoming obvious. It is reported that the US Strategic Command (USSTRATCOM), which provides the most globally opened sources for tracked and catalogued space objects through its SSA sharing program[18], currently issues approximately 20-30 emergency notifications per day.[19] In 2013, NASA reported that 29 collision avoidance maneuvers were conducted by the US operators[20], France reported 19 maneuvers[21], and the European Space Agency (ESA) reported 17 maneuvers.[22] The International Space Station (ISS), which is the only human outer space resident program to date, was also obligated to conduct collision avoidance maneuvers 18 times from 1999 to March 2014.[23] It should also be reminded that the congestion of outer space is not limited to a certain orbit but endangers both low Earth orbit (LEO) and geostationary Earth orbit (GEO) as the same situation.

Thus, not only would the existing space activities suffer from the deteriorating outer space environment, but the emerging ones may suffer as well. It may also endanger the lives in spacecrafts, as the Hollywood film "Gravity" produced in 2013 vividly attracted

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[18] Courtland B. McLeod, "Space Situational Awareness (SSA) Sharing", (Technical Presentation delivered at the 49th session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2012), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>.

[19] John W. Raymond, "Strategic Partnerships in Space," (Presentation delivered at the 2nd International Symposium on Sustainable Space Development and Utilization for Humankind, Tokyo, 28 February-1 March 2013), online: Japan Space Forum <http://www.jsforum.or.jp> at 12; Jaramillo, ed, *supra* note 3 at 26-27.

[20] Mark Matney, "USA Space Debris Environment, Operations, and Modeling Updates", (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

[21] Fernand Alby, "Overview on 2013 Space Debris Activities in France", (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 11 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

[22] Heiner Klinkrad, "Space Debris Mitigation Activities at ESA in 2013", (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

[23] NASA, "International Space Station Maneuvers Twice to Avoid Tracked Debris", *Orbital Debris Quarterly News* (15 April 2014) 1, online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

public attention to the problem.[24] Emerging activities, such as Chinese human spaceflights, suborbital spaceflights[25], or micro-satellite activities[26] will also suffer from, and may create further space debris, if the space community does not take further steps against the congestion of the outer space.

The current outer space situation is also evaluated as an increasingly contested area: that is to say, the man-made threats to deny, degrade, deceive, disrupt, or destroy space assets.[27] The ASAT test conducted by China in January 2007 shocked the international community by highlighting the threats against space security and space operations. The test resulted in the destruction of the still-functioning *Feng Yun 1C (FY-1C)* weather satellite in polar orbit by adding more than 3,000 pieces of space debris.[28] Although the ASAT test was not a newly developed technology at that time, as it had been conducted by the US and the former Soviet Union during the Cold War, the two States had refrained from conducting physical tests. The Chinese test was the first kinetic-kill test conducted by a third country rather than the US and Russia.[29] The test was significant in terms of security balance of the region. One can also say that the Chinese test placed the international community onto a slippery slope towards space weaponization.[30]

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[24] Denise Chow, "Clean Up Space Junk or Risk Real-Life 'Gravity' Disaster, Lawmakers Say", *Space.com* (9 May 2014) online: Space.com <http://www.space.com>.

[25] In this thesis, "suborbital spaceflight" is used as the definition of "the launch of an object or objects into outer space without that object or such objects completing one or more orbits around the earth." (Peter van Fenema, "Suborbital Flights and ICAO" (2005) 30:6 Air and Space Law 396 at 396.); Jaramillo, ed, *supra* note 3 at 58-60.

[26] NASA, "Small Satellite Possibly Hit by Even Smaller Object", *Orbital Debris Quarterly News* (15 April 2014) 1, online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

[27] *US National Security Space Strategy*, *supra* note 10 at 3.

[28] *BBC News*, *supra* note 4.

[29] Michael C. Mineiro, "FY-1C and USA-193 ASAT Intercepts: An Assessment of Legal Obligations under Article IX of the Outer Space Treaty" (2008) 34 Journal of Space Law 321 at 341.

[30] Theresa Hitchens, "Debris, Traffic Management, and Weaponization: Opportunities for and Challenges to Cooperation in Space" (2008) 14 Brown Journal of World Affairs 173. [Hitchens, "Debris, Traffic Management and Weaponization"]; for security aspects of the ASAT test c.f. Setsuko Aoki, "'Space Traffic Management' for the Prevention of Weaponization of Outer Space" (2008) 51 Proceedings of the Colloquium on the Law of Outer Space 154.

China has also continuously exhibited its ASAT ability in 2013, but only caused massive space debris generation from its first test of 2007.[31] The contamination from 2007 test is still recording as the worst one, as nearly 90% of the space debris remaining from the test.[32] The FY-1C destruction became a tragedy, because its interception was at the altitude of around 850 km: the middle of the useful altitude for low Earth orbit (LEO).[33] According to a recent report, the space debris generated by this test is distributed widely throughout the useful orbit of 500 km to 1,500 km.[34] This data shows that the kinetic destruction by ASAT creates a massive exacerbation of the outer space environment, to end up with the unsustainability of space activities.

In February 2008, the United States destroyed the USA-193 satellite, a defunct national security satellite, by a missile launched by a navy warship. The announced purpose of this operation was to disperse the 453 kg or highly toxic hydrazine fuel remaining in the satellite harmlessly. The missile hit the satellite approximately 247 km over the Pacific Ocean, nearly all of the debris was burned up within 24-48 hours from the impact, and the remaining debris would re-enter the atmosphere within 40 days, according to the US Department of Defense.[35] Despite the official statements of the US Government, several views indicate that this test was an ASAT test reflecting the Chinese FY-1C test.[36] Whatever the case may be, the escalation of ASAT tests may incur kinetic-kill in the useful orbits, ending up with generations of space debris similarly to the FY-1C case.

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[31] Bill Gertz, "China Launches Three ASAT Satellites", *The Washington Free Beacon* (26 August 2013), online: The Washington Free Beacon <http://freebeacon.com>.
[32] NASA, "Chinese Debris Reaches New Milestone", *Orbital Debris Quarterly News* (15 October 2010) 3, online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov> at 2-3.
[33] NASA, "Chinese Anti-satellite Test Creates Most Severe Orbital Debris Cloud in History", *Orbital Debris Quarterly News* (15 April 2007) 2, online: NASA Orbital Debris Program Office <www.orbitaldebris.jsc.nasa.gov>.
[34] NASA, "Debris by Object Type", *supra* note 12 at 3.
[35] US Department of Defense, News Release, "DoD Succeeds In Intercepting Non-Functioning Satellite" 20 February 2008, Release no 0139-08, online: US Department of Defense <http://www.defense.gov>.
[36] "US spy satellite plan 'a cover'", *BBC News* (17 February 2008), online: BBC <http://news.bbc.co.uk/>; Brian Wingfield, "A New Space Race?", *Forbes* (21 February 2008), online: Forbes <http://www.forbes.com>.

The technology and business development competition in outer space activities is going far beyond that among the superpowers in the Cold War age. The number of actors conducting space activities is dramatically increasing and the manufacturing of spacecrafts is gradually being transferred to many countries, although independent launch capability is still dominated by 11 countries.[37] It is reported that the US, Russia, Europe, China, Japan, India, South Korea, and a multinational provider called Sea Launch conducted 81 orbital launches in total in 2013: 23 of them were commercial, which is a three-launch increase from the previous year.[38] The space industry has grown up to a US$300 billion market.[39] The dilemma confronted by the space community involves designing policies and regulations in order to maintain sustainable space activities without restricting this growing industrial competitiveness.

[37] *US National Security Space Strategy*, *supra* note 10 at 2-3; Jaramillo, ed, *supra* note 3 at 45. With successful launch of the Democratic People's Republic of Korea in 14th December 2012 ("North Korea Launches First Satellite into Orbit", *Spacenews* (14 December 2012), online: Spacenews <http://www.spacenews.com>) and the Republic of Korea in January 30th 2013 ("S. Korea Successfully Launches Naro Space Rocket", *Spacenews* (30 January 2013), online: Spacenews <http://www.spacenews.com>).
[38] US Federal Aviation Administration [FAA] Office of Commercial Space Transportation, *Commercial Space Transportation 2013 Year in Review*, (Washington D.C., 2014), online: FAA Office of Commercial Space Transportation <http://www.faa.gov/go/ast>.
[39] Futron Corporation, *Futron's 2014 Space Competitiveness Index (Executive Summary)*, (Bethesda: Futron, 2014), online: Futron Corporation <http://www.futron.com>.

Chapter 2

Responses and Challenges Confronting the International Community

In order to de-escalate the congested, contested, and competed situation of outer space and maintain sustainable space activities, the international community has made several technical and regulatory efforts. This Chapter will briefly describe these efforts as the basis of the analysis for the necessity of STM Regime, since the efforts which have been taken by the international community are capricious and not enough for solving the situation.

2.1 Technical Responding Efforts

2.1.1 Space Debris Mitigation Technologies

In order to assure sustainable space activities in the future, the space-faring nations have extended their space agencies' research and technology for space debris mitigation. Currently, space agencies which have obtained launch capabilities have voluntarily established their standards for space debris mitigation in order to reflect their spacecraft and mission design.[40] Although the space agencies tailor the standards for each mission for technical reasons, these standards are generally kept in conformity in practice.[41] These

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[40] NASA, "Process for Limiting Orbital Debris", NASA-STD-8719.14, 28 August 2007; ESA Director General's Office, "Space Debris Mitigation for Agency Projects", ESA/ADMIN/IPOL(2008)2, 1 April 2008; JAXA, "Space Debris Mitigation Standard", JAXA-JMR-003A, October 2003 (updated to JAXA-JMR-003B at 1 February 2011); ESA, "European Code of Conduct for Space Debris Mitigation (Issue 1.0)", 28 June 2004; Russian Federation, "National Standard of the Russian Federation, General Requirements on Space Systems for the Mitigation of Human Produced Near Earth Space Pollution", 2009. France enacted in its Technical Regulations (*Arrêté du 31 mars 2011 relatif à la réglementation technique en application du décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales*, JO, 31 May 2011, 9415, art 21.3).

[41] Uwe Wirt, "UN-Space Debris Mitigation Guidelines – National Implementation Mechanism" (Technical Presentation delivered at the 48th COPUOS LSC, UN Office in Vienna, 23 March-3 April 2009), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>; Ulrike Bohlmann, "Requirements on Space Debris Mitigation for ESA Projects" (Technical Presentation delivered at the 48th COPUOS LSC, UN Office in Vienna, 23 March-3 April 2009), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>; Masahiko Sato, "Space Debris Mitigation Mechanisms"), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>

efforts by space agencies have contributed to spacecraft design meant to reduce the dissemination of objects during their missions, and also to protect the spacecraft itself from collisions by space debris. A technology used to shield the spacecraft, especially the human flight vehicle, from a collision of space debris less than 10 cm in diameter was applied to the ISS and other human flight equipment.[42] It has also made improvements on the detection and observation technologies. The Canadian Department of National Defense has developed a satellite-based space debris observation system called Sapphire, which is combined with the ground observation system and contributes to the US surveillance network of USSTRATCOM.[43] The Japan Aerospace Exploration Agency (JAXA) has developed a Micro-debris Sensor embarking on spacecrafts, formed by a thin film with striped electrical wire. This sensor can detect collisions of tiny debris less than 1 cm in diameter by counting the number of breaking wires.[44] The observation of tiny debris is essential since these are not large enough to detect from ground-based observation in spite of the fact that even these types of debris may cause malfunction or loss of the spacecraft.[45]

2.1.2 Space Situational Awareness and Collision Avoidance Technologies

Observation capability has been considered the most essential part of space debris mitigation, since it is the unique measure to obtain information regarding the situation happening in outer space. The major observation capability was developed by military entities in order to observe and protect their own space assets. These activities, generally called space situational awareness (SSA), are being conducted by the Joint Space Operation Center (JSPOC) of USSTRATCOM as well as several military entities of the other States.[46]

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[42] Eric L. Christiansen, "Design and Performance Equations for Advanced Meteoroid and Debris Shields" (1993) 14:1-4 International Journal of Impact Engineering 145; Kumi Nitta *et al.*, "Response of a Aluminum Honeycomb Subjected to Hypervelocity Impacts" (2013) 58 Procedia Engineering 709.

[43] Max Paris, "Canadian Forces put their 1st satellite in orbit", *CBC News* (25 February 2013) online: CBC News <http://www.cbc.ca>.

[44] Toshiya Hanada, "Research Topics for Asia-Pacific Regional Collaboration in the Area of Orbital Debris Issues", (Presentation delivered at the Workshop on the Protection of Space Environment sponsored by Ministry of Foreign Affairs of Japan, Kuala Lumpur, 12 December 2012), online: MOFA <http://www.mofa.go.jp> at 25.

[45] Akira Kato, "JAXA Strategic Plan for Space Debris-Related R&D" (2012) 26:2 Journal of Space Technology and Science 18 at 19.

[46] McLeod, *supra* note 18.

The Russian Federation maintains the similar ability of International Scientific Optical Network (ISON), but its open availability of information is still limited[47]. It is known that Australia, Canada, France, Germany, and Japan maintain some abilities, but most of their details are not disclosed.[48] The operators of the spacecraft mostly use the data published in the JSPOC website "Space-Track"[49], dedicated to the SSA services. JSPOC processes the data observed from its Space Surveillance Network (SSN) and provides it through three types of SSA services such as basic, advanced, and emergency notifications.[50] In order to use the basic services, the only requirement for the operator is to register its name, affiliation, and purposes of data use, and agree with the User Agreement through the Space-Track web site. The registered operator can find historical and current satellite data, as well as decay and re-entry data in the website, with no cost or obligation to provide information in exchange. The registered operator can request further detailed information from JSPOC for a specific object, and may communicate with them on a case-by-case basis.[51] JSPOC provides emergency notifications in case of a detected possible collision. This notification is provided spontaneously by JSPOC based on their own calculations transformed into Conjunction Summary Messages (CSM), directly provided to the spacecraft operator to the extent possible.[52] However, the notifications are based on JSPOC's knowledge from their observations and it may reach the wrong operator or end up lost the operator, since there is no measure for JSPOC to assure the corresponding operator of the respective observed object. The advanced services of their SSA services may complement this ambiguity since

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[47] Russian Academy of Sciences Keldysh Institute of Applied Mathematics, "International Scientific Optical Network (ISON) activities on highly elliptical orbit (HEO) and geosynchronous orbit (GEO) observations and analysis in 2013", (Technical Presentation delivered at the 49th session of the Scientific and Technical Subcommittee, UN Office in Vienna, 13 February 2014), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>.

[48] US Strategic Command Public Affairs, Press Release, "USSTRATCOM Signs Fifth Data Sharing Agreement", 27 January 2014, online: USSTRATCOM <http://www.stratcom.mil>; See also B. de Montluc, "SSA: Where Does Europe Stand Now?" (2012) 28:3 Space Policy 199 at 201.

[49] JSPOC, *Space-Track*, online: JSPOC <https://www.space-track.org>.

[50] McLeod, *supra* note 18.

[51] *Ibid.*

[52] *Ibid*.

they requires entering into an agreement with the operators and providing advanced data of conjunction assessment, data providing supports in the events of launch, deorbit, reentry, re-orbit, collision avoidance maneuver, or in some off-nominal cases.[53]

USSTRATCOM announced that five governmental agreements and more than 30 commercial agreements have already been signed.[54] The operators using the data from these services usually calculate and predict the potential collision risks of their own space assets and other space objects.[55] Since the SSA data contains some calculation margin, the operators can also use their own operational data to increase accuracy.[56] In the case of a predicted collision, based on the CSM data from JSPOC, the operator conducts conjunction assessment in multiple layers to evaluate the reliability of the predicted collision.[57] This task requires one to two days of "concentrated" work, since additional fuel consumption needs to be minimized.[58]

Currently, there is no specific unified method for collision avoidance, but the way to control it normally involves ascending or descending the altitude by accelerating or decreasing the speed of the spacecraft.[59] In many cases, there are constraints among the other operational factors of the spacecraft for avoidance maneuver, and often, the decision should be made with limited options within a short time frame.[60] It is expected that the

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[53] *Ibid*.
[54] *Ibid*; USSTRATCOM Public Affairs, *supra* note 48.
[55] Kaneaki Narita, "Space Operations: Risk Mitigation Experience from Collision" (Presentation delivered at the Space Environment Protection Workshop sponsored by the Ministry of Foreign Affairs of Japan, Kuala Lumpur, 12 December 2012), online: Ministry of Foreign Affairs of Japan <http://www.mofa.go.jp>; Ikumi Matsuda, Chikako Hirose & Nobuo Kudo, "The JAXA Conjunction Assessment Process", (Paper delivered at the SpaceOps 2010 Conference, Huntsville, 25-30 April 2010) at 2-3.
[56] Duane Bird, "Sharing Space Situational Awareness Data", (Paper delivered at the 2010 Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, 14-17 September 2010).
[57] Matsuda, Hirose & Kudo, *supra* note 55 at 2; Lauri Kraft Newman, "The NASA Robotic Conjunction Assessment Process: Overview and Operational Experiences" (2010) 66:7-8 Acta Astronautica 1253 at 1254-1255.
[58] Narita, *supra* note 55.
[59] Matsuda, Hirose & Kudo, *supra* note 55 at 4.
[60] Newman, *supra* note 57 at 1256-1257.

SSA data's accuracy from JSPOC would improve through data sharing agreements, and the advanced services would provide more accurate data to the operators. Improving the infrastructures of JSPOC is also expected.[61]

Among all the efforts to mitigate newly generated space debris, it has been reported that a catastrophic collision will remain a possibility every five to ten years, mainly between altitudes of 700 km and 1,000 km, even if any new launches are suspended.[62] The only way to prevent this situation is to remove certain pieces of major space debris from the peripheral orbits. A development race for these technologies has already started, and various types of missions have been proposed.[63] It will take a few more years until these technologies step up to practical use, but it is only a matter of time before we experience that era.

2.2 Regulatory Response Efforts

2.2.1 Legally Binding Regulations

The principal legal regime at the international level was established in the 1960s, with the adoption of the first international treaty for outer space activities. The Outer Space Treaty,[64] in accordance with the international law including the Charter of the United Nations[65], established the principle that the exploration and use of outer space, including

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[61] Bird, *supra* note 56.

[62] J. C. Liou & N. L. Johnson, "Risks in Space from Orbiting Debris" (2006) 311:5759 Science 340.

[63] Kentaro Iki, Satomi Kawamoto & Yoshiki Morino, "Experiments and Numerical Simulations of an Electrodynamic Tether Deployment from a Spool-type Reel Using Thrusters" (2014) 94:1 Acta Astronautica 318; Christophe Bonnal, Jean-Marc Ruault & Marie-Christine Desjean, "Active Debris Removal: Recent Progress and Current Trends" (2013) 85 Acta Astronautica 51; L. T. DeLuca *et al.*, "Active Space Debris Removal by a Hybrid Propulsion Module" (2013) 91 Acta Astronautica 20; Vladimir Aslanov & Vadim Yudintsev, "Dynamics of Large Space Debris Removal Using Tethered Space Tug" (2013) 91 Acta Astronautica 149.

[64] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205, 18 UST 2410, TIAS No 6347, 6 ILM 386 (entered into force 10 October 1967) [*Outer Space Treaty*].

[65] *Charter of the United Nations*, 26 June 1945, Can TS 1945 No 7, 59 Stat. 1031, 145 UKTS805, 24 UST 2225, TIAS No 7739 (entered into force 24 October 1945) [*UN Charter*].

the Moon and other celestial bodies, shall be free for all States[66], and no claim of appropriation by any State would be acceptable.[67] However, the freedom of outer space is limited in some aspects in the Treaty.

