Regulating a revolution : small satellites and the law of outer space

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Small Satellites and the Law of Outer Space

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Chapter 1: The Small Satellites Revolution

1. Introduction

In a SpaceNews piece titled: 'Small satellites are at the center of a space industry transformation', Chris Baker, NASA's Small Spacecraft Technology program executive explains:

> 'When you have a potentially disruptive innovation like cubesats and like smallsats, it tends to be the startups that are able to develop the new technology the fastest and most effectively in the beginning,' Baker said. 'Those startups then become attractive targets for strategic investment by larger more established firms when the capabilities of the small spacecraft have increased to the point where they intersect with the capabilities of the established aerospace industrial base.'[1]

Indeed, in recent years, small satellites have taken the space industry by storm. It seems that almost every space-faring entity has aspirations to use this technology, or is using it already, for its next satellites application project.

In order to learn about the 'small satellites phenomenon' this first chapter aims to introduce small satellites to the reader. The chapter will focus on the following questions: What are small satellites; and in what ways have they revolutionised the space industry?

Since there is no one official scientific definition to the term 'small satellites', and since the small satellites revolution exceeds the scientific characteristics of its technology, the first section of this chapter will define and contextualise the term, using multiple perspectives.

Key terminology will be presented in order to clarify terms, which are commonly used to describe small satellites activities. Following, small satellites activities will be explored by introducing their history, their uniqueness within the space industry, their uses, their launch to outer space and finally, their future.

As part of the mentioned examination, the popular concept of small satellites constellations will be presented, as well as new developments relating to small-dedicated launch vehicles and deep space exploration using small satellites. All of these are a testimony to the disruptive-innovative nature of small satellites activities, which are yet to be fulfilled.

[1] D Werner, 'Small satellites are at the center of a space industry transformation' (*SpaceNews*, 22 August 2018); available at: https://spacenews.com/small-satellites-are-at-the-center-of-a-space-industry-transformation/ . All the links provided in this study's footnotes were last accessed on March 2019.

The holistic approach to defining what small satellites are will aid the explanation of the small satellites revolution in the following section of this chapter. As such, it will explain in what ways these satellites are revolutionary.

Further, it will summarise the findings in the first section, distilling the (non-legal) characteristics that lead to the question: do small satellites operations require special regulatory attention?

Conclusions shall follow.

All of the above shall be the starting point of the regulatory and legal discussion relating to the topic, which will be elaborated in the next chapters of this study.

2. What are 'Small Satellites'?

In order to understand the small satellites revolution, one must first understand what 'small satellites' are. This section aims to explore and explain what are small satellites. An interdisciplinary approach was selected in order to reach a comprehensive answer, which will be valuable to the legal analysis in the next chapters.

The justification to explore the meaning of 'small satellites', in a broader perspective, lies in the fact that there is no one agreed scientific definition of this term, to date.[2]

Therefore, key terms that will be used throughout this study are defined in sub-section 2.1. The definitions will clarify *inter alia* the terminological difference between 'small satellites', 'nano-satellites' and 'CubeSats'.

Additionally, sub-section 2.2. will summarise the historical circumstances which led to the creation of small satellites, so as to understand the origin and rational behind this technology.

Thereafter, sub-section 2.3 shall highlight the difference between 'small' and 'traditional' satellites, adding a comparative perspective to the broad definition of 'small satellites'. This comparison will not be limited to the satellites' physical dimensions or technology, but rather, aims to clarify that the philosophy behind the two general types of satellites' operations is very different. In other words, in order to grasp the change in thought behind small satellites technology, there is a need to contextualise small satellites vis-à-vis traditional ones.

In the effort to further contextualise the term 'small satellites', sub-section 2.4 will briefly present examples of small satellites missions and applications in order to answer the question: How small satellites are used, and by whom?

[2] See further on the definition of 'small satellites' in sub-section 2.1.2 *infra*.

Moreover, sub-section 2.5 shall outline practices relating to the launch of small satellites, as these practices are one of the key elements that make 'small satellites' into what they currently are.

Finally, sub-section 2.6 shall provide a brief glance into the future of small satellites applications.

All the above will explain what small satellites are, and point out the relevant elements that make them revolutionary. Thus, the information in this second section contains the building blocks of the following third section of this chapter.

2.1 Key Terminology

2.1.1 Use of Terms

The following key terms are defined below for the following reasons:

First, it is essential that the term shall be included in this study, as it is commonly used to describe small satellites activities; and second, there is a need to clarify and contextualise the term in order to allow the reader to follow the arguments this study will present later on.

These terms shall be used in the study with the same meaning attached to them as per the explanations below, without constantly referring to this sub-section, and without capitalising the terms.