Specifically, in terms of the sustainable use of space, Articles VI and VII govern the responsibility of the contracting States.[68] At this point, the difference between the term "responsibility" employed in Article VI and the term "liability" employed in Article VII, must be recognized. The basic understanding of "responsibility" should be recognized as a broader concept than "liability", which is included in the previous term.[69] "Responsibility" signifies the answerability for conduct aligned with certain legal norms. "Liability", on the other hand, is created by a breach of applicable legal norms which damage another State, and requires reparation to the damaged State.[70] Noting this differentiation is important, since in the equally authentic Treaty languages other than English, the same word is employed the two different concepts: for example, the Chinese text uses "責任", French uses "*responsabilité*", and Spanish uses "*responsabilidad*" in both articles.[71] Considering this differentiation of the concepts, it is natural to read Article VI as the general statement for responsibility in space activities, and Article VII as the detailed provisions of liability. Article VIII should also be considered as a detailed provision for the registration of space objects as a part of the responsibility of State.[72]

Consequently, it is widely understood that the States Parties in general retain responsibility over whatever the space activities may be conducting in their jurisdiction, and are required to maintain "authorization and continuing supervision" for non-governmental activities (Article VI). As one of the breakdowns, the international liability

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[66] *Outer Space Treaty*, art I.
[67] *Ibid*, art II.
[68] Stephan Hobe, Bernhard Schmidt-Tedd & Kai-Uwe Schrogl, *Cologne Commentary on Space Law Vol I Outer Space Treaty* (Cologne: Carl Heymanns Verlag, 2009) at 104.
[69] Bin Cheng, *Studies in International Space Law* (Oxford: Clarendon Press, 1997) at 598-620. [Cheng, "International Space Law"]
[70] *Ibid* at 615-616.
[71] Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 104.
[72] *Ibid* at 115-116.

for damages should be imposed upon the launching State (Article VII). The other breakdown is that the State of registry should retain "jurisdiction and control" over such space objects (Article VIII). The detailed rules for liability and registration were established into the Liability Convention[73] and Registration Convention, respectively.[74] The liability is imposed on the launching States as a fault liability for in-orbit damages and absolute liability for ground damages[75]. One of the launching States is required to register the space object launched into outer space on its national registry and notify the UN Secretary-General for international registration.[76] The State of registry is expected to exercise jurisdiction and control over that particular space object. Consequently, Article VII of the Outer Space Treaty, together with the Liability Convention, established a launching-State-centric liability system with "authorization and continuing supervision", and Article VIII of the Outer Space Treaty, together with the Registration Convention, established a launching-State-based "jurisdiction and control" system over space objects. Obviously, international law is only applicable to the State, and thus relies on national legislation for the manner of "authorization and continuing supervision" or "jurisdiction and control".[77]

Article IX of the Outer Space Treaty established the obligation of the States Parties to explore and use outer space "with due regard to the corresponding interests of all other States Parties" and "avoid their harmful contamination and also adverse changes in the environment of the Earth". This signifies that a State must conduct space activities with the standard performance of care, attention, and observance. This provision requires the State to prove that every possible measure to prevent harmful acts was conducted.[78] The motivation to draft this article came from a historic fact related to the experiment contracted

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[73] *Convention on the International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 UNTS 187; 24 UST 2389; 10 ILM 965 (1971) (entered into force 1 September 1972) [*Liability Convention*].
[74] *Convention on Registration of Objects Launched into Outer Space*, 6 June 1975, 28 UST 695, 1023 UNTS 15 (entry into force 15 September 1976) [*Registration Convention*].
[75] *Liability Convention*, arts II-III.
[76] *Registration Convention*, arts II,IV
[77] *Outer Space Treaty*, arts VI,VIII.
[78] Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 175-176.

by the US Air Force with the Massachusetts Institute of Technology Lincoln Laboratory, named Project West Ford. The project placed millions of small needles into orbit in order to create a widely scattered belt for long-range communication of military services.[79] It was heavily criticized by the astronomical science community. The International Astronomical Union (IAU) adopted a resolution to appeal to the governments "launching space experiments which could possibly affect astronomical research to consult with the IAU before undertaking such experiments and to refrain from launching until it is established beyond doubt that no damage will be done to astronautical research."[80] As a result, the International Council of Scientific Unions Committee on Space Research established the Consultative Group of Potentially Harmful Effects of Space Experiments.[81] The draft for Article IX of the Outer Space Treaty was submitted by the Soviet Union in 1962 to UNCOPUOS, following this historical context.[82] This provision is also remarkable as this is the only article in this Treaty to require consultation among the States Parties. The third sentence of this article requires the Contracting States to spontaneously consult in advance with the States potentially suffering from harmful interference. The Article also provides a corresponding right of the potentially affected States to request a consultation regarding the concerning activity. In concert with rights and obligations, Article IX forms a mutual consultation mechanism for the potentially harmful interfering space activities.[83]

However, to date, it is regrettable that this mechanism was employed in very few cases, and most of them do not specifically disclose whether or not a State actually applied the mechanism. The most recent potentially applicable case was the ASAT test from China, conducted intermittently since 2007. The ASAT test is an activity which may cause harmful interference to the other States' space activities by colliding with other satellites or deploying space debris, as it did in the 2007 test. China violated Article IX by conducting the ASAT test without any international consultation, or even provision of the test

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[79] Delbert R. Terrill Jr, *The Air Force Role in Developing International Outer Space Law* (Alabama: Air University Press, 1999) at 63-68.
[80] *Ibid* at 65.
[81] Mineiro, *supra* note 29 at 328.
[82] *Ibid*.
[83] See also Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 179-181.

information to any other State.[84] The other space-faring nations, especially the partner States of the ISS such as the US, Europe, and Japan, publicly expressed their concerns about the test, and it is reported that they officially required a sound explanation regarding the test from the Chinese government.[85] Although those can be recognized as requests for *ex-posto facto* consultation under Article IX of the Outer Space Treaty, there are no specifications for the exercise of this right under the Outer Space Treaty.[86] There was no report that the Chinese government had conducted *ex-posto facto* consultations in the test either. It is also remarkable that while the only two other States had also conducted the ASAT test in the past, the US and Russia had not conducted any consultation with the other States. Mineiro pinpoints that these practices may establish a custom to extinguish ASAT from the necessary consultation prescribed under Article IX of the Outer Space Treaty.[87]

A previous case seems to be a proper use of this consultation mechanism. The Soviet Union's military satellite, Cosmos 954, equipped with nuclear power sources, crashed into Canadian territory in 1978.[88] At the time of the crash, the Canadian government officially expressed its surprise to the USSR government at their failure to give "notice of the possible re-entry of the satellite in the region of Canada".[89] This can be seen as a claim influenced by Article IX of the Outer Space Treaty, since it presupposes a notification to Canada from the USSR. Both States continued their consultation through diplomatic channels, mainly the USSR's Embassy in Ottawa, and concluded with a payment of C$3,000,000 to Canada from the Soviet Union. This conclusion was agreed to by both governments in 1981 as part of a protocol.[90] In this case, it seems that the consultation mechanism worked fairly well for the *ex posto facto* consultation, but neither State ever

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[84] Mineiro, *supra* note 29 at 341-345.
[85] Theresa Hitchens, "US-Sino Relations in Space: From 'War of Words' to Cold War in Space?" (2007) 3:1 China Security 12 at 23 [Hitchens, "US-Sino Relations"].
[86] C.f. Japan, Minister for Foreign Affairs, Press Conference, 19 January 2007 (Japanese), online: Ministry of Foreign Affairs of Japan <http://www.mofa.go.jp>.
[87] Mineiro, *supra* note 29 at 340-354.
[88] Gus W. Weiss, "The Life and Death of COSMOS 954" (1978) 22:Spring, Studies in Intelligence.
[89] "Statement of Claim" in *Protocol in respect of the claim for damages caused by the Satellite "Cosmos 954"*, Canada and Union of Soviet Socialist Republics, 2 April 1981, 1470 UNTS 269.
[90] *Ibid*.

mentioned the exercise of this right under Article IX of the Outer Space Treaty. Furthermore, the consultation before the accident was ignored again.

To date, there is no international law directly regulating space activities in terms of sustainable use of outer space, such as the prohibition of deploying space debris or the proper procedure for collision avoidance. More likely, it seems that the international legislation of binding instruments to regulate space activities has been carefully avoided "almost as an anathema"[91], especially those which regulate the use of nuclear power sources and space debris mitigation.

2.2.2 Non-Legally Binding Regulations

Because of the above situation of international law, the international community has made multiple efforts to formulate worldwide consensus in order to maintain the sustainability of space activities by non-legally binding instruments.

Based on several discussions regarding the issues of space debris in the late 1980s, the Inter-Agency Space Debris Coordination Committee (IADC) was founded in 1993 by the space agencies of Europe, Japan, Russia, and the US.[92] Currently, space agencies from 12 States around the world participate as members but four of the States maintaining independent launch capability are still non-members.[93] Although IADC's main mission is to exchange information, facilitate and review cooperative opportunities, and identify debris mitigation options,[94] it has moved towards establishing the Space Debris Mitigation Guidelines in 2007.[95] These were the first documents in the international sphere which accumulated the space debris mitigation practices of space agencies.[96] The Guidelines were

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[91] Setsuko Aoki, "The Function of 'Soft Law' in the Development of International Space Law" in Irmgard Marboe, ed., *Soft Law in Outer Space* (Vienna: Heribert, 2012) 57 at 73 [Aoki, "Function of Soft Law"].

[92] George M. Levin & Walter D. Flury, "Inter-Agency Space Debris Coordination Committee (IADC)", (Technical Presentation delivered at the 34th Session of of the UNCOPUOS STSC, UN Office in Vienna, February 1997), online: IADC <http://www.iadc-online.org>.

[93] IADC, *Member Agencies*, online: IADC <http://www.iadc-online.org/>.

[94] IADC, *Terms of Reference for the Inter-Agency Space Debris Coordination Committee (IADC)*, IADC-93-01 (rev.11.2), (1993), s 1,3.

[95] IADC, *IADC Space Debris Mitigation Guidelines*, IADC-02-01 Revision 1 (2007) [*IADC Debris Guidelines*].

[96] Kato, *supra* note 45 at 24.

presented to the Scientific and Technical Subcommittee (STSC0 of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) in 2002 as a draft, and endorsed in 2007 within the Report of UNCOPUOS to the 62nd Session of the UN General Assembly (UNGA) as its Annex. The Guidelines extracted the essence of the IADC Debris Guidelines and became known as the UNCOPUOS Debris Guidelines.[97] This transfer was necessary since the IADC Debris Guidelines, formulated as a technical *de facto* standard by the space agencies, had to be recognized by the sovereign States as a common recognized standard for space debris mitigation among worldwide space activities. Although it is inconceivable that the UNCOPUOS Debris Guidelines hold a legally binding effect, the importance of its endorsement at the UNGA level has been repeatedly recognized.[98]

Concerned about the ambiguity of the term "launching State" in the context of the common use of outer space, the Legal Subcommittee (LSC) of UNCOPUOS started its consideration of the Application of the Concept of the 'Launching State' in 2000, and resulted as a UNGA Resolution in 2004.[99] The significant recommendation stated by the Resolution was to recommend the States to consider the legislation of national laws to implement the authorization and continuing supervision of activities in outer space.[100] Harmonizing and increasing the consistency of national space legislation with international law was also recommended.[101] Aside from them, a consensus was reached only to repeat the description of the UN Space Treaties, although the discussion for drafting this issue

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[97] *Space Debris Mitigation Guidelines of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space*, UNGAOR, 62nd Sess, Supp 20, UN Doc A/62/20 (2007) at 47 [*COPUOS Debris Guidelines*].
[98] Marco Ferrazzani, "Soft Law in Space Activities" in Irmgard Marboe, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012) 99 at 108; Irmgard Marboe, "The Importance of Guidelines and Codes of Conduct for Liability of States and Private Actors" in Irmgard Marboe, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012) 119 at 139-143; Gerardine Meishan Goh, "Softly, Softly Catchee Monkey: Informalism and the Quiet Development of International Space Law;" (2008-2009) 87:3 Nebraska Law Review 725.
[99] *Application of the concept of the "launching State"*, GA Res 59/115, UNGAOR, 59th Sess, UN Doc A/RES/59/115 (2004) [*Concept of Launching States*]; Aoki, "Function of Soft Law", *supra* note 91 at 63-65.
[100] *Concept of Launching States*, *Ibid*, s 1.
[101] *Ibid*, s 4.

brought together the various perspectives of the Member States.[102] Nevertheless, this resolution can be recognized as a soft law meant to harmonize national laws, since there was no international common understanding pinpointing the necessity for the national legislation of space activities before this resolution.[103]

Another effort conducted in UNCOPUOS-LSC from 2004 to 2007 was to identify the necessary elements in practice to register under the Registration Convention. This consideration was based on the drastically deteriorated condition of space object registration in the post-Cold War years.[104] This recommendation to enhance the practice of the registration of space objects was adopted in 2007 as the UNGA Resolution.[105] The Resolution recommends "harmonization of practices" such as the contents of information being provided to the UN Secretary-General, prior consultation among potential launching States for the qualification of the State of registry in case of a joint launch, encouraging national operators to register nationally, as well as encouraging the States to notify the UN Secretary-General of additional information regarding operational changes.[106]

The latest effort was taken from 2009 to 2013, and resulted in the Recommendations on National Legislation for Space Activities of the UNGA.[107] The current international consensus involved in the preliminary understanding of the necessary elements to be implemented in national legislation appearing in these Recommendations the concretion of the concept of "authority and continuing supervision" can be recognized. It provides recommendation for the "national regulatory frameworks", which are similar to the many laws of space-faring nations, but together with certain possible additional provisions. It is anticipated that the national regulations will be further elaborated in line with the

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[102] Yu Takeuchi, "Challenges of International Space Law for Managing Space Traffic" (in Japanese) (2014) 55 Kuho (Journal of Air Law) 1 at 6 [Takeuchi, "Challenges"]; Aoki, "Function of Soft Law", *supra* note 91 at 64.
[103] Aoki, *Ibid* at 64-65.
[104] *Ibid* at 65.
[105] *Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects*, GA Res 62/101, UNGAOR, 62nd Sess, UN Doc A/RES/62/101 (2007).
[106] *Ibid*, ss 2-4.
[107] *Recommendations on national legislation relevant to the peaceful exploration and use of outer space*, GA Res 68/74, UNGAOR, 68th Sess, UN Doc A/RES/68/74, (2013) [*Recommendations on national legislation*].

Recommendations, and thus, the international community will reach a common understanding on the authorization and continuing supervision of Article VI of the Outer Space Treaty at an early date. As one of its preliminary steps, further elaboration of these Recommendations is expected, since its current version is entirely focused on notional descriptions.

The efforts in UNCOPUOS can also be seen in the STSC. Starting in 2010, the STSC has considered the agenda of "Long-term sustainability of outer space activities" (LTSSA) proposed by the French delegation.[108] This agenda intends to examine the measures that could enhance the long-term sustainability of space activities, as well as prepare a set of voluntary guidelines focused on practical measures.[109] It established a plan within its Working Group to generate the guidelines applicable on a voluntary basis by space actors, including States, international organizations, and non-governmental organizations, in order to reduce the risks to the long-term sustainability of outer space activities.[110] The Working Group formed four Expert Groups, and brought the experts of the Member States together to identify the issues and draft the guidelines. The Expert Groups are respectively dedicated to "Sustainable space utilization supporting sustainable development on Earth", "Space debris, space operations and tools to support collaborative space situational awareness", "Space weather", and "Regulatory regimes and guidance for actors in the space arena".[111] The Expert Groups generated the consolidated proposed guidelines respectively and submitted their works through the Chair of the Working Group at the STSC's 51st Session in February 2014.[112] It seemed that the Working Group did not reach a consensus on the proposed guidelines in this session, so a decision was made to continue its consideration

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[108] *International cooperation in the peaceful uses of outer space*, GA Res 64/86, UNGAOR, 64th Sess, UN Doc A/RES/64/86 (2010), Operative Paragraph [OP] 10.
[109] *Report of the Committee on the Peaceful Uses of Outer Space*, UNGAOR, 66th Sess, Sup No 20, UN Doc A/66/20 (2012), Annex II, OP 4.
[110] *Ibid*, OP 12-13.
[111] *Report of the Scientific and Technical Subcommittee on its forty-eighth session*, UNCOPUOSOR, 54th Sess, UN Doc A/AC.105/987, Annex IV, OP 8-9.
[112] Chair of the Working Group, *Proposal by the Chair of the Working Group on the Long-term Sustainability of Outer Space Activities for the consolidation of the set of draft guidelines on the long-term sustainability of outer space activities*, UNCOPUOSOR, 57th Sess, UN Doc A/AC.105/2014/CRP.5 (2014) [*LTSSA Proposed draft consolidated guidelines*].

by extending its mandate for one year until 2015.[113] The proposed guidelines consist of 33 guidelines on various topics including policy, regulatory, technology, international cooperation, and management.[114] It is remarkable that the guidelines for both the regulatory and technological sides especially address the ideal rules for the maintenance of sustainable space activities from the view of practical procedures, although they remain in abstract descriptions. As the result of this work, the guidelines are expected to be implemented in each Member State through their national legislation.[115]

The European Union (EU) published the "Draft Code of Conduct on Outer Space Activities" in 2008 as the European response to the UN General Assembly's inquiry.[116] The EU conducted initial consultations with key third countries based on this draft with the intention to initiate a worldwide negotiation to establish an international code of conduct for the maintenance of sustainable space activities. Following the initial consultations, in 2012, the US, Australia, and Japan announced that the basic idea should be supported, subject to several modifications on the EU draft, and entered into the international consultation of the "Draft International Code of Conduct on Outer Space Activities" (ICOC).[117] The EU convened two rounds of multilateral Open-ended Consultations in Kiev in May 2013 and in Bangkok in November 2013. The consultations were both attended by some 140 participants from 61 countries, and the third round of consultations was held in Luxembourg in May 2014.[118] The EU made efforts to reflect comments from the

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[113] *Report of the Scientific and Technical Subcommittee on its fifty-first session*, UNCOPUOSSTSCOR, 51st Sess, UN Doc A/AC.105/1065 (2014), OP 233.11.
[114] *LTSSA proposed draft consolidated guidelines*, *supra* note 112.
[115] *Ibid*, OP 25.
[116] *Transparency and confidence-building measures in outer space activities*, GA Res 61/75, UNGAOR, 61st Sess, UN Doc A/RES/61/75 (2006).
[117] US Secretary of State, Press Release, "International Code of Conduct for Outer Space Activities", 17 January 2012, online: US Department of State <http://www.state.gov>; Australia, Minister for Foreign Affairs, Media Release, "Australia joins the fight against space junk", 18 January 2012, online: Australian Department of Foreign Affairs and Trade <http://www.foreignminister.gov.au>; Japan, Minister for Foreign Affairs, Press Conference, 25 January 2012, online: Ministry of Foreign Affairs of Japan <http://www.mofa.go.jp>.
[118] European External Action Service [EEAS], "The EU leads a multilateral initiative on an International Code of Conduct for Outer Space Activities" (June 2014), online: EEAS <http://eeas.europa.eu>.

consultations of participating States by publishing multiple amendments to the draft as the latest version disclosed on March 31, 2014.[119] It must be noted that the ICOC intends to address not only civil space activities, but also security-related ones to complement existing international space laws.[120] This is remarkable, since the international community had reached a deadlock when discussing the prevention of an arms race in outer space in the Conference on Disarmament (CD) (former Committee on Disarmament) in the 1980s.

One of the EU's intentions to raise ICOC outside of the framework of CD was to break away from this chain and begin a worldwide discussion for the sustainability of space activities.[121] Based on the compliance of existing international laws[122], ICOC mainly addresses the measures for safety operations and space debris mitigation[123], notification of events in outer space activities[124], information sharing in operations[125], and consultation mechanism.[126] It is expected that the future ICOC shall be followed up by concrete "bottom-up" guidelines that could appear as a result of LTSSA.[127] To date, despite the advantages of the ICOC, opinions are still divided between promoting its subscription among the States, or being rather skeptical of the idea.[128] The other major space powers, Russia, China, and India, do not show their support for discussion and even seem to feel uncomfortable mainly with the forming of the consultation.[129] Since the consultation is

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[119] *Draft International Code of Conduct for Outer Space Activities*, 31 March 2014, online: EEAS <http://eeas.europa.eu> [*ICOC*].
[120] *Ibid*, preamble paragraph 10, s 2-4.
[121] Wolfgang Rathgeber, Nina-Louisa Remuss & Kai-Uwe Schrogl, "Space security and the European Code of Conduct for Outer Space Activities" [2009]:4 UNIDIR Disarmament Forum 33 at 33-34.
[122] *ICOC*, *supra* note 119, s 3.
[123] *Ibid*, s 4.
[124] *Ibid*, s 5.
[125] *Ibid*, s 6.
[126] *Ibid*, s 7.
[127] Rathgeber, Remuss & Schrogl, *supra* note 121 at 35.
[128] Michael Krepon, "Weak Arguments Against A Space Code Of Conduct", *Stimson Center* (17 January 2012), online: Stimson Center <http://www.stimson.org/spotlight>.
[129] Kazuto Suzuki, "Regulatory Power of the EU in Maintaining Security in Space: Politics beyond Normative Power", (Paper delivered at the European Union Studies Association (EUSA) 13th Biennial Conference, Baltimore, 9-11 May 2013); Rajeswari Pillai Rajagopalan & Daniel A. Porras, eds, *Awaiting Launch: Perspectives on the Draft*

conducted in an official closed meeting, it is not possible to learn much about its details. However, it seems that there are still more consultations required in order to reach consensus on the proposed Code.

Another approach, though a UN-based one, had already reached its initial goal for a similar purpose. The UN Group of Governmental Experts (GGE) on Transparency and Confidence-Building Measures (TCBM) in Outer Space Activities was an advisory group of 15 selected experts to the UN Secretary-General, formed by a resolution of the First Committee of the UNGA.[130] The GGE chaired by Victor Vasiliev, Deputy Permanent Representative of the Russian Federation to the UN in Geneva, concluded its final report in July 2013.[131] The Report presents substantive TCBMs useful for maintaining sustainable space activities as well as recommendations to the States for their voluntary consideration and implementation, including the exchange of various types of information about national space policies and activities (including major military expenditures in outer space), mutual risk reduction notifications, and mutual visits of experts from national space facilities. The criteria for developing TCBMs was also discussed and recommended to establish coordination between the UN Office for Disarmament Affairs, the UN Office for Outer Space Affairs (UNOOSA), and other appropriate UN entities. The Report also includes a proposal for coordination and consultative mechanisms for further interaction between the space actors.[132]

2.2.3 Problems in the Current Systems

Consequently, the legally binding principles governing space activities remain as those of the UN Space Treaties.[133] This is the result of the efforts of the international community,

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ICOC for Outer Space Activities (New Deli: Observer Research Foundation, 2014) at 133-198.

[130] *Transparency and confidence-building measures in outer space activities*, UN Res 65/68, UNGAOR, 65th Sess, UN Doc A/RES/65/68 (2011).

[131] *Report of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities*, UNGAOR, 68th Sess, UN Doc A/68/189, (2013) [GGE Report].

[132] *Ibid*.

[133] *Outer Space Treaty; Liability Convention; Registration Convention; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space,* 22 April 1968, 672 UNTS 119, 19 UST 7570, TIAS No 6599, 7 ILM 151(entry into force 3 December 1968) [*Rescue Agreement*]; *Agreement Governing the*

which recognizes the gap between the *lex lata* and the *lex ferenda* as a quick remedy for the maintenance of sustainable space activities. In other words, huge efforts have been made to address the issues involved in making the world purse sustainable space activities without new international legislation. This is because of the deadlock of legislative activities in the existing negotiation organizations resulting from the US' clear opposition to the development of a new legal regime infringing its current rights to conduct space activities.[134] To date, soft laws[135] have promoted international cooperation for mutual understanding, addressed the problem, or suggested the development of a new regime,[136] but soft laws have not been able to play a more effective role, such as providing a common interpretation of the treaties. In other words, despite the significant development of activities in outer space, the international legal system regulating these activities remains as it was when it was originally adopted in the 1960s. Space-faring nations have been continuously reluctant to make a legally binding modification to the current structure of international space law, since space activities are conducted without inexpedience to date. It is safe to say that soft laws partially serve to promote international cooperation, but their weakness is obvious. Overall, it is no exaggeration to say that currently, there is no international regime addressing sustainable space activities linked to STM established so

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Activities of States on the Moon and Other Celestial Bodies, 5 December 1979, 1363 UNTS 3 (entry into force 11 July 1984) [*Moon Agreement*].

[134] Rathgeber, Remuss & Schrogl, *supra* note 121 at 34; The US continuously took a policy to reject international treaties for possibilities to limit its freedom of action after clearly stating in the Bush administration's space policy (*National Space Policy of the United States of America*, (2006)). Hitchens, "Debris, Traffic Management and Weaponization", *supra* note 30 at 178; The Obama administration's space policy (*National Space Policy of the United States of America*, (2010)) does not specifically pinpoint the objection but it seems no sign of relaxation indication to date.

[135] Soft laws are the "instruments that might purport to specify standards of conduct, but do not emanate from the traditional 'sources' of public international law": Steven Freeland, "The Role of 'Soft Law' in Public International Law and its Relevance to the International Legal Regulation of Outer Space" in Irmgard Marboe, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012) 9 at 19. Various discussion on soft law are in Kenneth W. Abbott & Duncan Snidal, "Hard and Soft Law in International Governance" (2000) 54:3 International Organization 421.

[136] Aoki, "Function of Soft Law", *supra* note 91 at 57-86.

far. Even if there are some elements in some parts of international law or soft laws, they are spread too far apart to be easily ignored or overseen.

Problems lie in the States as well. The national legislations are crucial for the advancement of the concrete regulation of international law because the international rules in detail should be consistent with the state practices, which are reflected in national legislations. However, it is also true that the lack of common understanding in the international rules may emanate States' hesitation to implement these rules internally. States will further hesitate to implement these international rules with their originally additional detailed rules, because ruling in detail may deteriorate the competitiveness of its own industry. Therefore, this could be a controversial question, with its cause and effect. Soft laws generally play a role in the eventual formulation of common understanding of international laws, which they have also done in the area of international space law.[137] Although soft laws do not retain legal effects in public international law, it may be possible to constitute one of the essences of customary international law.[138]

Consequently, the emerging functions of soft law have enriched the international sphere's discussions[139], but the implementing national legislations by the States are still inadequate.

[137] Freeland, *supra* note 135.
[138] *Ibid* at 22-23; Cheng, "International Space Law", *supra* note 69 at 136-149.
[139] Aoki, "Function of Soft Law", *supra* note 91.

Chapter 3
International Regime for Space Traffic Management

With the series of problems in current international space law pinpointed in the previous chapter, it can be said that the issues are spread out in various areas of the current international space law and soft law, despite their compromising functions, and only work partially. To date, it has become inevitable to establish a new regime to regulate space activities in a comprehensive manner. STM is the most reasonable concept to recognize the improvement of space activities as being unified. There is no intention to do away with all existing legal regimes and replace them with the proposed STM regime, since the complexity of international activities is typically structured by multiple overlapping international regimes.[140] However, looking at the sequences of the issues arising from modern space activities without an effective solution from the old-fashioned UN space treaties regime, it is crucial to tackle the disposition of the current regulatory regimes. As mentioned in the previous chapter, the necessary cutting edge of today's space activities is the concept of "traffic", with analogies in maritime and aviation traffic management. Together with this concept, it will bring certain order into the current chaotic circumstances of outer space. Furthermore, the international community is already en route to accepting the STM regime, as mentioned below. Therefore, this thesis argues to introduce the international regime for STM.

In this Chapter, the concept of STM, which was proposed to date, will be introduced, together with some contemporary evaluations. Subsequently, the necessity and admissibility of an international regime for STM will be presented to follow the current problems of space operation pointed out in the previous Chapter. This Chapter will conclude by illuminating the international community's current trend, and implicate the development towards the proposed STM regime.

[140] Xavier LW Liao, "Regime Complex of Space Activities" (Paper delivered at the The 2nd Manfred Lachs International Conference on Space Governance, Montreal, McGill University Institute of Air and Space Law, 29 May 2014) [unpublished].

3.1 The Proposed Concept of STM and its Contemporary Evaluation

The current international regime for space activities is based on the UN space treaties and relevant soft laws.[141] However, STM is a new concept that has not appeared yet in the current regime. The IAA STM Report published in 2006, as the first comprehensive study and proposal of the STM concept, provides in its set of recommended regulations in a section titled the "Outline of a Comprehensive Space Traffic Management Regime" (the Outline).[142] These provide multiple insights, which are still paving the way towards an STM regime. An international inter-governmental agreement including provisions for liability and the basic principles of STM is suggested, together with a flexible annex part in addition to the UN space treaties. As well, the topics to be considered for regulatory aspects are enumerated[143]. These topics are divided into four parts: (1) Securing the Information Needs, (2) Notification System, (3) Traffic Management, and (4) Organization.[144] Although the crucial part is the third one, this section reviews all four parts and outlines the necessary set of rules to be established.

In the first and second parts, the Outline deals with information, data sharing, and notification.

> ***1. Securing the Information Needs***
> • Defines necessary data (on trajectories as well as radio frequencies).
> • Sets provision for the data (sources, governmental as well as private, including financing).
> • Establishes a database and distribution mechanisms for data (format of the database, access to data on request, collision warning as a service).
> • Establishes an information service on space weather.
> ***2. Notification System***
> • Sets pre-launch notification with better parameters than Registration Convention as well as other provisions (e.g. ITU and proposed UNIDROIT Protocol).

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[141] See generally Irmgard Marboe, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012).
[142] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 90-92.
[143] *Ibid* at 91-92.
[144] *Ibid*.

• Provides information on the end of active/operational lifetime of space objects.

• Provides pre-notification of orbital maneuvers and active de-orbiting (communication rules and cooperation provisions).[145]

Despite the Outline holding its reservation to "[d]efine necessary data" as an open action in its first part, one can assume it argues that the STM regime requires a worldwide, unified and reliable mechanism to gather and share necessary data and information on a non-discriminatory basis. In order to conform these elements to a set of rules, the following rules are necessary to be implemented: Information and data gathering procedure, including its obligatory nature together with the liability for failing to gather information and data; Information and data sharing procedure, including its obligatory natures together with the liability caused by the shared information or data; and Legal status of the shared information and data, including the admissibility of evidence for in-orbit accidents.

The third part of the Outline provides the necessary topics for the traffic management of space activities.

3. Traffic Management

• Provides traffic management rules based on the use of the database for the purpose of collision avoidance, including:

- Safety provisions for launches
- Safety provisions for human spaceflight (including space tourism)
- Zoning (selection of orbits)
- Right of way rules for in-orbit phase(s)
- Prioritization with regard to maneuver
- Specific provisions for GEO (harmonized with ITU rules)
- Specific rules for LEO satellite constellations
- Debris mitigation mechanisms
- Safety provisions for re-entries
- Environmental provisions (pollution of the atmosphere/troposphere, etc.).

[145] *Ibid* at 91.

• Clarifies "space objects", including legal distinction between valuable objects and valueless space debris.
• Clarifies "fault" or liability in case of damage caused in outer space with regard to the implications of traffic rules.
• Sets delimitation for the launch phase and clarifies the concept of "launching State".
• Provides a framework and main features for national licensing regimes (including insurance provisions), which implement the provisions of the agreement.
• Sets forth an enforcement mechanism (e.g. renouncement of access to information) and dispute settlement.
• Clarifies institutionalized interlinks with ICAO, ITU and other relevant organizations.[146]

Some of these requirements have already been partially implemented in current space activities. Safety provisions for launches, human spaceflight, re-entries, and protecting the environment have already been provided by the respective launching States' authorities.[147] The safety regulations for space tourism have been developing in the US by the FAA pushed by the current circumstances of the rapid growth of related industries.[148] The only absence is an international unified rule for these activities. However, the efforts to harmonize these rules have already been started by an inter-agency conference body, the Trilateral Safety and Mission Assurance Conference (TRISMAC), based on the

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[146] *Ibid*.
[147] C.f. *Commercial Space Launch Act*, 51 USC §509 (1984) [*CSLA*]; 14 CFR §1214 (1958); *Law Concerning Japan Aerospace Exploration Agency*, Law No 161 of 2002; *JAXA Standard Rules for Launching Space Objects* (in Japanese), Rule No 15-37, 2003, online: JAXA <http://www.jaxa.jp/about/disclosure/data/k_37.pdf>; Loi nº 2008-518 du 3 juin 2008 relative aux opérations spatiales, JO, 4 June 2008, 9169 [FSOA]; *Décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales*, JO, 11 June 2009, 9406, art 1 [French Authorization Decree].
[148] Jeff Foust, "Balancing safety and cost in commercial human spaceflight", *The Space Review* (February 10, 2014) online: The Space Review <http://www.thespacereview.com>.

participation of the ESA, JAXA, and NASA.[149] Debris mitigation mechanisms have been developed by the IADC and UNCOPUOS. The framework for national licensing regimes, which the Outline suggests to include in the STM regime, has been discussed in the report of the Recommendations of National Legislation.[150]

On the other hand, the zoning of orbits, right-of-way rules for in-orbit operations, prioritization rules for maneuvers, and specific rules for respective orbits proposed in the Outline[151] have not yet been established in the international forum to date. The Outline also pinpoints that the terms "space objects", "fault" or "liability", and "launching State" together with the delimitation of the launch phase should be clarified further from their stipulations in the UN space treaties. Furthermore, setting an enforcement mechanism, including dispute settlement mechanism, as well as clarifying institutionalized interlinks regarding the implementation of the regime, are included in the proposed outline of the Report. These are the operation-focused core topics for STM to be seriously considered from a legal perspective.

What the IAA STM Report has provided here are a starting point and a further legal elaboration based on the comprehensive picture of space operations. To help this process, the Report suggests several possible first steps to improve the situation in space traffic.[152] These steps include the regulatory issues that require further elaboration to establish the STM regime. To date, the evaluation of the regimes which existed at that time is almost complete, although certain updates are still required.

The Report firstly requests that the Space Debris Mitigation Guidelines of the IADC be endorsed by UNCOPUOS as a "UN legal document",[153] which has already been accomplished as the UNCOPUOS Debris Guidelines in 2007. For the SSA and collision avoidance measures, it encourages the establishment of common data policy and

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[149] JAXA Safety and Mission Assurance Department, *TRISMAC 2012*, online: JAXA <http://sma.jaxa.jp/TRISMAC2012/index.html>.
[150] *Recommendations on national legislation, supra* note 107.
[151] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 91-92.
[152] *Ibid* at 92.
[153] *Ibid*.

infrastructures among the States retaining SSA capabilities.[154] These steps are being taken gradually by the States, but this is not sufficient.[155] The IAA STM Report has also recommended establishing enforcement and checking mechanisms, resulting in obligatory notification/registration and provision of unified sets of data.[156] This has not been achieved yet, though discussions on its necessity have started. The Report suggests that the legal definition of space debris should be determined in order to reach legal measures towards the treatment of space debris,[157] because its removal is unavoidable to achieve STM.

Furthermore, the Report indicates nine regulatory issues that need to be studied further, and only one of them can be considered accomplished to date. Four of them are in the process of being considered in some fora, and the other four have not even reached their starting point. The issue which has been accomplished is the study on the relationship of the concept of notification of launches in international space law and the Hague Code of Conduct against Ballistic Missile Proliferation (HCOC).[158] This issue was elaborated in the world, and appeared in the ICOC consideration process as the principal nature to be inspired.[159] It is also recognized as the existing TCBM, effective for space activities in the GGE Report.[160]

The prioritization of space activities, the identification of the data transfer procedure of dual-use data, the acceptance of the industries' voices by governments, and the appropriate connection with CD[161] are issues that have been addressed by one or multiple initiatives of ICOC, LTSSA, or GGE, but have not been concretely stated in their outputs to date. Merging the International Telecommunication Union (ITU) registration and the UN registration system, identifying the expectations of military users, establishing technical regulations as binding instruments, and maintaining a level playing field while

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[154] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 92.
[155] See chapter 2 section 2.1.2 above.
[156] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 92.
[157] *Ibid*.
[158] *Ibid* at 90.
[159] Steven A Mirmina, "Reducing the Proliferation of Orbital Debris: Alternatives to a Legally Binding Instrument" (2005) 99 American Journal of International Law 649 at 654-657.
[160] *GGE Report*, *supra* note 131, OP 29.
[161] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 92.

avoiding "flags of convenience"[162] are issues which are not even on the table yet. The issues identified by the IAA STM Report have served, and will continue to serve, as the guiding light for the achievement of the STM regime. However, these issues are stated as disorderly and developed haphazardly. Therefore, it is necessary to reorganize them systematically and in order of affordability to achieve them for practical use. By doing so, a realistic step towards the STM regime can be provided.

It is also necessary to note, at this point, that the report of International Space University conducted a thorough research and elaborated certain points that IAA STM Report identified. Namely its "Space Traffic Rules" provides a valuable series of technically well-considered rules for implementing STM Regime.[163] On the other hand, its legal consideration for constituting the STM concept as a regime needs to be reinforced.[164]

3.2 Necessity and Admissibility of the International Regime of STM

3.2.1 Roles of the STM Regime

The actual condition of the application of the UN space treaties, illustrated in the previous chapter, is proving to be inadequate as a legal solution for the problems occurring in space operations. Turning a blind eye over this status quo is putting strain on the outer space environment and reducing the possibility of conducting sustainable space activities in our future. To overcome this situation, it is crucial to recapture the entire flow of space activities as "traffic".

The concept of outer space "traffic" has not been properly addressed until now, and space activities have gradually accumulated operational problems. The problems themselves did not occur from the lack of the concept of "traffic", but one of the reasons that the international community is not able to produce a breakthrough to these problems is the lack of the concept of "traffic".

From a legal point of view, there is obviously no international legal instrument regarding the STM regime to date. Some of the peripheral regimes, such as the ATM

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[162] *Ibid.*
[163] International Space University, *Space Traffic Management* (Beijing: International Space University (ISU), 2007) at 17-41.
[164] *Ibid* at 17.

regime for air traffic or the maritime traffic management (MTM] regime, address space activities in terms of regulating some specific cases related to the regulation of their primary subject matter. It is part of the nominal operation of ATM for the launch operator to provide the competent agency of aviation controlling the respective air space with relevant information in order to issue an international notice to airmen (NOTAM) to vacate the ascending and descending area of the launch vehicle.[165] NOTAM is a rule described in the Chicago Convention,[166] which signifies that the space activities are partially regulated by the ATM regime in order to maintain its own purpose. Likewise, in the MTM, coastal States respectively issue the Notice to Mariners.[167]

Developing an original traffic management system solely for outer space will involve greater complexity basis than currently exists for existing traffic management regimes governing air traffic and maritime navigation. An original traffic management system will allow a further technology development by seeking better regulating measures. Partial regulation of the other traffic management systems relies on the purposes of the entire regime itself. The principal purpose of aviation regulation is, of course, the smooth progress of air traffic. It could contain the safety of space activities, but is only subject to the contribution to aviation safety. Aviation regulation is ultimately for aviation only, no matter what may be regulated instead. Therefore, we cannot expect to establish a rule in order to contribute solely to space activity. Space activities contain multiple dimensions that cannot directly apply to aviation regulation, such as the nature of maneuver for the object or the area or planet to be explored. The environment is very different as well. In micro-gravity conditions, every object orbits in a certain trajectory in a certain speed. Otherwise, it would be pulled towards the planet by gravity and fall to the ground. Relying solely on the other peripheral regulations would result in an ill-assorted regulatory system, which is unwholesome for the entirety of space activities.

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[165] 14 CFR 91.143 (2004).
[166] *Convention on International Civil Aviation*, 7 December 1944, 15 UNTS 295, ICAO Doc 7300/6 (entered into force 4 April 1947), Annex 15 chapter 5 [*Chicago Convention*].
[167] US National Geospatial-Intelligence Agency, *Notice to Mariners*, online: USNGA <http://.msi.nga.mil/NGAPortal/MSI.Portal>; Canadian Coast Guard, *Notice to Mariners*, online: Canadian Coast Guard <http://www.notmar.go.ca>.

Moreover, with regards to the regulation of space traffic, the FAA has currently mentioned several times that space was initially regulated in terms of maintaining the safety of aviation.[168] It should be said to date that the FAA is dedicated by its mandate to ensure aviation safety.[169] Naturally, they should take space traffic into consideration, simply because it could become a threat to aviation safety. It is no exaggeration to say that space traffic can be seen as no more than an unwelcome interruption passing through airspace. In this vein, it should be noted that the FAA pursued an anomalous track as a civil aviation authority, since the US Congress decided to expand its mandate to regulate commercial space transportation in 1984.[170] This is because the FAA has become the pioneer aviation agency dealing with space activity issues within their own aviation mandate. Expectations for similar treatment in the aviation agencies of the other States should be considered relatively low. Thus, even if the FAA treats space activities as beneficial for aviation, we cannot expect other agencies to deal with or regulate space activities outside the context of aviation.

3.2.2 Necessity to Establish the STM Regime

The current deadlocked situation needs a breakthrough. For a regulatory breakthrough, there is an urge to make a self-standing regulation, which would allow the operators to work in a safe manner by themselves. STM is the key concept which encompasses overall space activities as "flowing traffic". Under the concept of STM will space activities will not be recognized discretely, but as integrated and mutually independent factors as they are in reality. The STM regime can also be the ultimate type of TCBM. Take the example of ASAT tests, and the resultant creation of space debris, which will pose incredible challenges to future space traffic. Space debris is and will be increased by ASAT tests. As well, ASAT tests will encourage ASAT technology development for the other countries,

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[168] Frank Morring Jr., "Space Traffic Control An Issue For NextGen", *Aviation Week* (10 February 2014), online: Aviation Week <http://aviationweek.com/>.
[169] 14 CFR Chapter 1 (1966); See also Daniel P. Murray, "The FAA's Current Approach to Integrating Commercial Space Operations into the National Airspace System" in Ram S. Jakhu & Kuan-Wei (David) Chen, eds., Regulation of Emerging Modes of Aerospace Transportation (Montreal: McGill University Center for Research in Air and Space Law, 2014) at 169-184.
[170] 51 USC §509 (1984); 14 CFR §1214 (1992).

which are trying to balance their own powers. Thus, without TCBM, this ASAT development race will result in the further pollution of the space environment. STM will promote the accountability of each State's space activities, while sharing information for controlling traffic. Challenges will remain on how to organize the information exchange regarding national security assets, but it would certainly increase TCBM for space activities.[171]

The rationale for establishing a new STM regime should be clearly determined as outlined by the following three points:

First, a unified basic rule to allow traffic flow in outer space is essential in order to achieve effective and safe spacecraft operations. The lack of an STM regime allows discrete rules of operations, and results in operator hesitations and miscommunications in making accurate decisions.[172] The rule may start from a very fundamental level and gradually build up with the international community's mutual consensus.

Second, unified basic STM rules are necessary to shape the basis of liability. Since the sovereign States are the governors of today's international community, it is necessary to elaborate liability rules to strengthen legal control over the States by *ex-posto facto* regulation. This expands the compliance with international law in the international community.

Third, it is necessary to expect a "regulatory big bang" instead of "piecemeal engineering" in order to solve current problems occurring in international space law.[173] The establishment of an STM regime will enable the conduct of safe and sustainable operation rules in outer space.

3.2.3 Admissibility of STM Regime in International Law

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[171] See also Jana Robinson, "Transparency and confidence-building measures for space security" (2011) 27:1 Space Policy 27; Peter Martinez *et al*, "Criteria for developing and testing Transparency and Confidence-Building Measures (TCBMs) for outer space activities" (2014) 30:2 Space Policy 91.

[172] William H. Ailor, "Space Traffic Management: Implementations and Implications" (2006) 58:5 Acta Astronautica 279.

[173] Kai-Uwe Schrogl, "Space Traffic Management: The New Comprehensive Approach for Regulating the Use of Outer Space - Results from the 2006 IAA Cosmic Study" (2008) 62:2–3 Acta Astronautica 272.

Although the regime guided by the concept of STM can be considered a part of soft law for the present date because of political reasons, there is theoretically no exaggeration or inaccuracy to take an approach of giving the regime a legal status in the international legal system in the near future. Obviously, the regime will work only with voluntary compliance of States under its soft law format. Together with hard law, on the other hand, it may gain legal enforceability regarding what the hard law regulates, so that it ensures the operability of the regime. The format whether the regime contains hard law or not reflects to the degree of enforceability. On reflection, it does not affect the function or the existence of the regime to the international community. The regime may start from a combination of pure soft laws and gradually sublimate by shifting its parts to hard law. Hence, no one should stand on the assumption that the current international political situation is horizonless for a STM regime.

Since the other traffic management regulations for maritime or aviation consist of sets of legally binding and non-legally binding instruments, STM can exist as a set of both rules as well. In this regard, it is beneficial to use the practices of MTM and ATM as peripheral references. Both management areas have a point in common that the basic principles of the whole structure of each regulating area are prescribed by an international treaty in order to assure a solid platform on which the entire regimes can stand.

3.2.3.1 Air Traffic Management Regime

The basic framework of ATM was established by the Chicago Convention of 1944, and that of the sea was established by the UN Convention of the Law of the Sea of 1982.[174] The Chicago Convention created the International Civil Aviation Organization (ICAO) and assigns the State of registry to take primary responsibility for the safety and security of their registered aircrafts under certain harmonized circumstances of the Convention prescriptions.[175] It ensures a certain level of safety for the aircraft,[176] of skill for the flight

[174] *United Nations Convention on the Law of the Sea,* 10 December 1982, 1833 UNTS 396, 21 ILM 1261 (entered into force on 16 November 1994) [*UNCLOS*].
[175] *Chicago Convention*, arts 17-21.
[176] *Ibid*, arts 31 and 33.

crew,[177] as well as unified radio equipment[178] and journey logbooks.[179] The Convention expects that the details of these flying conditions will be enforced by the State of registration, subject to the International Standards and Recommended Practices (SARPs) adopted by the ICAO Council.[180] The ICAO Council designates SARPs as the Annexes of the Chicago Convention for convenience, and the SARPs will become effective within three months unless the majority of States notify their disapproval within this period.[181] The SARPs provide international standards to harmonize the technical levels of necessary elements in order to reach a unified safety level for global aviation.[182]

The basic legal infrastructure for air navigation is established by Article 22 of the Chicago Convention, and Article 28 delegates the SARPs for detailed technical issues in reaching the purpose of Article 22. Article 68 prescribes the rights of States in designating the routes and airports for international services within its territory, and Article 12 provides the uniformity of domestic rules to SARPs to the greatest extent possible, while at the same time designating that the rules over the high seas shall be established exclusively by ICAO.[183] Article 15 requires the States to conform the navigation facility conditions in those airports, and in reflection of these, Annex 2 (Rules of the Air), Annex 6 (Operation of Aircraft, International Commercial Transport), Annex 11 (Air Traffic Services), and Annex 15 (Aeronautical Information Services) establish the technical standards for unified international operations.

The legality of SARPs is controversial, since its compliance relies on each State and lacks binding sanctions. It is uncertain if the uniformity assumed by SARPs is achieved in the domestic legislation of each State, since the majority of States do not respect the procedure of disapproval notification because of unknown reasons, including lack of

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[177] *Ibid*, arts 32-33.
[178] *Ibid*, art 30.
[179] *Ibid*, art 34.
[180] *Ibid*, art 37, annexes.
[181] *Ibid*, arts 54(1) and90.
[182] Paul Stephen Dempsey, *Public International Air Law* (Montreal: McGill University, 2008) at 65-74 [Dempsey, "Air Law"].
[183] "Air Law", *ibid* at 80.

understanding.[184] As a matter of form, SARPs should be considered soft laws because of their recommended nature. Also, the understanding of impracticability to comply or differ with the domestic practices of any States will be respected more than SARPs, even though they appear as Annexes of the Chicago Convention.[185] However, by focusing on the aspect of the implicit sanctions arising as a result of the non-compliance of SARPs, it is widely understood that SARPs need to be considered as a part of hard law "whatever *de jure* 'soft law' attributes SARPs may have".[186] International standardized measures for air navigation is one of the significant areas established by SARPs.[187] It is widely understood that the ultimate responsibility of air navigation is held by each State through issuing any special law or regulations, even if many States shift towards privatizing air navigation services.[188]

Since the SARPs are recognized as a part of hard law, it is safe to say that the basis of ATM rules are established as legally binding instruments, in spite of the vast amounts of other documents issued by ICAO regarding the research and recommendations on safety. The documents adopted in the Council but not recognized as annexes of the Chicago Convention do not formally consist of hard law, but serve as a *de facto* standard for the comprehension of SARPs or the Convention itself.[189] It is remarkable that the regime for ATM is established based on the Chicago Convention and detailed by SARPs, which have the nature of quasi-legally binding instruments,[190] and surrounded by the other soft law documents produced in ICAO, which serves as a supplement to hard law.

The vital elements for the regime were all described and maintained in SARPs. The ATM system is based on the principle of complete and exclusive sovereignty of air space

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[184] *Ibid* at 75-80.
[185] *Ibid* at 75-80; *Chicago Convention*, art 38.
[186] "Air Law", *ibid* at 79.
[187] *Chicago Convention*, art 37(c).
[188] *Ibid*, art 22; Dempsey, "Air Law", *supra* note 182 at 171-205.
[189] For example the Council of ICAO adopt ICAO's policies signifying the way of comprehensions of SARPs (ICAO, *ICAO's Policies on Charges for Airports and Air Navigation Services*, ICAO Doc 9082, 9th ed, (2012) [*ICAO's Policies on Charges*]; ICAO, *2013–2028 Global Air Navigation Plan*, ICAO Doc 9750-AN/963, 4th ed, (2013)).
[190] Michael Milde, "The International Civil Aviation Organization: After 50 Years and Beyond" [1996] Australian International Law Journal 60.

above the territory of each State.[191] Reflecting this principle, the Chicago Convention established seven classes of air space by the different types of air traffic services (ATS) provided, and set Flight Information Region (FIR) as the basic system, which is solely for the purpose of providing information. The air space over the entire globe is categorized as part of a FIR, and the provision of basic information for flight safety in this area is given to the designated State as a responsibility. A FIR is typically designated based on the territory of each sovereign State, and designations to some States include the area over the high seas.[192] For instance, the US, Portugal, Canada, and the United Kingdom share the responsibilities involving providing information over the North Atlantic Ocean, while Russia, Japan, and the US share those over the Pacific Ocean. Some States in Africa or South America have formed regional navigation organizations to jointly provide services in the area, while most States in the other regions provide these services individually.[193]

The distinguishing aspect of ATS is that only the States retain the responsibility to provide each service, even though States may privatize the service provision itself.[194] ICAO established recommended principles for these services to charge costs based on a service fee by the providing States.[195] The Chicago Convention also regulates that the fees or charges shall not be imposed solely for the right of transit over the territory or entry into it, and these charges should have a non-discriminatory basis between national and foreign aircrafts.[196] Several recommendations, such as the charges, should not be imposed to discourage the use of facilities and services necessary for safety, no double charges should ever be imposed, and only reasonable charges related to the cost of facilities used should be imposed.[197] Only a single fee should be charged, based on the distance flown in the service-providing air space and the weight of the aircraft, which is an objective criterion used in imposing a non-discriminatory charge.[198] Any changes in the charges should be

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[191] *Chicago Convention*, art 1.
[192] *Ibid*, annex 11,15.
[193] Walter Schwenk & Rüdiger Schwenk, *Aspects of International Co-operation in Air Traffic Management* (The Hague; Boston; Cambridge: Martinus Nijhoff, 1997) at 39-41.
[194] Dempsey, "Air Law", *supra* note 182 at 172-175, 179-186.
[195] *ICAO's Policies on Charges*, *supra* note 189 ss I.2-I.3.
[196] *Chicago Convention*, art 15.
[197] *ICAO's Policies on Charges*, *supra* note 189, s III.6.
[198] Dempsey, "Air Law", *supra* note 182 at 179.

based on the agreement between the service provider and users, and if they do not agree, the user should have the right to appeal the charge to an independent body.[199]

The Rules of the Air are established under the belief that air travel must be safe and efficient.[200] The visual flight rules (VFR) and instrument flight rules (IFR) are set up as the unified basic way of flying, applicable without exceptions over the high seas. It is also the standard way of flying in the territorial air space, unless otherwise regulated by the respective State.[201] The distinction of using IFR or VFR is made mainly by the classification of the air space and meteorological conditions. Most airlines, especially long-distance flights such as international flights, are flown by IFR.[202] Flying by IFR is obligatory depending on the ATS, and must follow the air routes respectively designated by each State. International flights will provide a flight plan in advance so that they can enter into foreign airspace and conduct transportation services, as the States of registry are mutually agreed upon in advance with bilateral agreements.[203] Primary responsibility to avoid a collision is imposed on the pilot by using the necessary support from the on-board instruments and the ATS services from the ground.[204] Right-of-way rules are also described in the Rules of the Air: when two aircrafts are on the collision course at the same altitude, the aircraft on the right has the right of way, the exception being that aeroplanes must give way to airships, gliders, balloons, and aircrafts towing objects. An overtaken aircraft has the right of way, and the overtaking aircraft must remain in the clear by turning to the right. When two aircrafts approach each other head-on, they must both change direction by turning right.[205] In aviation, these unified rules provide the safety of operations. The only exception in the application of these rules is for State aircrafts, which are excluded the application of the Chicago Convention.[206]

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[199] *ICAO's Policies on Charges*, *supra* note 189, ss I.17-I.22.
[200] Dempsey, "Air Law", *supra* note 182 at 209.
[201] *Chicago Convention*, annex 2.
[202] Dempsey, "Air Law", *supra* note 182 at 209-210.
[203] *Ibid* at 517-522, 523-581.
[204] *Chicago Convention*, arts 5-6.
[205] *Ibid*, annex 2, s 3.2.2.
[206] *Chicago Convention*, art 3.

Nonetheless, the Convention requires the States to have "due regard for the safety of navigation of civil aircraft" when regulating their State aircraft.[207] The most critical point elicited from this provision should be recognized as the obligation of the State to establish the norms for achieving communicative interface between civil and state aircrafts.[208] This includes not only the on-board communication instruments among civil aircrafts, state aircrafts, and ATS authorities, but also those of the civil and state air authorities.[209] The importance of the hybrid coordination of air space by civil air space authority should also be recognized.[210] Furthermore, it is important to add that ICAO continues its daily efforts in collaborating and harmonizing the technologies as well as regulatory standards, to increase the safety of operations by issuing documents other than SARPs.[211]

Nonetheless, in aviation, State aircrafts carrying objects of a sensitive nature, such as an aircraft used in a classified mission or test, would fly in the military-restricted air space. Although reaching to a common understanding regarding the "due regard" of Article 3(d) of the Chicago Convention is important at this point, it is hard to imagine a real issue happening in the current circumstances in which most State aircrafts equip compatible communication equipment while civil and state aviation authorities maintain contact with each other. The implication of this issue may be harder for space activities, since no restricted space exists in outer space and most military satellite operators are reluctant to identify themselves.

3.2.3.2 Maritime Traffic Management Regime

In the field of the sea, the development of traffic regulations is relatively slow. UNCLOS regulates the jurisdiction over ships on the basis of the flagship principle,[212] but

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[207] *Ibid*, art 3(d).
[208] Michel Bourbonniere & Louis Haeck, "Military Aircraft and International Law: Chicago Opus 3" (2000) 66 Journal of Air Law and Commerce 885 at 912-930.
[209] *Ibid*.
[210] *Ibid*. at 921-922.
[211] ICAO, *Global Air Traffic Management Operational Concept*, ICAO Doc 9854, AN/458, 1st ed, (2005). (An overall concept of ICAO for ATM.); Procedures for Air Navigation Services [PANS]: PANS - Air Traffic Management (ATM), ICAO Doc 4444, (2007); PANS – Aircraft Operations (OPS), ICAO Doc 8168, (2006); PANS – ICAO Abbreviations and Codes (ABC), ICAO Doc 8400, (2010); PANS-Training (TRG), ICAO Doc 9868, (2006).
[212] *UNCLOS*, arts 92(1), 97(1).

relies on coastal States regarding the regulations, including navigation safety using shore-based navigation systems.[213] The Vessel Traffic Services (VTS) are rather regulated as the accumulation of the national port authorities without the harmonization of governmental international organizations.[214] For ships, different from aircrafts, the liability-related responsibilities all lie on the Master of vessels.[215] It is true that international conventions such as the Convention on the International Regulations for Preventing Collisions at Sea,[216] the International Convention for the Safety of Life at Sea,[217] and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers,[218] have implemented international regulations for traffic management at sea. However, it is even fair to say that this area consists of a much significant mixture of hard law and soft law compared to the area of ATM, and therefore, a unified rule is required.[219] The VTS was initiated in 1968 on the Recommendation of the Inter-Governmental Maritime Consultative Organization (IMCO), followed by the guidelines of International Maritime Organization (IMO) in 1985.[220] These Guidelines do not describe the liability or responsibility issues, but only the operational procedures and planning for the VTS.[221] Currently, the 1997 revised version of the Guidelines[222] is the internationally recognized

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[213] Gesa Praetorius et al, "Learning Lessons in Resilient Traffic Management: A Cross-domain Study of Vessel Traffic Service and Air Traffic Control", in Dick de Waard et al, eds, *Proceedings of the Human Factors and Ergonomics Society [HFES] Europe Chapter Conference, Toulouse, 2012* (HFES Europe Chapter, 2012) at 277-288.
[214] *Ibid*; International Association of Marine Aids to Navigation and Lighthouse Authorities, *IALA Vessel Traffic Services Manual*, 5th ed (Saint Germain en Laye: 2012). [*IALA VTS Manual*]
[215] Praetorius et al, *supra* note 213 at 278-279.
[216] *Convention on the International Regulations for Preventing Collisions at Sea*, 20 October 1972, 1050 UNTS 16.
[217] *International Convention for the Safety of Life at Sea*, 1 November 1974, 1184 UNTS 2.
[218] *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers*, 7 July 1978, 1361 UNTS 2.
[219] Fulko van Westrenen & Gesa Praetorius, "Maritime Traffic Management: a Need for Central Coordination?" (2014) 16:1 Cognition, Technology & Work 59.
[220] IMO, *Guidelines for Vessel Traffic Services*, IMO Res A.578(14) (1985).
[221] *IALA VTS Manual*, *supra* note 214 at 17.
[222] IMO, *Guidelines for Vessel Traffic Services*, IMO Res A.857(20) (1997).

source policy for the VTS.[223] Further development of the Guidelines is being considered in the IMO, in consultation with related organizations such as the IALA and five other international non-governmental institutions.[224] Basically, VTS is conducted by each coastal State in accordance with the Guidelines of IMO and the IALA VTS Manual under the authority of UNCLOS.

Along the lines of MTM and ATM, the necessary rules for realizing STM should consist of a combination of hard law and soft law. Despite the fact that the major space-faring nations are disinclined to making more hard law , this thesis does not argue that hard law must be placed as the first priority for an STM regime. On the contrary, the initial structure of the STM regime may be established as a series of soft laws without a legally binding nature. The international community is also pointing in that direction, as described in the next section. However, it should also be noted that some of the previsions of current international space law may require revisions sooner or later.

3.2.4 Preventive Controlling Norms of the Outer Space Treaty

A connection for admissibility of STM regime also exists in the Outer Space Treaty. Article IX of this Treaty can be considered the basic principle for protection of the space environment. It can be said that avoiding harmful contamination and adverse changes in Earth's environment are the preventive controlling norms in conducting space activities. Obviously, these abstract norms are open to interpretation in today's circumstances because of the lack of concrete regulations when it comes to implementing them.

There have been few discussions of applying the "precautionary principle"[225] of the environmental law to outer space.[226] This notion seems reasonable, but no State has ever recognized the applicability of this principle to outer space. Moreover, there is no norm preventing the maintenance of sustainable space activities: that is to say, a norm for the

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[223] *IALA VTS Manual*, *supra* note 214 at 17.
[224] *Ibid* at 18-21.
[225] *Rio Declaration on Environment and Development*, UNGAOR, (1992), Principle 15.
[226] Paul B Larsen, "Application of the Precautionary Principle to the Moon" (2006) 71 Journal of Air Law and Commerce 295. Larsen argues the legal basis of applying the principle to the Moon based on the general acceptance of the principle by Article V and IX of the Outer Space Treaty, which is slightly out of the context of this thesis.

control of space activities, as traffic control is lacking. In order to prevent a collision in orbit, it is necessary to consider an operational rule, which regulates the direction or altitude of collision avoidance, an avoidance maneuver procedure, procedures for communication with other operators, or collision-avoidance prediction calculation. Currently, these kinds of rules do not exist for space activities.

3.3 Existing Trajectory to STM Regime

The necessity for an international regime shall be accompanied by the admissibility of the international sphere. Legal admissibility will be discussed in the following Chapter, but this section will shed some light on the movement of the international community towards discussing the way to maintain sustainable space activities. Thus, it can be seen as an emerging process for the political admissibility of the STM regime.

3.3.1 Nexus of LTSSA, ICOC and GGE – Existing Trajectory toward STM

Several approaches have already been initiated towards the establishment of an STM regime, but the term STM itself has been carefully avoided since it is still too ambiguous for official use in international governmental discussions. The worst case scenario for the governments involves the circumstances that would allow an ever-changing definition of the term STM, resulting in political conflicts among space-faring nations. The concept is still only a concept for now, and there is no way stabilizing its meanings rather than be defined by the lawmakers. However, many initiatives show that it is not an exaggeration to say that the international community has already proceeded toward establishing the STM regime. These initiatives are ICOC, LTSSA, and GGE.

ICOC, LTSSA, and GGE can be politically seen as competitive initiatives for the new governance of space activities. It is true that there are some ways in which the US, Europe, and Russia are acting out a leadership struggle for their power of influence in governing space activities.[227] However, even when looking at the contents of the three documents closely, one can observe the process of comprehensive norm formation for the maintenance of sustainable space activities: the road towards an STM regime.[228]

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[227] Takeuchi, “Challenges”, *supra* note 102 at 8-9.

[228] Yu Takeuchi, "Space Traffic Management as a Guiding Principle of the International Regime of Sustainable Space Activities" (2011) 4:2 Journal of East Asia and

ICOC and LTSSA, which are both initiatives from Europe, initially considered that ICOC should be a document meant for building up political commitments, and that LTSSA should be a bottom-up technical recommendation corresponding to ICOC.[229] During their respective international considerations in a different forum, it is unclear if these goals are still achievable, but it is still clear that the contents considered in these documents will serve for space operations and traffic control.

The GGE Report was the first initiative to reach a conclusion in this context. Its swiftness was probably due to its nature as a small expert panel. The significance of this group is that the initiative was taken by the First Committee of the UNGA dealing with disarmament issues, which is neither UNCOPUOS nor CD, but the reporting body of CD. Therefore, its report included a significant recommendation coming from traditional measures of TCBM: promoting voluntary visits to launch sites and control centers, and demonstrations of space and rocket technologies.[230] The other TCBMs included in the recommendations are similar to those in the drafts of ICOC and LTSSA. Namely, the information exchange on national space policies and space activities, including orbital parameters, possible conjunctions, planned launches and natural space hazards, and notifications for reducing risks, are almost the same issues discussed in the ICOC and LTSSA.[231]

Therefore, at least in terms of content, the situation is still the same as when the discussion regarding sustainable space activities began. Namely, most of the topics can be seen in the latest version of ICOC: Compliance and promotion of the existing regulations, Measures for operation safety and space debris mitigation, Notification in space operation, Information sharing, Consultation mechanism, and Management mechanism of the Code

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International Law 319. [Takeuchi, "STM Guiding Principle"] (Described the STM regime's parallel development with the sustainable development regime.)

[229] Rathgeber, Remuss & Schrogl, *supra* note 121 at 35.

[230] *GGE Report*, *supra* note 131, OP 46-48.

[231] *Ibid*, OP 37-45; *LTSSA Proposed draft consolidated guidelines*, *supra* note 112, Guidelines 6,20-21,23-30; *ICOC*, *supra* note 119, ss 4-6.

among the subscribing States.[232] It is remarkable that the Code includes the establishment of TCBMs as one of the four purposes.[233] In its General Principles, it is also declared that preventing outer space from becoming an area of conflict should be taken into consideration. [234] This can be recognized in its successful involvement of the recommendation made by GGE. It also signifies the separate establishment of "internationally accepted practices, operating procedures, technical standards and policies associated with the long-term sustainability of outer space activities"[235], especially for the safe conduct of outer space activities with LTSSA in mind.

ICOC will become a comprehensive and abstract representation of the political will of the States if it attracts the subscription of the majority of the international community. It implies that LTSSA would become its technical guidelines for the implementation of the Code, and therefore, the maintenance of sustainable space activities would be able to reach into the technical operative level, with political consensus to do so. The latest revised version of the LTSSA, which does not seem to be harmonized with ICOC yet, intends to recommend the adoption of national regulatory frameworks to exercise appropriate jurisdiction and control,[236] operational safety rules such as collecting and sharing space debris monitoring information,[237] or performing conjunction assessments during the orbital phases of controlled flights.[238] The topics in LTSSA almost fully correspond to those of ICOC, except the issue of TCBMs, which can only be found in the ICOC and GGE.

Whatever ulterior motives the States participating in the considerations may have, it is safe to say that the three initiatives discuss the common purpose of establishing international, non-legally binding guidelines for the maintenance of sustainable space activities. Three prominent elements involve all three initiatives sharing their core contents: commonly implementing the existing rules in every State, establishing rules for safe operation of the spacecraft, and establishing a procedure for collecting and sharing

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[232] *ICOC*, *ibid*, ss 4-8.
[233] *Ibid*, s 1.3.
[234] *Ibid*, s 2.
[235] *Ibid*.
[236] *LTSSA Proposed draft consolidated guidelines*, *supra* note 112, Guideline 9.
[237] *Ibid*, Guideline 21.
[238] *Ibid*, Guideline 25.

SSA data. The three elements required in the three initiatives correspond to the current problems in space operations described in Chapter 2 of this thesis as their solutions. Furthermore, recalling the definition of STM such as "the set of technical and regulatory provisions for promoting safe access into outer space..."[239] it can be said that the elements being currently discussed in the international community by the three initiatives are encouraging the establishment of an international regime for STM.

3.3.2 Possible next steps

It is always a daunting task to anticipate the movements of international politics since there is a fine line dividing anticipation and prognostication: it is not only logic that dominates politics. Considering the possible presumption from the moves regarding the STM regime described above, there is no doubt about the existence of international consensus for the general necessity of norms when it comes to the maintenance of sustainable space activities. It should be said that the question is only about timing. The contentions to start the discussions still exist in the forum where the rule-making and detailing level of the norms must take place, but these contentions do not actually exist in the context of the regime.

The next possible steps following the ICOC, LTSSA, and GGE should not be to establish new contentions to attract attention, but to deepen the established guidelines and make efforts to unify the corresponding political top-down commitments and bottom-up technical guidelines, if both of them reach a consensus. Therefore, it can be predicted that this STM regime will be the central component of discussion in the maintenance of sustainable space activities, since this will be the only comprehensive regime used to achieve safe and sustainable space operations in the next few decades. Also, it is not an enigmatic opinion to say that the next legally binding treaty regulating space activities would appear in this regime. It is, of course, necessary to consider the constrained political environment. This will be described in the last Chapter since it is not the lawyers, but the States, who establish international law.[240]

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[239] Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 10.
[240] Bin Cheng, "The Legal Status of Outer Space and Relevant Issues: Delimitation of Outer Space and Definition of Peaceful Use" (1983) 11 Journal of Space Law 89 at 97 [Cheng, "Legal Status"].

Chapter 4

Re-capturing International Space Law for Space Traffic Management

For the sound implementation of an international STM regime, this regime needs to be established in the scope of international law in order to locate the rules within the necessary rights and obligations of State sovereignty. In order to reach this purpose, it is necessary to analyze its legality within the entire framework of the international legal system. Although the major space-faring nations are currently skeptical about new treaties involved in legally binding international space law, it is crucial to analyze the legality of STM and its possible position in the system, in order to facilitate turning a non-legally binding soft law into a legal principle in the near future.

At this stage, the major part of the STM regime can be achieved by the re-interpretation of the UN space treaties or building international consensus with soft laws. Some may end up considering amendments of the existing treaties. This Chapter conducts an analysis to re-capture the current international space law in the context of STM by discussing each individual point. The first two points are the new proposal for the establishment of Space Traffic Rules as necessary norms essential to an STM regime (4.1) and a new concept and structure for fair and effective SSA information and data sharing (4.2). The latter three points are a re-interpretation of the UN space treaties: the delimitation issue of outer space (4.3), the re-consideration of the scope of space objects (4.4), and the way of thinking for State responsibility (4.5).

4.1 Space Traffic Rules

Traffic rules for space operations should be considered the central topic for an STM regime, since the rules regulating traffic will be the most direct rules used to manage the traffic activities. Furthermore, there is no single rule for managing space traffic to date, and this is the only radically new proposal in this thesis.

Establishing rules for space traffic should first start with the "Rules of Space" akin to the thinking and conceptualization behind "Rules of the Air".[241] Rules of Space, as the operational rules for space traffic, should cover the basic methodologies to launch, orbit,

[241] *Chicago Convention*, annex 2.

re-orbit, and de-orbit space traffic to and from outer space. It should be emphasized that providing the highest standard among the States is not effective, and should not be recognized as the purpose of this kind of regulation. Despite this, the most important point is to establish a unified manner of common recognition among all space actors, so that the safety measures can also be included. This method can also be seen in the "Rules of the Air".[242]

The second traffic rule must be the "Rules of Collision Avoidance". Since the collision avoidance procedures have already been implemented by the majority of the operators using SSA data provided by JSPOC, only the recognition and sharing of these procedures as a standardized manner is required. In traffic rules, it is efficient to break down these measures into nominal rules and emergency rules in order to tolerate the emergency collision avoidance procedures, in case the operators do not have enough time to communicate with each other for a nominal maneuver. The contents of the nominal rules will almost have the same manner of the current practices of the operators, but the unification of the operating manner and the recognition of the unified rules are the key of these rules. Since the operators know that all the other operators operate their spacecraft under a unified rule, they would be much more confident in their own calculations, in communicating their predicted collision partners, and in making decisions about their maneuvers.

The emergency rules should be, for instance, that the spacecraft recognizing another space object coming in the direction of its own movement in a certain short distance needs to perform a maneuver in a certain direction and speed in a certain pre-supposed condition. The emergency rules would become applicable in cases when the operator could not expect a possible collision by a predicted calculation based on SSA data, or expect the other object's maneuver in a certain amount of hours in advance. These timeframes, in space operations, should be considered as being last-minute, since space objects need to maintain their speed in orbit and need to move a certain amount of minutes before the expected

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[242] Paul B Larsen, *The Regulation of Air Traffic Control Liability by International Convention* (LLM Thesis, McGill University Institute of Air and Space Law, 1965) at 8-9 [unpublished].

movement subject to their limited propulsion. In cases of the other possible colliding object being space debris, there is no choice but to apply emergency rules.

It is also essential for the STM regime to establish standard measures that include the technologies to be utilized for STM. Namely, these are the communication measures for collision avoidance and the methods of orbital calculation and maneuver, including the treatment of their calculation margins. It would become possible to introduce a device for collision avoidance in the future, similarly to the Airborne Collision Avoidance System (ACAS) in aviation.[243] Differing from aviation, of course, the system would mostly alert the operators in the ground control stations, and a handful of manned spacecrafts.

The necessary traffic rules for an STM regime consist of: Rules of the space; Rules of collision avoidance; Rules for Data Sharing Center; and Communication and technology standards.

4.2 Fair and Effective SSA Information and Data Sharing

At this point, it is unavoidable to consider how to achieve fair and effective sharing of SSA information and data, since SSA is the only measure to date which recognizes the situation in outer space.[244] In order to settle the political challenges and assure the provision of unified SSA information and data to spacecraft or space object operators globally,[245] it is necessary to consider the establishment of an international clearinghouse for data and information sharing. In order to implement this clearinghouse, it is crucial to set an effective and transparent operation for it.[246] The ATM realizes the provisions of ATS from States by dividing airspace into multiple FIRs. However, the nature of space activities does not allow for the same manner, since the satellites in LEO make one round of the Earth in about 90 minutes. They may pass over a country in a few seconds, so controlling these movements by the same concept as FIRs would not be realistic. Furthermore, the concept of FIRs works under the mutual recognition of every State having "complete and exclusive

[243] *Chicago Convention*, annex 2, s 3.2.
[244] See also Schrogl, Lála & Contant-Jorgenson, "IAA STM Report", *supra* note 8 at 91.
[245] See section 3.1 above.
[246] Paul B Larsen, "Outer Space Traffic Management: Space Situational Awareness Requires Transparency" (2008) 51 Proceedings of the Colloquium on the Law of Outer Space 338.

sovereignty over the airspace above its territory"[247], which has never been recognized for outer space.[248] Therefore, it is legally and operationally reasonable to locate a clearinghouse as the central data provider for STM, instead of requiring each State to directly provide information for space operations.

Only for descriptive purposes, this clearinghouse will be called "Data Sharing Center" in this thesis without any other implications. The Data Sharing Center will channel the responsibilities for information and data provision, gather observation data from the SSA entities and operation data from the operators, as well as neutralize the information and data by shadowing, eliminating, or anonymizing sensitive information and data upon the requests of data providers.[249] The main objective of the Data Sharing Center is to provide necessary and sufficient information and data for safety operation to the operators of space traffic. In order to ensure fairness and prevent free riders from using the Data Sharing Center, it should be co-founded by all space object operators, who would share its eligible costs. The integral role of this system is to standardize the data and information utilized for space traffic for the clearinghouse, and thus, the reliability of the operators amongst each other can be reinforced.

On the other hand, it should not be assumed that the State would be free from any obligations regarding data and information sharing. Under current technical availability, only the respective militaries of the US and Russia could provide comprehensive data and information for SSA. Nonetheless, the other States, such as Australia, China, France, Germany, or Japan would have limited ability for SSA[250], so the entire world would have no choice but to depend on the two major space powers for comprehensive data. However, the observation data of the other States would complement that of the US and Russia, and so data from these States could be used for data calibration as well. The orbital information from the space operators would increase the accuracy of the observed data's orbital information: the observation can only be done as passive monitoring, but the operators could track their own satellites by a combination of passive and active tracking. Therefore,

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[247] *Chicago Convention*, art 1.
[248] *Outer Space Treaty*, art 2.
[249] The issue of responsibility and liability will be discussed in subsection 4.5 below.
[250] USSTRATCOM Public Affairs, *supra* note 48.

it is worth it to impose obligations on all the States to provide useful STM data to the Data Sharing Center, allowing the States to conduct a self-screening process to cast aside their security concerns.[251] The data provision from the States may start from voluntary basis provision but it has to become a legal obligation eventually to achieve constant data gathering with equal basis among all of States in space operation. The obligations to the States can be grounded by the Article X of the Outer Space Treaty, which requires promotion of international cooperation to observe the space objects upon request of other States. Although the Article's second sentence leaves the detailed arrangement to the other international agreements, this provision can be seen as the legal basis for SSA Data Sharing Center. Actually, the Soviet Union was conducting its bilateral space object observation cooperation based on this provision from 1966.[252] Admittedly, a new international treaty is needed for imposing the aforementioned obligations to States.

The Space Data Association Limited (SDA) founded by the three major worldwide satellite operators, Inmarsat, Intelsat and SES can be seen as a leading model of SSA Data Sharing Center. SDA, a not-for-profit private company with limited guaranty and incorporated in the Isle of Man, operate a system for sharing real-time operational data for collision avoidance of the members' satellite.[253] SDA is gradually expanding its participation and in 2012 the US National Oceanic and Atmospheric Administration (NOAA) and NASA were joined.[254] It should be seen that the necessity of this type of

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[251] A similar approach is taken by ICAO requesting the States to provide "any potential risks to civil aviation in their airspace", which mainly gathered by intelligence capabilities: ICAO, News Release, "ICAO Clarifies State Responsibilities Arising from Conflict Zones" (24 July 2014) online: ICAO <http://www.icao.int>; ICAO, International Air Transport Association (IATA), Airports Council International (ACI) and Civil Air Navigation Services Organisation (CANSO), "Joint Statement on Risks to Civil Aviation Arising from Conflict Zones"(29 July 2014) online: ICAO <http://www.icao.int>.

[252] Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 188.

[253] Richard DalBello & Michael Mendelson, "Private Risk Management in Orbital Operations: Inter-Operator Liability and the Space Data Association" (2011) 60 German Journal of Air and Space Law 218.

[254] Space Data Association Limited (SDA), Press Release, "Space Data Association: NOAA to Participate in the SDA", 22 May 2012, online: SDA <http://www.space-data.org>; Space Data Association Limited (SDA), Press Release, "Space Data Association: NASA to Participate in the SDA", 8 August 2012, online: SDA <http://www.space-data.org>.

international data center is widely recognized by both commercial and civil governmental operators. Those data should also be gathered in the Data Sharing Center for enhancing the accuracy of its outputs. Since these data is focusing on the operational satellites of the respective entity, it is expected to be precise only with the data of certain satellite but nothing with the others such as non-operational satellites, which are the majority of space object to date. Those data must be relied on observation and those abilities are concentrated on the governmental sides. On the other hand, it is also necessary to remind that the data from commercial operators should also be treated in a similar fashion of those from the governmental entities, including the anonymity, neutralization of data, and liability.

As a consequence, it is reasonable to consider two possible issues regarding the Data Sharing Center. One is that a State may show low motivation to provide data based due to national security considerations. National security concern is the fundamental inherent instinctive State behavior, which is impossible to negate by any unassured reasons.[255] Therefore, there is nothing to do but leave the decision regarding national security issues in the hands of each State.[256] The purpose of the Data Sharing Center should be exclusively for traffic management and the extent of gathering data, and information should be as restricted as possible in order to allow the State to select information to be provided.

The second issue is that the State would willing to differentiate data sharing with certain countries from the multilateral data provision and increase bilateral data sharing aside from the Data Sharing Center. Besides all of this, promoting bilateral SSA data sharing cooperation is a situation to be welcomed. Although unified information and data sharing are indispensable for STM, cooperation with advanced information and data beyond the generally shared information would aid progress in the safety of space traffic. Bilateral cooperation would also eventually raise the level of multi-lateral cooperation, since it is simpler for a State to share certain information with a State with which it has strong relations under a bilateral cooperation and expand the same level of cooperation to

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[255] Hedly Bull, *The Anarchical Society*, 3rd ed (New York: Columbia University Press, 1977); *UN Charter*, art 51.
[256] See also Cheng, "Legal Status", *supra* note 240 at 97.

other States with which it has a weaker relationship if desired. The expansion of bilateral cooperation could be a step for multilateral cooperation but would not impair the purpose of the Data Sharing Center unless the States ignore the minimum level of information sharing to the Center critical to STM. Therefore, it is essential to include in the STM regime the minimum requirements involving providing data to the Data Sharing Center for the maintenance of safety operations, but excluding the factors to withhold the States from conducting a bilateral SSA cooperation aside from the data provision to the Center.

It is also definitely possible to try setting a detailed regulatory circumscription to the State in the STM regime for their provision of data and information in order to prevent States from holding off their provision of information. However, it is in the nature of the international community's current system that the voluntary motivation of the State is always stronger than any other compulsory regulations. The international regulations without authentic agreements from the States would be easily nullified by the States.[257] Though the liability against the damage occurred by the Data Sharing Center will be discussed in the section 4.5.4 below, it is necessary to provide several rationale that SSA Data Sharing Center could be accepted by the States. Besides the demands from the industries and civil space operators reflected to the development of SDA, data sharing cooperation is less costly than continuously taking the risk of environment deterioration by space debris. Another collision in the orbit will not only increase the number of space debris but also may increase the future operation cost by possible expansion of insurance premium and additional risk assessment measures. The security leak concern of sensitive information may be prevented by introducing a mechanism such as assigning liaison officers from the intelligence or military entity to the Center.

4.3 Relativized Delimitation of Outer Space

The delimitation of "outer space" is an issue which has been discussed in the UNCOPUOS-LSC for more than half of the century. Most of the space-faring nations have set forth to give priority neither to the functionalist nor the spatialistspatialist approach: it is given to the "wait-and-see" approach.[258] This attitude is followed by the other space-

[257] See also Bull, *supra* note 255 at 122-155.
[258] Cheng, "Legal Status", *supra* note 240 at 92-95.

faring nations, and the issue is still on the agenda of UNCOPUOS-LSC today. In considering the sustainability of space activities, therefore, the aerial scope of the existing legal regime is still ambiguous. This ambiguity does not bring practical problems at this moment, but remains the fundamental problem in regulating space activities, especially in the issue of to what extent the UN space treaties govern space activities. This problem will occur at some point in the near future because the development of space activities is approaching a crucial point, which will appear in marginal events.

The demarcation of applicable air law and space law is crucial for suborbital spaceflight because its nature of operation straddles both air and outer space.[259] In planning active space debris removal, it is necessary to identify the applicable space law and relevant air law, which may be affected by safety considerations. In controlling space activities, such as a satellite or launch vehicle as systematic traffic, the regulation should identify whether the applicable law should be air law, space law, or both, and to what extent.

It should be said that the time has come to go forward in terms of the developing variation of space activities.[260] But, at the same time, the changed circumstances of the activities have relativized the delimitation issue itself. Namely, considering the current practices of space activities to date, it is realistic to understand that outer space is a hybrid meaning of spatialist and functionalist approaches.

The merit of the spatialist approach involves differentiating air space from outer space with a clear-cut edge. Since this approach would establish a delimitation line between both types of space, defining the applicable law based on the area would be easier, despite the activity's nature. It would also be useful to classify military activity within the regulation of one area or the other. Several exemptions are also required in military activities, so taking the spatialist approach would allow their consideration within at least one of the regulation areas. Moreover, the spatialist approach would allow specifying the applicable law just based on the area of its activities, whatever nature the object or activity may retain. It is the easier way to address the objective indication.

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[259] Vernon Nase, "Delimitation and the Suborbital Passenger: Time to End Prevarication" (2012) 77 Journal of Air Law and Commerce 747.
[260] *Ibid*.

The functionalist approach, on the other hand, would require close observation of the activity's function in order to identify whether the activity should be regulated by air law or space law. Therefore, it might be problematic to recognize that an activity falls under a certain category of law only from its external form. In terms of traffic management, it seems beneficial to have an identifiable external form to allow the regulator to easily identify the applicable rule of the object. However, the physical nature of spacecraft maneuver differs from that of aircrafts or vessels. It is impossible to gain visual images of a spacecraft during its flight in outer space. This differs greatly from the assumption to prioritize visual contact in aircrafts, vessels, or automobiles. Almost all spacecrafts are operated by positioning data, the transmitted GPS data from the satellite itself, the radar observation data from certain ground observation stations, and SSA data. Therefore, identifiability plays only a minor role in the delimitation of space activities. In fact, the functionalist approach is more reasonable, since space objects will be functionally identified by their telemetry, tracking, and control (TT&C) or operational capabilities.

Another rationale used to argue that the functionalist approach is more well-suited for application than the spatialist approach is that the functionalist approach may have the flexibility of allowing any other category of spacecraft or space activities within space regulations. For example, JAXA is currently developing a Super Low Altitude Test Satellite (SLATS), which flies at a relatively low altitude of 200-300km in order to advance the high-resolution Earth observation sensor technology.[261] This altitude is comparatively lower than the orbiting altitude of a normal satellite, which is around 600-800km, while the International Space Station orbit is around 400km. One should easily imagine that the spatialist approach can face another challenge to its criteria in the very near future. It is no exaggeration to say that the altitudes of space activities are gradually relativized, and thus, the criteria of the spatialist approach are gradually becoming vague. The functionalist approach has the advantage in contemporary space

[261] Keizo Nakagawa, "R&D of JAXA Satellite Application Mission", (Presentation delivered at the 26th Microelectronics Workshop, Tsukuba, 24 October 2013) [unpublished].

activities, but moreover, it is also reasonable to say that being a spatialist or a functionalist does not affect the STM regime in practice.

4.4 Scope of Space Object for STM

Considering the premise that the result of outer space delimitation would not affect the scope of the STM regime, the definition of a space object would be the sole integral definition for the STM used to settle its scope. Obviously, the scope of the STM regime has not yet been defined. Therefore, the issue involves whether it should be defined as being in the same scope as space objects, or if it establishes some other category.

4.4.1 Definition and Scope of Space Object

International space law has always faced the constant pressure involved with the absence of a clear definition of "space object". Its only definition in current international space law is "[t]he term of 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof".[262] Literally, space objects are the only regulatory materials subject to the Liability Convention and Registration Convention, as well as Article VII and VIII of the Outer Space Treaty, while Article VI of the Outer Space Treaty only regulates the "activities in outer space". The provision of the definition of space object in the Liability and Registration Convention reinforces this notion. However, considering the way to comprehend these three Articles of the Outer Space Treaty aligned with their ordinary context,[263] Articles VII and VIII can be understood as the detailed prescriptions for State liability of damage and for the registration of space objects, respectively. In turn, Article VI should be understood as stating the general responsibility of the State for space activities. Consequently, the object falling under the definition of "space object" will become the international responsibility of the launching State shouldered with the duty of authorization and continuing supervision, as well as retained jurisdiction and control by the State of registry. Therefore, it can be said that the subject matter designated by "space object" is a dedicated description for the liability and registration systems, which are only a part of international space law. There is no doubt that the two systems were important and both considered to be crucial at the time of drafting

[262] *Liability Convention*, art 1(d); *Registration Convention*, art 1(b).
[263] See section 3.2.3.1 above.

of the UN space treaties. However, regulating other aspects such as the sustainable use of outer space, whether or not the concept of "space object" can be used as subject matter still remains ambiguous.

Aside from this fundamental issue, there are also some cases in which the concept of "space object" falls under ambiguity of application. It is obvious that the satellite, launch vehicle, and trans-orbital vehicle, including rovers on the surface of celestial bodies, fall into the definition of "space object". The controversial objects are space debris and suborbital spacecraft, which may fall outside of the definition. Nonetheless, the prescription of the Liability and Registration Convention on the definition of "space object" obviously expresses that space debris is included under the definition of "space object". This signifies that space debris should be recognized under the "authorization and continuing supervision" by the appropriate State, the damages occurred as a result of space debris should be liable to the launching State of that debris, and the "jurisdiction and control" over it are on the State of registry. As a result, it is clear at this point that space debris is not an issue of the definition of space object, but an issue of controlling its measures or determining the appropriate State in control, which will be discussed in the next subsection.

The case of suborbital spacecraft is much more complicated. A suborbital spacecraft, differing from space debris, cannot be settled spontaneously under the definition of space object because it can be both an aircraft and a space object at the same time. International air law defines "aircraft" as "[a]ny machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface."[264] It also defines "aeroplane" as being included in the aircraft category as "[a] power-driven heavier-than-air-aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight."[265] *Space Ship One* sparked the epoch-making movement of suborbital spaceflight business development by winning the *Ansari X* Prize in 2004.[266] Taking its configuration as the example, the majority of the

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[264] *Chicago Convention*, annex 7, chapter 1.
[265] *Ibid*.
[266] "SpaceShipOne rockets to success", *BBC News* (7 October 2005) online: BBC News <http://news.bbc.co.uk/>.

suborbital spacecraft under development have a similar concept: the suborbital spacecraft takes off from and lands on a runway, similarly to an aircraft. It ascends into air space using jet propulsion in a similar way to the aircraft, and ignites the rocket propulsion system or separates the space flight module along with it to ascend further. After reaching an altitude of around 100 km to perform "space tourism", it descends back down to an altitude where it becomes possible to fly in aerodynamic reactions and come back to the ground as a glider.[267] Therefore, suborbital spacecraft have a reason to meet the definition of aircraft and aeroplane. Reflecting this controversy, ICAO has warned that suborbital spacecrafts should be regulated under international air law, at least when they share the same international air space of other aircrafts conducting international operations.[268] This observation is an inevitable conclusion from the safety point of view of aviation operation.[269] It is easy to imagine that the ICAO limits its own mentioning in international air space, simply because national air space is outside of ICAO's mandate.[270] It is obvious that the nature of safety consideration does not differ from national air space and international air space. Since suborbital spacecraft retain a high potential to pass through air space more frequently than launch vehicles, dodging each case by letting them pass through a special national air space dedicated to them will easily face the limit.[271] It was a self-explanatory conclusion for the aviation community that ICAO called for international regulation for suborbital spacecraft under air law. The ambiguity of the definition of "space object" emanates difficulties, not only for space law because of its applicability to

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[267] *Concept of Suborbital Flights: Information from the International Civil Aviation Organization (ICAO)*, UNCOPUOSLSCOR, 49th Sess, UN Doc A/AC.105/C.2/2010/CRP.9, (2010), s 1.3 [*ICAO's Concept*].
[268] *Ibid*.
[269] See also Ram S. Jakhu, Tommaso Sgobba & Paul Stephen Dempsey, *The Need for an Integrated Regulatory Regime for Aviation and Space, ICAO for Space?* (Vienna: Springer-Verlag, 2012).
[270] *ICAO's Concept*, *supra* note 267.
[271] See also Murray, *supra* note 169. Although it seems still affordable to date to let them use dedicated national air space: John M. Falker, *Engineering and Policy Analysis of Strategic and Tactical Options for Future Aerospace Traffic Management* (Ph. D. in Aerospace Engineering and Policy Analysis Thesis, Massachusetts Institute of Technology, 2002) [unpublished].

suborbital spacecraft, but also for the demarcation of air law and space law to be applied to suborbital spacecraft.

From the STM viewpoint, it is practical to disconnect the subject matter of STM from space objects and focus on "space traffic", since the primary purpose of the STM regime is to regulate traffic in outer space in order to maintain safe and sustainable space activities. The status of "space object" functions in terms of the liability regime under the current international space law. Therefore, the STM regime can exist as a parallel regime of the existing liability regime of international space law. Nonetheless, the result of interference to a space "object" can be subject to the liability regime, interference to space "traffic" may not be subject to the liability regime unless specified to do so in the STM regime.

"Space traffic" needs to be defined as manageable traffic flow located outside of air traffic control. Literally, the flow of ballistic missiles is not manageable even under international air law, and therefore may be excluded from the subject matter of "space traffic". Ballistic missiles are generally justified under international space law by un-categorizing as space objects, with the reason that they do not "orbit" the Earth.[272] However, if suborbital spacecrafts are categorized as space objects, the justification of ballistic missiles becomes inconsistent. This is because the suborbital spacecraft follows a similar trajectory to that of the ballistic missile in terms of its altitude transition. When the suborbital spacecraft was developed to travel to other continents for transportation purposes, it had exactly the same behavior.[273] However, in order to deepen the understanding on the categorization of suborbital spaceflight or ballistic missile under the UN space treaties, a slight stretch of the definition of "space object" is needed anyway because there is essentially no precise definition in existence yet.

From the parallel thought involving the distinction between state and civil aircrafts, it is also possible to distinguish the security used spacecraft from the civil spacecraft based on the States' concerns regarding intelligence satellites. At this point, it is inevitable to

[272] Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 79.
[273] Milton L Smith, "Legal Implications of a Space-Based Ballistic Missile Defense" (1985) 15 California Western International Law Journal 52 at 69-75.

establish regulations for due regards to the safety of the other civil spacecrafts like in air law, which is understood as a legal obligation from the Chicago Convention to the State.[274]

4.4.2 Procedure for Relinquishment of Rights on Space Debris

The crucial points for the scope of space objects in terms of STM are the demarcation between an operational space object and a non-operational space object, as well as the procedure for relinquish the rights over non-operational one. From the stand point of the space operators, all space objects are targets for collision avoidance, but avoiding non-operational objects is given a higher priority since there is no chance that they could move by themselves to avoiding the collision. Therefore, it is necessary to establish a measure to allow the operators to identify whether the object is an operational removable spacecraft or just space debris. Furthermore, it is inevitable to consider removing space debris in the near future.

From this viewpoint, a procedure to relinquish rights over abandoned satellites or upper stages of launch vehicles should be established in order to allow their collection or abolishment in order to reduce space debris.[275] A new rule used in identifying operational and non-operational space objects and procedures for relinquish the rights over them should be determined by the STM regime.[276] This new rule should identify the condition and procedure of relinquishment of the State's rights, as well as the removing measures by ensuring international transparency over using proper technology. However, relinquish the rights over space debris is a double-edged sword: it means the suspension of "jurisdiction and control" of Article VIII from the Outer Space Treaty, as well as a waiver of the launching State's international responsibilities from Article VI, since obligations are always inextricably linked to relative rights. Therefore, the regime should ensure that the relinquishing of jurisdiction and control by the State should be extremely confined in certain conditions. It should also be considered that micro-satellites, which do not maintain abilities for maneuver, must be treated as similar as non-functional satellites in the context

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[274] *Chicago Convention*, art 15.
[275] Brian Weeden, "Overview of the Legal and Policy Challenges of Orbital Debris Removal" (2011) 27:1 Space Policy 38.
[276] *Ibid* at 40.

of safety operation. Since these satellites are still functional, it may cause conflicts among the respective operators. However, leaving these micro-satellites out of the regulation may cause further deployment of space debris in near future.

4.4.3 Regulating Suborbital Spaceflight

From an STM viewpoint, it is also important to recognize suborbital spacecraft as traffic, since they are potential traffic for STM, showing behavior similar to that of launch vehicles until re-entry. The registration and licensing regimes for suborbital spacecraft are necessary for vehicle identification, determination of liability, and safety operation.[277] As "[a] comprehensive and uniform legal regime that specifically envisages the complete launch and return journey of private individuals should be preferred",[278] there is no reason to prevent the application of both regimes of international air law and space law. Since the suborbital spacecraft used for space tourism is a hybrid type which should be regulated in both ways, there are only two options: establishing a new category for regulation, or regulating it by applying all of the existing applicable regulations. It is, of course, more desirable to establish a new category rather than to forcibly regulate through a set of existing regulations, but the current political circumstances do not allow a new establishment of legal regulation. Therefore, at this stage, the only contemporary choice is to apply multiple applicable regulations. The definition of aircraft in international air law signifies that it would only be applicable to when the suborbital spacecraft flies as an aircraft. The regulation of international space law can be applied outside of these scopes, regardless of the delimitation of air space and outer space.

Either way, in terms of traffic management, the hybrid-type suborbital spacecraft should be entitled under the regulation of air traffic as well as space traffic. As a desperate measure without establishing a new legal category, it is beneficial to regulate it as an aircraft while it is being operated as an aircraft or aeroplane, and as a space object when it does not fall under either of these categories. It is also beneficial to allow the international

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[277] Zhao Yun, "Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space" (2009) 74 Journal of Air Law and Commerce 959 at 974-978.

[278] Steven Freeland, "Up, up and ... Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space" (2005-2006) 6:1 Chicago Journal of International Law 1 at 9; See also Jakhu, Sgobba & Dempsey, *supra* note 269 at 119-139.

regime for outer space, including the STM regime, to be applicable to the suborbital spacecraft in such a manner in order to reduce the area of *lacunae* of law.

4.5 State Responsibility and Liability in STM

4.5.1 Encourage National Implementation

The liability system is the key legal element for *ex-posto facto* control, and if the system becomes non-functional, this could create an anarchical situation. Since legal enforcement measures are impossible to anticipate, the liability system should also be considered as a measure for compliance reinforcement of the regime. The current liability system of international space law established fault-based liability for in-orbit damages and absolute liability for ground damages[279]. The liability system in the international legal sphere is quite obvious. The problem is in their national implementation phase, which is the breakdown of the international liability system for the actual operators in each jurisdiction. The domestic implementation of the liability system is necessary because the non-governmental entities, which are the increasing number of actors conducting space activities in this decade, are not subject to liability under international law.[280] It is the State that retains the possibility to be seen as liable for damage inflicted by a non-governmental space activity. In other words, the international liability of the State needs to be implemented domestically as a liability against a private entity in order to bridge the two different legal layers.

The establishment of a license system taken in some space-faring nations is one of the implementing measures. The license systems of the US and France, which can be recognized as those representing the current space-faring nations, include liability procedures in case of an accident. Both of them establish absolute liability to the operators with the obligatory purchase of insurance or equivalent funding for third-party compensation, with a certain ceiling amount of liability and set State coverage systems for the amount exceeding this ceiling.[281] Both systems also embrace channeling liability to

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[279] *Liability Convention*, arts 2-3.
[280] *Outer Space Treaty*, art VI.
[281] 51 USC §50914, 50915 (1984); FSOA, arts 14-17. See also Daisuke Saisho, "Liability Risk Sharing Regime of the Bill of Japan's Legislation on Space Activities and Its

operators. Nonetheless, even if the French Space Operations Act (FSOA) designates the launch operator and satellite operator as the actors obtaining absolute liability,[282] the US Commercial Launch Act of 1984 (CSLA) addresses only the launch and reentry licensee, which does not include satellite operators.[283] The problem is that there are few States which have established a comprehensive license system, and this kind of gaps may create *lacunae* of the law when the activity falls under lack of jurisdiction to be regulated.[284] The existing systems in national law address compensation to the States when the State suffers from the licensed activities, together with the compensation rules to the victims. The States legislating these provisions in their national law will be able to seek compensation from commercial operators in case international compensation is made by the State. It is foreseeable that a State may end up in a situation of being unable to compensate the real liable operator for damage caused by a non-governmental space activity and put pressure on public finance because of the legislation failure of domestic compensation.[285] This is especially true for States such as Canada, Germany, or Japan: they are categorized as space-faring nations and the fact that they have not legislated such a regulation to date might be problematic.

A further precise discussion on the Recommendations in the international fora for enhancing a common understanding is further required. In the field of aviation, a unified regime for civil liability was established as the Warsaw Convention[286] in 1929, and

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Comparison with the US and French Law" (2011) 55 Proceedings of the Colloquium on the Law of Outer Space 107.

[282] FSOA, arts 1.4, 1.5.

[283] 51 USC §50914 (1984).

[284] Apart from the US and France, the States establishing similar provisions are Belgium (Loi du 17 septembre 2005 relative aux activité de lancement, d'opération de vol ou de guidage d'objets spatiaux, 15 January 2014), art 15, Republic of Korea (Compensation for Aerospace Damage Guarantee Act, Act No 8852, 29 February 2008), art 3, and Netherlands (Rules Concerning Space Activities and the Establishment of a Registry of Space Objects, 6 June 2013), art 12, for example.

[285] Atsuyo Ito, *Legal Aspects of Satellite Remote Sensing* (Leiden; Boston: Martinus Nijhoff, 2011) at 283-298.

[286] *Convention for the Unification of certain Rules relating to International Carriage by Air,* 12 October 1929, 49 Stat 3000; 137 LNTS 11 (entered into force 13 February 1933) [*Warsaw Convention*].

amended as the Montreal Convention[287] in 1999. The effort of this legislation was rewarded adequately through multi-layered international discussions based on a common understanding of the rules. Notably, the development of further interpretations of the international rules is conducted through litigations in various jurisdictions, but always based on the Montreal Convention.[288] In STM, the establishment of a unified civil liability regime similar to the Montreal Convention should be considered as an effective solution.

4.5.2 Responsible State for STM

It is worth it to examine the applicable scope of the State responsible for "jurisdiction and control" over a space activity.[289] Notably, the "authority and continuing supervision" is promulgated as the responsibility of the "appropriate State Party", which shall be understood as the respective State in the jurisdiction of the relevant activity.[290] On the other hand, the subject of the State retaining the "jurisdiction and control" over the space object is the "State Party ... on whose registry ... is carried"[291]: that is, the State of registry. At this point, there is a gap between the State exercising the jurisdiction and control, and the State authorizing and supervising the activity. For example, if satellite communication company A' in State A contracts with launch operator B' from State B to launch its Satellite, there could be a gap if these actors did not consult in advance and if State B was not aware regarding the launch of B'. This situation may sometimes happen for micro-satellites, or if State B is a novice in space activities. In current practice, it is a manageable case since State A would normally consult with State B regarding the space object's registration in accordance with Article II.2 of the Registration Convention. However, a problem could occur if State B transfers the satellite's operation to State C after having operated it for

[287] *Montreal Convention for the Unification of Certain Rules for International Carriage by Air*, 28 May 1999, 2242 UNTS 309; S Treaty Doc No 106-45 (2000) (entered into force 4 November 2003) [*Montreal Convention*].
[288] George N Tompkins, "The Continuing Development of Montreal Convention 1999 Jurisprudence" (2010) 35:6 Air and Space Law 433; George N Tompkins, "The Continuing Development of Montreal Convention 1999 Jurisprudence" (2012) 37:3 Air and Space Law 259.
[289] *Outer Space Treaty*, art VIII.
[290] *Ibid*, art VI.
[291] *Ibid*, art VIII.

several years. Since the State of registry is assumed only to be the launching State[292], how can State C, as a newly appeared State, exercise its jurisdiction and control over the satellite?[293]

No other actors other than the sovereign States can play a major role in the international sphere. The "launching State" is considered the subjective actor for the identification of the liable State causing the damage.[294] Despite the importance of the concept, it creates some ambiguities when it comes to determining which State should be liable. The current issues regarding the concept of the launching State are its mismatch with the role of operating States, and poor bilateral coordination among the launching States. The liability system of the UN space treaties does not seem to consider that the operation of a spacecraft could be conducted in a different State than the launching State. However, understanding the "authorization and continuing supervision" as dynamic rights and obligations, and "jurisdiction and control" as static rights and obligations, it is also possible to understand that the active role for space objects is deemed to be the responsibility of the appropriate States, rather than that of the launching States. Consequently, the jurisdiction retained by the State of registry, which is one of the launching States, would be questioned only in the case of relinquishment of rights over space debris, as proposed in section 4.4.2 above.

In other STM regime cases, it should be the appropriate States retaining responsibility as "authority and continuous supervision". Therefore, there is no need for the STM regime to focus on the launching State, but there is a need to entail certain responsibilities to the appropriate States.

4.5.3 Fairness of the Current International Liability System

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[292] *Registration Convention*, art II.1.
[293] Setsuko Aoki, "Satellite Ownership Transfers and the Liability of the Launching States" (in Japanese) (2013) 54 Kuho (Journal of Air Law) 1; *Report of the Chair of the Working Group on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space*, UNCOPUOS LSCOR, 53rd Sess, UN Doc A/AC.105/942 Annex III, (2010), para 8.
[294] *Liability Convention*; *Registration Convention*, arts 2, 4.

Aside from the establishment of a common understanding of the national liability system, it is also necessary to question the international system itself, something which the fairness in current times when it comes to maintaining a fault liability system for orbital damages as Article III of the Liability Convention regulates.[295] As the case of Cosmos-Iridium pointed out, the possibility of identifying the circumstances of a collision in outer space is relatively low because it is difficult to collect objective data, and the potential risk of in-orbit accidents damaging daily activities on the ground gradually rises.[296]

We must recall that the basis of differed liability requirements provided in the Liability Convention exists because of the need for the particular protection of third parties on the ground from damage caused by ultra-hazardous activities.[297] In-orbit damage is considered a fault liability only by a corollary of this necessity. Therefore, in current circumstances, the possibility of third parties suffering from damage caused by space activities is increasing, so the rationale to distinguish the requirements of liability for damage caused by space activities in whatever locus is relativized.[298] It is also remarkable that the difference was stated only in the Liability Convention, but not in the Outer Space Treaty, which is considered the basis of the UN space treaties' framework.

The problem lying here is whether the liability for ground damage should be considered fault liability, or if that for in-orbit damage should be considered absolute liability. With the purpose of assuring the implementation of the STM regime, and considering the difficulty to pinpoint the faulty event in outer space, it is reasonable to argue that the liability arising from outer space activities should be integrated into absolute liability, regardless of the locus of the event. Obviously, premises to incorporate this novice liability regime and the treatment for the amount above the insurance ceiling level should

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[295] Takeuchi, "Challenges", *supra* note 102 at 10-12.
[296] Ram S. Jakhu, "Iridium Cosmos Collision and Its Implications for Space Operations" in Kai-Uwe Schrogl *et al.*, eds., *Yearbook on Space Policy 2008/2009* (Vienna: Springer Vienna, 2010) 254-275. [Jakhu, "Iridium Cosmos Collision"].
[297] James Crawford et al, *The Law of International Responsibility* (Oxford; New York: Oxford University Press, 2010) at 505-512.
[298] Takeuchi, "Challenges", *supra* note 102 at 10-12.

reach a common understanding internationally. States may agree with this new liability system in the future since it will increase the protection of victims and facilitate conflict resolution procedure.

A similar issue has already been discussed in aviation, starting from the first stage of the international discussions of aviation law, and has recently been run into a proposed convention at ICAO.[299] The Rome Convention[300] of 1952 designated strict liability to the operator of the aircraft against third-party damage, and this concept has taken over.[301] Since that time, the international community has unsuccessfully continued the "'guesswork' unsubstantiated by any economic data or statistics"[302] to determine the final limitation of the liability amount. The imbalance appeared in 1999 when the States accepted the *de facto* unlimited liability of the airlines for the damage inflicted on passengers, but the lack of major accidents with a third party's casualties on ground means this issues has remained a low priority.[303]

After the 9/11 tragedy in 2001, the discussions regarding liability against third-party damage were reactivated, and the Unlawful Interference Convention[304] and General Risk Convention[305] were developed in ICAO, which currently waiting for entry into force with sufficient ratifications. No one can predict whether these conventions will enter into force or not, but this should be considered one of the possible regime types that isolate extreme

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[299] Michael Milde, "Liability for Damage Caused by Aircraft on the Surface-Past and Current Efforts to Unify the Law" (2008) 57 German Journal of Air and Space Law 532 at 532-533.
[300] *Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface,* 7 October 1952, ICAO Doc. 7364; 310 UNTS 182 (entered into force 4 February 1958) [*Rome Convention*].
[301] Milde, *supra* note 299.
[302] *Ibid* at 544.
[303] *Ibid* at 545.
[304] *Convention on Compensation for Damage to Third Parties, Resulting from Acts of Unlawful Interference Involving Aircraft,* 2 May 2009, ICAO Doc 9920 (not yet in force) [*Unlawful Interference Convention*].
[305] *Convention on Compensation for Damage Caused by Aircraft to Third Parties,* 2 May 2009, ICAO Doc 9919 (not yet in force) [*General Risks Convention*].

cases from the general risks and establish dual standards for liability regarding third-party damage.

4.5.4 Validation and Liability of SSA Data

Another problem in the current liability system is the absence of verification measures in proving liability in cases of in-orbit accidents. The case of the Cosmos-Iridium collision provided a most suitable example to illuminate this problem. This accident in 2009 clearly showed the difficulty of identifying the fact happening in outer space as legal evidence. Aside from this, there has been no official reaction until now of either the US or Russia seeking compensation against each other regarding the damage arising from the accident based on any international law. In case of one of the State parties being willing to seek compensation based on the Liability Convention, one would have to claim its compensation not later than one year from the date of the damage or the identification of the launching State.[306] Therefore, it can be said that there is no possibility to seek compensation based on the Liability Convention remaining at this stage. Given this perspective, it might be unrealistic to review this case regarding its liability under the provisions of international space law, but this rare case must have taught a lesson.

Under the current liability system, in-orbit damage is regulated as a fault liability. In order to acknowledge the fault of the other party in case of an in-orbit accident, it is normal for the State making the accusation of damage to need to collect evidence with a causal connection between the action of the perpetrating State and the damage itself.[307] Applying this procedure, it becomes complicated to identify the liable side in the collision for the Cosmos-Iridium accident. SSA data may serve as objective information in a technical matter.

However, considering the circumstance that the operations of the comprehensive SSA systems are currently conducted by military entities of the limited space-faring nations, it is questionable from the view of transparency and fairness for this data to be used directly

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[306] *Liability Convention*, art 10.1.
[307] James Crawford, *Brownlie's Principles of Public International Law*, 8th ed. (Oxford: Oxford University Press, 2012) at 542-543 [Crawford, "*Brownlie's International Law*"].

as evidence for a legal solution for the accident. Essentially, there have been no witnesses who could provide legal evidence for accidents in outer space yet.[308]

Another rather legal procedural problem when it comes to using current SSA data for evidence of on-orbit accidents is the problem of burden of proof in an international tribunal. The principle of *onus probandi actor incumbit* is basically considered the due process followed in the International Court of Justice (ICJ) and the majority of international tribunals.[309] As described above, in cases where the technically neutral data is the SSA data, which is considered politically biased whatever the fact may be, the damaged State has no way to retain accurate data other than by the telemetry, tracking, and control (TT&C) data of the operator itself. It should therefore be presumed that there is no chance for the damaged State to collect and present enough evidence like the operated side of the relevant spacecraft.[310]

The liability for indirect damage is essential in order to keep a comprehensive *ex-posto facto* control system for an STM regime. Notably, the liability dealing with the information and data of space objects needs to be considered in addition to the current system, since they are the only means to visualize the situation in outer space and indispensable to proving factual accuracy in case of accidents. Therefore, establishing the liability system for information and data procedures is essential in order to implement the STM regime.[311]

The liability for SSA information and data procedures can be divided into three parts: namely, gathering, provision, and utilization. At this point, it should be recalled that the SSA Data Sharing Center would also play a crucial role to assure the uniformity of the

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[308] Jakhu, "Iridium Cosmos Collision", *supra* note 296 at 259-260; Setsuko Aoki, "The Implications of the Cosmos 2251-Iridium 33 Collision: A State with "Genuine Link" Matters, not a Launching State" (in Japanese) (2011) 110:2 Kokusaiho Gaiko Zassi (Journal of International Law and Diplomacy) 157 [Aoki, "Implications of Collision"].
[309] Chittharanjan Felix Amerasinghe, *Evidence in International Litigation* (Leiden; Boston: Martinus Nijhoff, 2005) at 61-74.
[310] Jakhu, "Iridium Cosmos Collision", *supra* note 296 at 255-260; Aoki. "Implications of Collision", *supra* note 308 at 172-181.
[311] At this point, Ito elucidates the liability for remote sensing data and satellite based navigation data and it can be said the same thing for the SSA data since its data distribution are conducting in the nearly same scheme. (Ito, *supra* note 285 at 244-298.)

information and data in terms of making this data available for the basis of compensation. This conception needs to have its fairness widely guaranteed among the States of space operations, and legal liability to be channeled to the data providers for the operators of space objects is fundamental in this regard.[312] Liability of the damages occurring on the basis of space operations could not only be considered the liabilities to in-orbit operations, but also the damages caused on the ground because of satellite malfunctioning during an in-orbit accident. SSA data also contributes to the calculation of space debris re-entry events by providing a predicted re-entry point, even though pinpointing the precise spot is impossible under current technology.[313]

Concerning the huge potential of being held liable for the data-providing failure, negative effects to the information and data providers are easily presumable. If this liability is imposed solely on the SSA entities, they will simply refrain from providing information and data, which will lead to a lack of swiftness and inclusiveness of the information and data-providing services. A single benefit cannot be provided by this circumstance to the entire operation of space objects, since the SSA entities are the sole entities available to observe the situation of space objects. This discussion refers back to the necessity of the Data Sharing Center of section 4.2.

[312] See section 4.2 above.
[313] Carmen Pardini & Luciano Anselmo, "Reentry predictions of three massive uncontrolled spacecraft", (Paper delivered at the 23rd International Symposium on Space Flight Dynamics, Pasadena, 29 October-2 November 2012).

Chapter 5

Establishment of the New International Regime for STM

Following the examination of the possible set of rules provided by the IAA STM Report and the legal analysis on the existing issues in the above chapter, this chapter summarizes the author's proposal as the recommended set of rules for the STM international regime. Recalling the negotiation history of the Outer Space Treaty, it was started by the discussion for the adoption of an UNGA resolution without legally binding effect,[314] however the resolution later became the basis of international space law. The history of the international STM regime could also have begun with soft laws.

In order for an international regime to work efficiently, it should define its subject matter as appropriate as can be manageable, describe reasonable control measures, and address each actor's roles workably and effectively. The proposal will follow this structure for the sake of comprehensiveness.

5.1 Subject Matters

Designating the subject matters is essential for the international regime, since it frames the scope of objectives to be regulated by the regime. Without an exact scope of the subject matters, the regime could easily be incapacitated or abused by simply pointing out the ambiguity of the scope.

Current international space law designates the material subject matter in two ways. The first one is the exploration and use of "outer space"[315], and the other is "space object".[316]

An STM regime, considering its purpose, does not need to stick to the definition of space object, but apply to overall "space traffic". Space traffic includes all kinds of spacecrafts, space debris, and suborbital spacecrafts during its uncontrolled stage by air law. Although an STM regime has an affinity for the functional definition of outer space, it can stand on either the spatialist or functionalist definition of outer space. The STM

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[314] Cheng, "International Space Law", *supra* note 69 at 125-149.
[315] *Outer Space Treaty*, art I.
[316] *Ibid*, art VIII; *Liability Convention*, art I(d); *Registration Convention*, art I(b).

regime's legal authority would generally fall under the definition of "authorization and continuous supervision" (Article VI, Outer Space Treaty), and thus, the appropriate States would retain responsibility over the regime. Nonetheless, it can be formed only by soft laws until the political situation allows the new international legislation. In addition, because of the "jurisdiction and control" over the spacecraft remaining in the launching States, the procedure to relinquish the rights of obligations over space debris must be determined.

5.2 Measures to Control the Regime

The control measures to ensure the regime's compliance is made up of *ex-posto facto* control measures, which are the liability system and consulting mechanisms, and preventive control measures. Nevertheless, consulting mechanisms can play both roles, since they can contain the mechanism to case prevention or remedy.

The major issue of the STM regime involves establishing the preventive control mechanism of Space Traffic Rules and the SSA Data Sharing Center (tentative name). It is necessary to establish Space Traffic Rules, consisting of Rules of space, Rules of collision avoidance, Standard measures of communications and calculations, and technology standards as the key rules of the STM regime. The fundamental functions of SSA data sharing to sustain the regime would be brought together in the Data Sharing Center, jointly funded by the operators, exclusively for the promotion of safety operations by the spacecraft operators, and the Center would channel the liability caused by the provided data. This liability has to be considered as one of the additional legislation, since it may be pursued by the data users. Although the liability system plays an important role to retain compliance with the regime, it may consider a separate regime. The liability arising from activities in the STM regime, such as in-orbit collisions or the failure of data provision, would fall under the current liability regime.

Several aspects would become incompatible to the nature of the current space liability system. The fairness of the current liability system should be questioned, since the damage resulting from the implementation of STM would arise equally in orbit and on the ground.

5.3 Space Actors

It is more than clear that the central actor in the sphere of international law is the sovereign State. No actor other than the State is able to establish international law, to

become a regulator, or to implement regulations domestically.[317] Therefore, it is illogical to question who should play the central role in promoting an international regime. Even if the international community is going to experiencing a further less State-centric era for space activities, it is only the States that can create and apply the law.

However, it is by no means free from a question of on which stage should the topic of an international regime of space activities be discussed.

From 1959, UNCOPUOS has taken the primary role for information exchange in space activities, as well as the legislation of UN space treaties. After the adoption of the Moon Agreement and its failure to attract the ratification of the major space-faring nations, UNCOPUOS entered into an era of complimentary responses by soft laws, since it could not reach the adoption of binding international treaties.[318] This situation is the reason which has pointed out the weakening of UNCOPUOS. It has always been hoped that the international community would find a way to reorganize the international treaty-making function back to the main stage, which has never been done until now.[319]

Starting in the 1980s, CD has deliberated the prevention of an arms race in outer space (PAROS), which immediately faced the adverse effect of the consensus adoption system and ended in an endless loop of political games involving continuously declining the adoption of PAROS as the agenda item.[320] From 2002, China and Russia have been proposing to prevent the deployment of weapons and the use of force in outer space, and have turned to the draft treaty to prevent the positioning of weapons in outer space (PPWT) in 2008. This proposal has not reached the start of its negotiations because of the US' constant opposition.[321] Some experts have analyzed this situation as a political show from China to gain an excuse to developing ASAT[322], but whatever the motivation may have

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[317] Crawford, "Brownlie's International Law", *supra* note 307 at 48-111; Cheng, "International Space Law", *supra* note 240.
[318] Hobe, Schmidt-Tedd & Schrogl, *supra* note 68 at 16-17.
[319] *Ibid*.
[320] Robinson, *supra* note 171 at 30-31; Rathgeber, Remuss & Schrogl, *supra* note 121.
[321] Mischa Hansel, "The USA and Arms Control in Space: An IR Analysis" (2010) 26:2 Space Policy 91; Hitchens,"US-Sino Relations", *supra* note 85.
[322] Hansel, *ibid*.

been, it again exposed the deadlocked situation of treaty-making in CD similar to UNCOPUOS. Therefore, the EU moved to an ad-hoc consultation forum to consider the ICOC. The problem that could be raised here is whether UNCOPUOS and CD have lost their ability to produce international law. If so, which international mechanism should be embraced to negotiate and reach international consensus to maintain sustainable space activities? At this point, the internal study of ICAO regarding its possibility to regulate suborbital flight concludes that it should be the ICAO's task in the near future to regulate these activities[323]. A few experts have also argued with this view.[324]

The existing international organizations dealing with the international adjustment of space activities have been experiencing stagnation following the reluctance of the major space powers to promote international legislation in this area. However, it should be recognized that UNCOPUOS is continuing its efforts to have the norms of UN space treaties emerge, though most of them end with an abstract result. The efforts themselves are going in the right direction, and it should be known that even just forming these abstract results requires struggles.[325] The obstacles are the consensus system and ad-hoc working system in implementing both UNCOPUOS and CD. The consensus system, which is employed in UNCOPUOS and CD for its adoption from the agenda item to the output products, was the established system from the beginning of these international conferences.[326] However, the number of applying consensus systems has been diminishing among international organizations.[327]

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[323] *ICAO's Concept*, *supra* note 267.

[324] Dempsey, "Air Law", *supra* note 182 at 761; Zhao, *supra* note 277; Jakhu, Sgobba & Dempsey, *supra* note 269.

[325] *Recommendations on national legislation* (*supra* note 107) required two years after the adoption of the Report of the Working Group only for modifying final wordings and submitting to the UNGA as its draft resolution even the contents were essentially the same. The author served as a part of Japanese delegation to UNCOPUOS from 2010 to 2013 and obliged to let his colleagues spending the whole two weeks term of the LSC and eight days of UNCOPUOS by himself in total to reach consensus on a proposal of one year agenda of "General exchange of information on non-legally binding United Nations instruments on outer space" in 2013. (C.f. *Report of the Committee on the Peaceful Uses of Outer Space*, UNGAOR, COPUOS 56th Sess, 2013, OP 252).

[326] Cheng, "International Space Law", *supra* note 69 at 128.

[327] Most of the committee and GA of the UN apply the single majority procedure and the Security Council takes a specified majority procedure. (*Rules of Procedure of the*

In order to advance the discussion in UNCOPUOS and CD, it is necessary to shift from the complete consensus system to at least a partial one: for instance, applying the single majority for the procedural matters. Otherwise, it is clear that these international conference bodies will eventually lose their substance. The working systems of these conferences follow the ad-hoc and time-targeted systems. In other words, for the sake of achieving a certain result in an effective timeframe, it is usual to adopt an agenda item with a timeframe of one to four years and form a working group for detailed consideration. All the work advancement relies on the delegations, and most of them use their best efforts to maintain the time frame. However, since the delegations meet only one to three times a year, and most of their portfolio is not dedicated solely to space affairs but to science diplomacy in general, it is difficult to make major progress in every single agenda item.

The conference bodies making rapid progress generally retain more resources and professional staff. For instance, the International Atomic Energy Agency (IAEA) has 1,142 professional staff members in six departments.[328] ICAO has 536 professional staff members in five bureaus.[329] OOSA, serving as the secretariat of UNCOPUOS, has only two sections and around 23 staff members.[330] This cannot be promising when it comes to conducting consecutive professional work to fully support the delegations. In order to extend UNOOSA's tasks to promote the STM regime, its drastic augmentation is imperative. More expert staff members dealing with the substantial issues of the deliberation in UNCOPUOS would be required, inter-sessional activities would be more

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General Assembly, UNGAOR, UN Doc A/520/Rev 17, (2007); *Provisional Rules of Procedure of the Security Council*, UNOR, UN Doc S/96/Rev 7, (1982)) The World Trade Organization embraces the negative consensus procedure for adopting the case for its Dispute Settlement Body. (*Rules of Conduct for the Understanding on Rules and Procedures Governing the Settlement of Disputes*, WTO Doc WT/DSB/RC/1 (96-5267), (1996)).

[328] IAEA, *Personnel Staffing of the Agency's Committee*, IAEA, Report of the Director General, IAEA Doc GOV/2013/34-GC(57)/14, (2013).

[329] ICAO, *Budget of the Organization 2014 – 2015 – 2016*, ICAO Doc 10030, 38th Assembly, (2013), Exhibit 1.

[330] *Proposed programme budget for the biennium 2014-2015*, UNGAOR, 68th Sess, UN Doc A/68/6 (Sect. 6), (2014).

active, and the substantive cooperation with delegation and UNOOSA could become more frequent.

5.4 Other Necessary Political issues for installation of STM regime

Before concluding this thesis, it is necessary to mention several political issues as challenges being confronted in establishing the STM regime. As Milde states, "[a]cademic perfection is of little relevance if it is not in harmony with the political will of states and if it does not respond to a sense of priority and the necessity for international action."[331]

5.4.1 Ideal Regulatory Organization

The voices allowing ICAO to regulate space traffic, or at least suborbital spacecraft, seem to be becoming loud among academia.[332] The primary concern of these voices is the issue of aviation safety. Shedding light only on the aspects of safety, there is no logical doubt for ICAO to regulate suborbital spacecraft while there are flights in air space. However, the hesitation is rather based on political issues. Namely, the portfolio conflicts of international officials and financial problems are what needs to be solved.

As described in Section 5.3, it is no exaggeration to say that OOSA is currently dealing with overwhelming tasks in its small office. In order to impose some additional functions for STM, or regulatory matters, the current secretariat needs to be reinforced 20 fold, reaching that of ICAO. This funding issue would be a daunting task to mention to the international community. If ICAO became involved in the STM regime, it may eventually become involved not only for the aviation safety aspect of the suborbital spaceflight, but also for the other STM aspects, such as managing entire space traffic. One should be reminded that regulating suborbital spaceflight is mere entrance of the regulation of entire STM regime. This is because space law and air law are both applicable to suborbital spacecraft at the same time. Starting regulating from one side will require regulation of the other side accordingly. While arguing that ICAO should take the role of "regulating suborbital spaceflight", it should be together with future prospects. Obviously, since ICAO

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[331] Milde, *supra* note 190 at 66.

[332] Jakhu, Sgobba & Dempsey, *supra* note 269; Nase, *supra* note 259; Melanie Walker, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 Journal of Space Law 375.

does not retain authority to regulate suborbital spaceflight outside of the definition of aircraft under the current Chicago Convention, review on it will be required at that time. Furthermore, space activities experts for the secretariat have to be recruited for serving the professional works. It should be reminded that this would be an overwhelming project. It is also said that the ITU may also be a candidate for ruling international organization for STM regime.[333] The author doubt it since the ITU is an international organization dealing with telecommunication and radio frequency. It is true that radio frequency is indispensable for space activity but it is only a measure for space activity and not the space activity itself. The regulatory organization of STM regime should be the one with the entire picture of space activities.

5.4.2 Cost Allocation

An STM regime requires certain costs, such as that to operate the Data Sharing Center, continuous negotiations to implement the rules, and daily operations to prepare and report for the support of these governmental negotiations. These costs will be absorbed by the State sovereignty as beneficiaries, which is the same as the other international regimes' systems. Obviously, the operating costs will continue increasing.

The ICOC intends to shape a Central Point of Contact as its secretariat function, though the details have not been decided yet.[334] Aside from these institutional costs, when it comes to accomplishing the main purpose of the STM regime as to ensure the safety of space operations, an equal cost allocation system should be embraced among the States, for the additional costs of the Data Sharing Center. At this point, the process of the aviation navigation cost allocation system should be further examined for comparative research on this topic. This issue should be carefully examined including the questions whether the differences or equality of developed countries and developing countries or the cost allocation plan from the beginning to the future.

5.4.3 Political Momentum

[333] ITU, "Supervisory Authority of the future international registration system for Space Assets" (2014) online: ITU < http://www.itu.int/>.
[334] *ICOC, supra* note 119, s 9.

The topics raised by the STM regime are closely related to the security issues of the major space powers. Since the STM regime intends to regulate all spacecraft, including their security capabilities, promoting the establishment should be based on careful attention to the international security circumstances, which is, of course, does not only relate to space issues.

Based on this consideration, today is certainly not the right time to promote it, due to other security issues. Issues involved in Ukraine and the East and South China Seas are casting a shadow on international security circumstances. The movement of the US administration in this half-decade reacting to the continuing development of the Chinese ASAT ability can be seen as a touchstone. The Chinese ASAT ability development evolved from the US' disregard of the Chinese reaction to the US' domination as a space power. Because of the US' continuous denial of the existence of an arms race in outer space, China has reinforced its concern, which ended up in developing ASAT capability.[335] After the Chinese physical capability was demonstrated, the issue became whether the US would start to find a compromise with China or maintain a hard line. It is therefore not a mystery if the US also admits to proposing the discussion of the STM regime in order to solve their compromised approach towards China. Their policy of turning towards being an active partner regarding ICOC shows its possibility in the near future. Certain senior officials have expressed their views signifying the same direction.[336]

[335] Hitchens, "US-Sino Relations", *supra* note 85.
[336] Frank A. Rose, Press Release, "Remarks made at the Carnegie Endowment for International Peace" (24 July 2013) online: US Department of State <http://www.state.gov>.

Chapter 6
Conclusion

The congested, contested and competing situation in outer space has been bringing humankind to a heavy challenge since the beginning of space activities. The international community's efforts are fairly well-related to the performance of technology development, but less for the regulatory aspect. Introducing the concept of STM is not a mere trend, but a rare catalyst for regulatory evolution to confront the challenge. This thesis, following the historical milestone known as the IAA STM Report, demonstrated the necessity and admissibility to locate the STM concept as an international regime together with the reinterpretation of current international space law.

The three reasons of the necessity to establish STM regime are: a unified basic rule for STM is essential for effective and safe space operations, the unified rule will also serves as the basis of liability, which eventually works as *ex-posto facto* regulation against States, and the regime as "regulatory big bang" is necessary for solving the current situation. Guided by the traffic management regime of the air and maritime, STM regime can start its establishment from a set of soft laws and elaborate their certain rules toward hard laws in near future. Space Traffic Rules and the SSA Data Sharing Center are the two core mechanisms that must be newly established for STM regime. Without these two functions the regime will not achieve its purpose. As premises for establishing the regime, several points of international space treaties must be re-interpreted. STM regime must not be subject to "space objects" but a new concept of "space traffic", including suborbital spacecraft, and it should not be considered that the launching State is solely responsible for the regime rules but all of the appropriate States would be so. A procedure for relinquish the rights on space debris is necessary to allow space debris removal. The liability system continues to regulate the States as a parallel regime of the STM regime, although the current differentiation of liability criteria against in-orbit and ground damages should be questioned its fairness under the current circumstances that space technologies are familiarized in our daily lives.

The power to establish the international regime is undoubtedly held by the States: hence, putting these proposals into practice depends on the political will of these States,

especially the space-faring nations. However, several demerits described in this thesis show that the States, which are the major players in space activities, will also suffer damage if the STM regime is not put into function. The starting point can be settled within arm's reach from the current political situation, but the goal should be ambitious, especially considering the total harm potentially involved in the failure to act. We must realize that no other policy is as harmful as continuing the current unsustainable space activities, which jeopardize the outer space environment, because it could mean ruining our entire proud history of space development.

LIST OF REFERENCES

LEGISLATION: INTERNATIONAL DOCUMENTS

Agreement governing the Activities of States on the Moon and Other Celestial Bodies, 5 December 1979, 1363 UNTS 3 (entry into force 11 July 1984).

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched Into Outer Space, 22 April 1968, 672 UNTS 119, 19 UST 7570, TIAS No 6599, 7 ILM 151 (entered into force 3 December 1968).

Application of the concept of the "launching State", GA Res 59/115, UNGAOR, 59th Sess, UN Doc A/RES/59/115 (2004).

Chair of the Working Group, *Proposal by the Chair of the Working Group on the Long-term Sustainability of Outer Space Activities for the consolidation of the set of draft guidelines on the long-term sustainability of outer space activities*, UNCOPUOSOR, 57th Sess, UN Doc A/AC.105/2014/CRP.5 (2014).

Charter of the United Nations, 26 June 1945, Can TS 1945 No 7, 59 Stat. 1031, 145 UKTS805, 24 UST 2225, TIAS No 7739 (entered into force 24 October 1945).

Concept of Suborbital Flights: Information from the International Civil Aviation Organization (ICAO), UNCOPUOS, Legal Subcommittee, 49th Sess, A/AC.105/C.2/2010/CRP.9, (2010).

Convention for the Unification of Certain Rules Relating to International Carriage by Air, 12 October 1929, 49 Stat 3000; 137 LNTS 11 (entered into force 13 February 1933).

Convention on Compensation for Damage Caused by Aircraft to Third Parties, 2 May 2009, ICAO Doc 9919 (not yet in force).

Convention on Compensation for Damage to Third Parties, Resulting from Acts of Unlawful Interference Involving Aircraft, 2 May 2009, ICAO Doc 9920 (not yet in force).

Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface, 7 October 1952, ICAO Doc. 7364; 310 UNTS 182 (entered into force 4 February 1958).

Convention on International Civil Aviation, 7 December 1944, 15 UNTS 295, ICAO Doc 7300/6 (entered into force 4 April 1947).

Convention on International Liability for Damage Caused by Space Objects, 29 March 1972, 961 UNTS 187; 24 UST 2389; 10 ILM 965 (1971) (entered into force 1 September 1972).

Convention on Registration of Objects Launched into Outer Space, 6 June 1975, 28 UST 695, 1023 UNTS 15 (entry into force 15 September 1976).

Convention on the International Regulations for Preventing Collisions at Sea, 20 October 1972, 1050 UNTS 16.

Draft International Code of Conduct for Outer Space Activities, 31 March 2014.

Guidelines for Vessel Traffic Services, IMO Res A.578(14) (1985).

Guidelines for Vessel Traffic Services, IMO Res A.857(20) (1997).

Inter-Agency Space Debris Coordination Committee (IADC), *IADC Space Debris Mitigation Guidelines,* IADC-02-01 Revision 1 (2007).

————, *Terms of Reference for the Inter-Agency Space Debris Coordination Committee (IADC),* IADC-93-01 (rev.11.2), (1993).

International Convention for the Safety of Life at Sea, 1 November 1974, 1184 UNTS 2.

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 7 July 1978, 1361 UNTS 2.

International Civil Aviation Organization (ICAO), *Global Air Traffic Management Operational Concept*, ICAO Doc 9854, AN/458, 1st ed, (2005).

————, *Procedures for Air Navigation Services (PANS) - Air Traffic Management (ATM),* ICAO Doc 4444, (2007).

————, *Procedures for Air Navigation Services (PANS) – Aircraft Operations (OPS),* ICAO Doc 8168, (2006).

————, *Procedures for Air Navigation Services (PANS) – ICAO Abreviations and Codes (ABC),* ICAO Doc 8400, (2010).

————, *Procedures for Air Navigation Services (PANS)-Training (TRG),* ICAO Doc 9868, (2006).

————, *Budget of the Organization 2014 – 2015 – 2016,* ICAO Doc 10030, 38th Assembly, (2013).

———, *2013–2028 Global Air Navigation Plan*, ICAO Doc 9750-AN/963, 4th ed, (2013).

———, *ICAO's Policies on Charges for Airports and Air Navigation Services*, ICAO Doc 9082, 9th ed, (2012).

International cooperation in the peaceful uses of outer space, GA Res 64/86, UNGAOR, 64th Sess, UN Doc A/RES/64/86 (2010).

Montreal Convention for the Unification of Certain Rules for International Carriage by Air, 28 May 1999, 2242 UNTS 309; S Treaty Doc No 106-45 (2000) (entered into force 4 November 2003).

Personnel Staffing of the Agency's Committee, IAEA, Report of the Director General, GOV/2013/34-GC(57)/14, (2013).

Proposed programme budget for the biennium 2014-2015, UNGAOR, 68th Sess, A/68/6 (Sect. 6), (2014).

Protocol in respect of the claim for damages caused by the Satellite "Cosmos 954", Canada and Union of Soviet Socialist Republics, 2 April 1981, 1470 UNTS 269.

Provisional Rules of Procedure of the Security Council, UNOR S/96/Rev 7, (1982).

Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects, GA Res 62/101, UNGAOR, 62nd Sess, UN Doc A/RES/62/101 (2007).

Recommendations on national legislation relevant to the peaceful exploration and use of outer space, GA Res 68/74, UNGAOR, 68th Sess, UN Doc A/RES/68/74, (2013).

Report of the Chair of the Working Group on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space, UNCOPUOSLSCOR, 53rd Sess, UN Doc A/AC.105/942 Annex III, (2010).

Report of the Committee on the Peaceful Uses of Outer Space, UNGAOR, 68th Sess, Sup No20, UN Doc A/68/20 (2013).

Report of the Committee on the Peaceful Uses of Outer Space, UNGAOR, 67th Sess, Sup No 20, UN Doc A/67/20 (2012).

Report of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities, UNGAOR, 68th Sess, UN Doc A/68/189, (2013).

Report of the Scientific and Technical Subcommittee on its forty-eighth session, UNCOPUOSOR, 54th Sess, UN Doc A/AC.105/987.

Report of the Scientific and Technical Subcommittee on its fifty-first session, UNCOPUOSSTSCOR, 51st Sess, UN Doc A/AC.105/1065 (2014).

Rio Declaration on Environment and Development, UNGAOR, (1992).

Rules of Conduct for the Understanding on Rules and Procedures Governing the Settlement of Disputes, WTO WT/DSB/RC/1 (96-5267), (1996).

Rules of Procedure of the General Assembly, UNGAOR A/520/Rev 17, (2007).

Space Debris Mitigation Guidelines of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, UNGAOR, Res 62/217, (2007).

Transparency and confidence-building measures in outer space activities, GA Res 61/75, UNGAOR, 61st Sess, UN Doc A/RES/61/75 (2006).

Transparency and confidence-building measures in outer space activities, UN Res 65/68, UNGAOR, 65th Sess, UN Doc A/RES/65/68 (2011).

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 27 January 1967, 610 UNTS 205, 18 UST 2410, TIAS No 6347, 6 ILM 386 (entered into force on 10 October 1967).

United Nations Convention on the Law of the Sea, 10 December 1982, 21 ILM 1261 (entered into force on 16 November 1994).

LEGISLATION: DOMESTIC DOCUMENTS

Belgium, *Loi du 17 septembre 2005 relative aux activité de lancement, d'opération de vol ou de guidage d'objets spatiaux*, 15 January 2014.

European Space Agency (ESA), "European Code of Conduct for Space Debris Mitigation (Issue 1.0)", 28 June 2004.

————, Director General's Office, "Space Debris Mitigation for Agency Projects", ESA/ADMIN/IPOL(2008)2, 1 April 2008.

France, *Loi nº 2008-518 du 3 juin 2008 relative aux opérations spatiales*, JO, 4 June 2008, 9169.

———, *Décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales*, JO, 11 June 2009, 9406.

———, *Arrêté du 31 mars 2011 relatif à la réglementation technique en application du décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales*, JO, 31 May 2011, 9415.

Japan, *Law Concerning Japan Aerospace Exploration Agency*, Law No 161 of 2002.

———, Japan Aerospace Exploration Agency (JAXA), "Space Debris Mitigation Standard", JAXA-JMR-003A, October 2003 (updated to JAXA-JMR-003B at 1 February 2011).

———, JAXA, *JAXA Standard Rules for Launching Space Objects* (in Japanese), Rule No 15-37, 2003 <http://www.jaxa.jp/about/disclosure/data/k_37.pdf>.

Netherlands, Rules Concerning Space Activities and the Establishment of a Registry of Space Objects, 6 June 2013.

Republic of Korea, Compensation for Aerospace Damage Guarantee Act, Act No 8852, 29 February 2008.

Russian Federation, "National Standard of the Russian Federation, General Requirements on Space Systems fo the Mitigation of Human Producted Near Earth Space Pollution", 2009.

United States of America (US), *Commercial Space Launch Act*, 51 USC §509 (1984).

———, 14 CFR §1214 (1958).

———, 14 CFR Chapter 1 (1966)

———, 14 CFR 91.143 (2004).

———, *National Space Policy of the United States of America*, (2006).

———, *National Space Policy of the United States of America*, (2010)

———, Department of Defense & Office of the Director of National Intelligence*National Security Space Strategy (Unclassified Summary)*, (2011).

———, "Process for Limiting Orbital Debris", NASA-STD-8719.14, 28 August 2007.

SECONDARY MATERIALS: MONOGRAPHS

Amerasinghe, Chittharanjan Felix, *Evidence in International Litigation* (Leiden; Boston: Martinus Nijhoff, 2005).

Bull, Hedly, *The Anarchical Society*, 3rd ed. (New York: Columbia University Press, 1977).

Cheng, Bin, *Studies in International Space Law* (Oxford: Clarendon Press, 1997).

Crawford, James, *Brownlie's Principles of Public International Law*, 8th ed. (Oxford: Oxford University Press, 2012).

———, et al, *The Law of International Responsibility* (Oxford; New York: Oxford University Press, 2010).

Dempsey, Paul Stephen, *Public International Air Law* (Montreal: McGill University, 2008).

Dempsey, Paul Stephen & Laurence E. Gesell, *Public Policy and the Regulation of Commercial Aviation* (Chandler: Coast Aire Publications, 2013).

Falker, John M, *Engineering and Policy Analysis of Strategic and Tactical Options for Future Aerospace Traffic Management* (Ph. D. in Aerospace Engineering and Policy Analysis Thesis, Massachusetts Institute of Technology, 2002) [unpublished].

Hobe, Stephan, Bernhard Schmidt-Tedd & Kai-Uwe Schrogl, *Cologne Commentary on Space Law Vol I Outer Space Treaty* (Cologne: Carl Heymanns Verlag, 2009).

Ito, Atsuyo, *Legal aspects of satellite remote sensing* (Leiden; Boston: Martinus Nijhoff, 2011).

Jakhu, Ram S., Tommaso Sgobba & Paul Stephen Dempsey, *The Need for an Integrated Regulatory Regime for Aviation and Space, ICAO for Space?* (Vienna: Springer-Verlag, 2012).

Jaramillo, Cesar, ed, *Space Security Index 2013*, 10th ed. (Waterloo, Canada: Project Ploughshares, 2013).

Krasner, Stephen D., *International Regimes* (Ithaca: Cornell University Press, 1983).

Marboe, Irmgard, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012).

Rajagopalan, Rajeswari Pillai & Daniel A. Porras, eds, *Awaiting Launch: Perspectives on the Draft ICOC for Outer Space Activities* (New Deli: Observer Research Foundation, 2014).

Schrogl, Kai-Uwe, Petr Lála & Corinne Contant-Jorgenson, *Cosmic Study on Space Traffic Management* (Paris: International Academy of Astronautics (IAA), 2006).

Schwenk, Walter & Rüdiger Schwenk, *Aspects of International Co-operation in Air Traffic Management* (The Hague; Boston; Cambridge: Martinus Nijhoff, 1997).

SECONDARY MATERIALS: ARTICLES

Abbott, Kenneth W. & Duncan Snidal, "Hard and Soft Law in International Governance" (2000) 54:3 International Organization 421.

Ailor, William H., "Space traffic management: Implementations and implications" (2006) 58:5 Acta Astronautica 279.

Aoki, Setsuko, "The Function of 'Soft Law' in the Development of International Space Law" in Irmgard Marboe, ed, *Soft Law in Outer Space* (Vienna: Heribert, 2012) 57.

———, "The Implications of the Cosmos 2251-Iridium 33 Collision : A State with 'Genuine Link' Matters, not a Launching State" (in Japanese) (2011) 110:2 Kokusaiho Gaiko Zassi (Journal of International Law and Diplomacy) 157.

———, "Satellite Ownership Transfers and the Liability of the Launching States" (in Japanese) (2013) 54 Kuho (Journal of Air Law) 1.

———, "'Space Traffic Management' for the Prevention of Weaponization of Outer Space" (2008) 51 Proceedings of the Colloquium on the Law of Outer Space 154.

Aslanov, Vladimir & Vadim Yudintsev, "Dynamics of Large Space Debris Removal Using Tethered Space Tug" (2013) 91 Acta Astronautica 149.

Bird, Duane, "Sharing Space Situational Awareness Data", (Paper delivered at the 2010 Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, 14-17 September 2010).

Bonnal, Christophe, Jean-Marc Ruault & Marie-Christine Desjean, "Active Debris Removal: Recent Progress and Current Trends" (2013) 85 Acta Astronautica 51.

Bourbonniere, Michel & Louis Haeck, "Military Aircraft and International Law: Chicago Opus 3" (2000) 66 Journal of Air Law and Commerce 885.

Cheng, Bin, "The Legal Status of Outer Space and Relevant Issues: Delimitation of Outer Space and Definition of Peaceful Use" (1983) 11 Journal of Space Law 89.

Christiansen, Eric L., "Design and Performance Equations for Advanced Meteoroid and Debris Shields" (1993) 14:1-4 International Journal of Impact Engineering 145.

DalBello, Richard & Michael Mendelson, "Private Risk Management in Orbital Operations: Inter-Operator Liability and the Space Data Association" (2011) 60 German Journal of Air and Space Law 218.

de Montluc, B., "SSA: Where Does Europe Stand Now?" (2012) 28:3 Space Policy 199.

DeLuca, L. T. *et al.*, "Active space debris removal by a hybrid propulsion module" (2013) 91 Acta Astronautica 20.

Ferrazzani, Marco, "Soft Law in Space Activities" in Irmgard Marboe, ed., *Soft Law in Outer Space* (Vienna: Heribert, 2012) 99.

Freeland, Steven, "The Role of 'Soft Law' in Public International Law and its Relevance to the International Legal Regulation of Outer Space" in Irmgard Marboe, ed., *Soft Law in Outer Space* (Vienna: Heribert, 2012) 9.

———, "Up, up and ... Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space" (2005-2006) 6:1 Chicago Journal of International Law 1.

Goh, Gerardine Meishan, "Softly, Softly Catchee Monkey: Informalism and the Quiet Development of International Space Law;" (2008-2009) 87:3 Nebraska Law Review 725.

Hansel, Mischa, "The USA and Arms Control in Space: An IR Analysis" (2010) 26:2 Space Policy 91.

Hitchens, Theresa, "Debris, Traffic Management, and Weaponization: Opportunities for and Challenges to Cooperation in Space" (2008) 14 Brown Journal of World Affairs 173.

———, "U.S.-Sino Relations in Space: From 'War of Words' to Cold War in Space?" (2007) 3:1 China Security 12.

International Space University, *Space Traffic Management* (Beijing: International Space University (ISU), 2007).

Iki, Kentaro, Satomi Kawamoto & Yoshiki Morino, "Experiments and Numerical Simulations of an Electrodynamic Tether Deployment from a Spool-type Reel Using Thrusters" (2014) 94:1 Acta Astronautica 318.

Jakhu, Ram S., "Iridium Cosmos Collision and Its Implications for Space Operations" in Kai-Uwe Schrogl *et al*, eds, *Yearbook on Space Policy 2008/2009* (Vienna: Springer Vienna, 2010) 254-275.

Kato, Akira, "JAXA Strategic Plan for Space Debris-Related R&D" (2012) 26:2 The Journal of Space Technology and Science 18.

Kessler, Donald J & Burton G Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt" (1978) 83:A6 Journal of Geophysical Research: Space Physics 2637.

———, *et al*, "The Kessler Syndrome: Implications to Future Space Operations", (Paper delivered at the 33rd Annual American Astraunotical Society Guidance and Control Conference, Breckenridge, Colorado, 6 -10 February 2010) [unpublished].

Larsen, Paul B., "Application of the Precautionary Principle to the Moon" (2006) 71 Journal of Air Law and Commerce 295.

———, "Outer Space Traffic Management: Space Situational Awareness Requires Transparency" (2008) 51 Proceedings of the Colloquium on the Law of Outer Space 338.

———, *The Regulation of Air Traffic Control Liability by International Convention* (LLM Thesis, McGill University Institute of Air and Space Law, 1965) [unpublished].

Liao, Xavier L.W., "Regime Complex of Space Activities", (Paper delivered at the The 2nd Manfred Lachs International Conference on Space Governance, Montreal, McGill University Institute of Air and Space Law, 29 May 2014) [unpublished].

Liou, J. C. & N. L. Johnson, "Risks in Space from Orbiting Debris" (2006) 311:5759 Science 340.

Marboe, Irmgard, "The Importance of Guidelines and Codes of Conduct for Liability of States and Private Actors" in Irmgard Marboe, ed., *Soft Law in Outer Space* (Vienna: Heribert, 2012) 119.

Martinez, Peter *et al*, "Criteria for developing and testing Transparency and Confidence-Building Measures (TCBMs) for outer space activities" (2014) 30:2 Space Policy 91.

Matsuda, Ikumi, Chikako Hirose & Nobuo Kudo, "The JAXA Conjunction Assessment Process",(Paper delivered at the SpaceOps 2010 Conference, Huntsville, 25-30 April 2010).

Milde, Michael, "The International Civil Aviation Organization: After 50 Years and Beyond" [1996] Australian International Law Journal 60.

————, "Liability for Damage Caused by Aircraft on the Surface-Past and Current Efforts to Unify the Law" (2008) 57 German Journal of Air and Space Law 532.

Mineiro, Michael C., "FY-1C and USA-193 ASAT Intercepts: An Assessment of Legal Obligations under Article IX of the Outer Space Treaty" (2008) 34 Journal of Space Law 321.

Mirmina, Steven A, "Reducing the Proliferation of Orbital Debris: Alternatives to a Legally Binding Instrument" (2005) 99 American Journal of International Law 649.

Murray, Daniel P., "The FAA's Current Approach to Integrating Commercial Space Operations into the National Airspace System" in Ram S. Jakhu & Kuan-Wei (David) Chen, eds., *Regulation of Emerging Modes of Aerospace Transportation* (Montreal: McGill University Center for Research in Air and Space Law, 2014) 169.

Nase, Vernon, "Delimitation and the Suborbital Passenger: Time to End Prevarication" (2012) 77 Journal of Air Law and Commerce 747.

Newman, Lauri Kraft, "The NASA Robotic Conjunction Assessment Process: Overview and Operational Experiences" (2010) 66:7-8 Acta Astronautica 1253.

Nitta, Kumi *et al*, "Response of a Aluminum Honeycomb Subjected to Hypervelocity Impacts" (2013) 58 Procedia Engineering 709.

Pardini, Carmen & Luciano Anselmo, "Reentry predictions of three massive uncontrolled spacecraft", (Paper delivered at the 23rd International Symposium on Space Flight Dynamics, Pasadena, 29 October-2 November 2012).

Praetorius, Gesa *et al*, "Learning Lessons in Resilient Traffic Management: A Cross-domain Study of Vessel Traffic Service and Air Traffic Control" in Dick de Waard *et al*, eds., *Proceedings of the Human Factors and Ergonomics Society [HFES] Europe Chapter Conference, Toulouse, 2012* (HFES Europe Chapter, 2012) 277.

Rathgeber, Wolfgang, Nina-Louisa Remuss & Kai-Uwe Schrogl, "Space security and the European Code of Conduct for Outer Space Activities" (2009):4 UNIDIR Disarmament Forum "A safer space environment?" 33.

Robinson, Jana, "Transparency and confidence-building measures for space security" (2011) 27:1 Space Policy 27.

Saisho, Daisuke, "Liability Risk Sharing Regime of the Bill of Japan's Legislation on Space Activities and Its Comparison with the US and French Law" (2011) 55 Proceedings of the Colloquium on the Law of Outer Space 107.

Schrogl, Kai-Uwe, "Space traffic management: The new comprehensive approach for regulating the use of outer space-Results from the 2006 IAA cosmic study" (2008) 62:2-3 Acta Astronautica 272.

Smith, Milton L, "Legal Implications of a Space-Based Ballistic Missle Defense" (1985) 15 California Western International Law Journal 52.

Suzuki, Kazuto, "Regulatory Power of the EU in Maintaining Security in Space: Politics beyond Normative Power", (Paper delivered at the European Union Studies Association (EUSA) 13th Biennial Conference, Baltimore, 9-11 May 2013).

Takeuchi, Yu, "Challenges of International Space Law for Managing Space Traffic" (in Japanese) (2014) 55 Kuho (Journal of Air Law) 1.

————, "Space Traffic Management as a Guiding Principle of the International Regime of Sustainable Space Activities" (2011) 4:2 Journal of East Asia and International Law 319.

Terrill, Delbert R. Jr, *The Air Force Role in Developing International Outer Space Law* (Alabama: Air University Press, 1999).

Tompkins, George N, "The Continuing Development of Montreal Convention 1999 Jurisprudence" (2012) 37:3 Air and Space Law 259.

————, "The Continuing Development of Montreal Convention 1999 Jurisprudence" (2010) 35:6 Air and Space Law 433.

Walker, Melanie, "Suborbital Space Tourism Flights: An Overview of Some Regulatory Issues at the Interface of Air and Space Law" (2007) 33 Journal of Space Law 375.

Weeden, Brian, "Overview of the Legal and Policy Challenges of Orbital Debris Removal" (2011) 27:1 Space Policy 38.

Weiss, Gus W., "The Life and Death of COSMOS 954" (1978) 22:Spring, Studies in Intelligence.

van Fenema, Peter, "Suborbital Flights and ICAO" (2005) 30:6 Air and Space Law 396.

van Westrenen, Fulko & Gesa Praetorius, "Maritime traffic management: a need for central coordination?" (2014) 16:1 Cognition, Technology & Work 59.

Zhao, Yun, "Legal Regime for Space Tourism: Creating Legal Certainty in Outer Space" (2009) 74 Journal of Air Law and Commerce 959.

OTHERS

Alby, Fernand, “Overview on 2013 Space Debris Activities in France”, (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 11 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

Australia, Minister for Foreign Affairs, Media Release, “Australia joins the fight against space junk”, 18 January 2012, online: Australian Department of Foreign Affairs and Trade <http://www.foreignminister.gov.au>.

Bohlmann, Ulrike, “Requirements on Space Debris Mitigation for ESA Projects” (Technical Presentation delivered at the 48th session of the UNCOPUOS LSC, UN Office in Vienna, 23 March-3 April, 2009), online: OOSA <http://www.oosa.unvienna.org>.

Canadian Coast Guard, *Notice to Mariners*, online: Canadian Coast Guard <http://www.notmar.go.ca>.

"Concern over China's missile test", *BBC News* (19 January 2007) online: BBC News <http://news.bbc.co.uk>.

Chow, Denise, "Clean Up Space Junk or Risk Real-Life 'Gravity' Disaster, Lawmakers Say", *Space.com* (9 May 2014) online: Space.com <http://www.space.com>.

European External Action Service (EEAS), "The EU leads a multilateral initiative on an International Code of Conduct for Outer Space Activities" (June 2014), online: EEAS <http://eeas.europa.eu>.

Foust, Jeff, "Balancing safety and cost in commercial human spaceflight", *Space Review* (February 10, 2014) online: Space Review <http://www.thespacereview.com>.

Florick, Davis & Col. Lina Cashin, "Space Situational Awareness Sharing for the 21st Century", *Space News* (27 May 2013) online: Space News <http://www.spacenews.com>.

Futron Corporation, *Futron's 2014 Space Competitiveness Index (Executive Summary)* (Bethesda: Futron Corporation, 2014).

Gertz, Bill, "China Launches Three ASAT Satellites", *Washington Free Beacon* (26 August 2013) online: Washington Free Beacon <http://freebeacon.com>.

Hanada, Toshiya, "Research Topics for Asia-Pacific Regional Collaboration in the Area of Orbital Debris Issues", (Presentation delivered at the Workshop on the Protection of Space Environment sponsored by Ministry of Foreign Affairs of Japan, Kuala Lumpur, 12 December 2012), online: MOFA <http://www.mofa.go.jp>.

Inter-Agency Space Debris Cordination Committee (IADC), online: <http://www.iadc-online.org>.

International Association of Marine Aids to Navigation and Lighthouse Authorities, *IALA Vessel Traffic Services Manual*, 5th ed. (Saint Germain en Laye: 2012).

International Civil Aviation Organization (ICAO), News Release, "ICAO Clarifies State Responsibilities Arising from Conflict Zones" (24 July 2014) online: ICAO <http://www.icao.int>.

ICAO, International Air Transport Association (IATA), Airports Council International (ACI) and Civil Air Navigation Services Organisation (CANSO), "Joint Statement on Risks to Civil Aviation Arising from Conflict Zones"(29 July 2014) online: ICAO <http://www.icao.int>.

International Telecommunication Union, “Supervisory Authority of the future international registration system for Space Assets” (2014) online: ITU < http://www.itu.int/>.

Japan, Ministry of Foreign Affairs, online: <http://www.mofa.go.jp>.

――――, Minister for Foreign Affairs, Press Conference, 25 January 2012, online: Ministry of Foreign Affairs of Japan <http://www.mofa.go.jp>.

――――, JAXA Safety and Mission Assurance Department, *TRISMAC 2012*, online: JAXA <http://sma.jaxa.jp/TRISMAC2012/index.html>.

Klinkrad, Heiner, “Space Debris Mitigation Activities at ESA in 2013”, (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

Krepon, Michael, "Weak Arguments Against A Space Code Of Conduct", *Stimson Center* (17 January 2012) online: Stimson Center <http://www.stimson.org/spotlight/>.

Levin, George M. & Walter D. Flury, "Inter-Agency Space Debris Coordination Committee (IADC)", (Technical Presentation delivered at the 34th Session of of the UNCOPUOS STSC, UN Office in Vienna, February 1997), online: IADC <http://www.iadc-online.org>.

Matney, Mark, “USA Space Debris Environment, Operations, and Modeling Updates”, (Technical Presentation delivered at the 51st session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2014), online: OOSA <http://www.oosa.unvienna.org>.

McLeod, Courtland B., "Space Situational Awareness (SSA) Sharing", (Technical Presentation delivered at the 49th session of the UNCOPUOS STSC, UN Office in Vienna, 14 February 2012), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>.

Morring, Frank Jr., "Space Traffic Control An Issue For NextGen", *Aviation Week* (10 February 2014) online: Aviation Week <http://aviationweek.com/>.

Nakagawa, Keizo, "R&D of JAXA Satellite Application Mission", (Presentation delivered at the 26th Microelectronics Workshop, Tsukuba, 24 October 2013) [unpublished].

Narita, Kaneaki, "Space Operations: Risk Mitigation Experience from Collision", (Presentation delivered at the Space Environment Protection Workshop sponsored by the Ministry of Foreign Affairs of Japan, Kuala Lumpur, 12 December 2012), online: Ministry of Foreign Affairs of Japan <http://www.mofa.go.jp>.

National Aeronautics and Space Administration (NASA), "Chinese Anti-satellite Test Creates Most Severe Orbital Debris Cloud in History", *Orbital Debris Quarterly News* (15 April 2007) 2online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

————, "Chinese Debris Reaches New Milestone", *Orbital Debris Quarterly News* (15 October 2010) 3online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

————, "International Space Station Maneuvers Twice to Avoid Tracked Debris", *Orbital Debris Quarterly News* (15 April 2014) 1online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

————, "Monthly Number of Cataloged Objects in Earth Orbit by Object Type", *Orbital Debris Quarterly News* (15 January 2014) 10online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

————, "Small Satellite Possibly Hit by Even Smaller Object", *Orbital Debris Quarterly News* (15 April 2014) 1online: NASA Orbital Debris Program Office <http://orbitaldebris.jsc.nasa.gov>.

”North Korea Launches First Satellite into Orbit", *Spacenews* (14 December 2012) online: Spacenews <http://www.spacenews.com>.

Paris, Max, "Canadian Forces put their 1st satellite in orbit", *CBC News* (25 February 2013) online: CBC News <http://www.cbc.ca>.

Raymond, John W., “Strategic Partnerships in Space,” (Presentation delivered at the 2nd International Symposium on Sustainable Space Development and Utilization for Humankind, Tokyo, 28 February-1 March 2013), online: Japan Space Forum <http://www.jsforum.or.jp>.

Rose, Frank A., Press Release, "Remarks made at the Carnegie Endowment for International Peace" (24 July 2013) online: US Department of State <http://www.state.gov>.

Russian Academy of Sciences Keldysh Institute of Applied Mathematics, "International Scientific Optical Network (ISON) activities on highly elliptical orbit (HEO) and geosynchronous orbit (GEO) observations and analysis in 2013", (Technical Presentation delivered at the 49th session of the Scientific and Technical Subcommittee, UN Office in Vienna, 13 February 2014), online: United Nations Office of Outer Space Affairs [OOSA] <http://www.oosa.unvienna.org>.

"Russian and US Satellites Collide", *BBC News* (12 February 2009) online: BBC News <http://news.bbc.co.uk>.

Sato, Masahiko, "Space Debris Mitigation Mechanisms" (Technical Presentation delivered at the 48th session of the UNCOPUOS LSC, UN Office in Vienna, 23 March-3 April, 2009), online: OOSA <http://www.oosa.unvienna.org>.

"S. Korea Successfully Launches Naro Space Rocket", *Spacenews* (30 January 2013) online: Spacenews <http://www.spacenews.com>)

Space Data Association Limited (SDA), Press Release, "Space Data Association: NASA to Participate in the SDA", 8 August 2012, online: SDA <http://www.space-data.org>.

————, Press Release, "Space Data Association: NOAA to Participate in the SDA", 22 May 2012, online: SDA <http://www.space-data.org>.

"SpaceShipOne rockets to success", *BBC News* (7 October 2005) online: BBC News <http://news.bbc.co.uk>.

US Department of Defense, News Release, "DoD Succeeds In Intercepting Non-Functioning Satellite" 20 February 2008, Release no 0139-08, online: US Department of Defense <http://www.defense.gov>.

US Federal Aviation Administration, *Commercial Space Transportation 2013 Year in Review* (Washington D. C.: 2014).

US National Geospatial-Intelligence Agency, *Notice to Mariners*, online: USNGA <http://.msi.nga.mil/NGAPortal/MSI.Portal>.

US Secretary of State, Press Release, "International Code of Conduct for Outer Space Activities", 17 January 2012, online: US Department of State <http://www.state.gov>.

“US spy satellite plan 'a cover'”, *BBC News* (17 February 2008) online: BBC <http://news.bbc.co.uk>.

US Strategic Command Public Affairs, Press Release, "USSTRATCOM Signs Fifth Data Sharing Agreement", 27 January 2014, online: USSTRATCOM <http://www.stratcom.mil>.

Wingfield, Brian, "A New Space Race?", *Forbes* (21 February 2008) online: Forbes <http://www.forbes.com/>.

Wirt, Uwe, “UN-Space Debris Mitigation Guidelines – National Implementation Mechanism” (Technical Presentation delivered at the 48th COPUOS LSC, UN Office in Vienna, 23 March-3 April 2009), online: OOSA <http://www.oosa.unvienna.org>.