2.1.2 'Small satellites'

As mentioned in the introduction, there is no official and accepted definition of what 'small satellites' are.[3] In 2005 the International Academy of Astronautics (IAA) conducted a study titled 'Cost Effective Earth Observation Missions'[4] which resulted in the widely accepted division of small satellite class-size or mass. Generally, any satellite with a mass lower than 1,000 kilograms is considered a small satellite.[5] The sub-classification of small satellites is as follows:

- 'Mini-satellite': a satellite with mass lower than 1,000 kilograms[6];

[3] United Nations, Office for Outer Space Affairs and the International Telecommunication Union, 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites' (2015) 2; available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2015_CRP17E.pdf;
O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7.

[4] R Sandau (ed), *International Study on Cost-Effective Earth Observation Missions* (Taylor & Francis 2006).

[5] See: UNISPACE III, *Small Satellite Missions*, Background paper 9, 5 A/CONF.184/BP/9 (26 May 1998).

[6] Some scientists classify mini-satellites in the range of between 100 to 500 kilograms, and add another sub-class of 'medium satellites' for satellites with mass between 500 to 1,000 kilograms. See O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances*, (Brill Nijhoff 2016) 7 at note 4. Others prefer to limit this class of satellites even further and propose that mini-satellites should have a mass range of between 100 to 150 kilograms. See O Volynskaya and R Kasyanov, 'Launching Numerus Small Satellites- A Flourishing Business? The Case of the Russian Federation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances*,

- 'Micro-satellite': a satellite with mass lower than 100 kilograms;
- 'Nano-satellite': a satellite with mass lower than 10 kilograms;
- 'Pico-satellite': a satellite with mass lower than 1 kilogram; and
- 'Femto-satellite': a satellite with mass lower than 0.1 kilogram

As nano-satellites and micro-satellites are the ones, which are most commonly used for NewSpace[7] applications and also capture the unique characteristics of small satellites, this study will focus on these classes of small satellites.

2.1.3 'Very small satellites'

In 2014, the fifty-third session of the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) Legal Subcommittee in Vienna hosted the IISL/ECSL Symposium on: 'Regulatory Needs for Very Small Satellites.'[8]

In 2015, UN OOSA and the International Telecommunication Union (ITU) issued a document titled: 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites'. The document does not include a definition of the term 'very small satellites' but states:

> Presently, a legal or regulatory definition of a small satellite does not exist. The information in this handout relates to all satellites, including small and very small satellites.[9]

This implies that the authors saw a need to indicate the smaller classes of 'small satellites' particularly, for a reason, which is not provided in the document.

This study will not differentiate 'small' from 'very small' satellites in principle, unless explicitly indicated otherwise. Notwithstanding the foregoing, the study will focus on the smaller classes of satellites, as mentioned in sub-section 2.2.1 above.

2.1.4 'Nano-satellites'

As mentioned in sub-section 2.1.2 nano-satellites are a class of small satellites whose mass typically ranges between 1 to 10 kilograms. Up to date, most CubeSats[10] are in the nano-

(Nijhoff 2016) 83, 85-86 at note 7. As this study will focus on the smaller classes of small satellites, there is no need to discuss the justification and relevance of adding such sub-classification.

[7] For information about NewSpace see: D Paikowsky, 'What Is New Space? The Changing Ecosystem of Global Space Activity' (2017) 5(2) NEW SPACE 84, available at: http://online.liebertpub.com/doi/pdfplus/10.1089/space.2016.0027 .

[8] For information on the symposium see: United Nations, Office for Outer Space Affairs, Legal Subcommittee: 2014, *IISL/ECSL Symposium on 'Regulatory Needs for Very Small Satellites'*, 24 March 2014; available at: http://www.unoosa.org/oosa/en/ourwork/copuos/lsc/2014/symposium.html .

[9] United Nations, Office for Outer Space Affairs and the International Telecommunication Union, *Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites* (2015) 2; available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2015_CRP17E.pdf.

[10] See sub-section 2.1.5 *infra* for further explanation about this terminology.

satellites class, however, there are non-standardized nano-satellites as well, meaning a nano-satellite which is not a standard CubeSat.[11]

2.1.5 'CubeSats'

A 'CubeSat' is a standardized small satellite and more specifically, a cube-shaped nano-satellite platform. CubeSats typically range from a 1-unit cube, measuring 10X10X10 centimetres, commonly referred to as a '1U' CubeSat, and ranging above, depending on the number of standard cube units.[12] Each cube unit has an approximate mass of between 1-1.33 kilograms (depending on its components), and a volume of 1 litre.[13]

2.1.6 'Traditional' satellites

For the purpose of this study, 'traditional satellites' means any satellites that are not small satellites. The expression 'traditional' was selected since there is a need to differentiate small satellites from other types of satellites. Another justification derives from the fact that small satellites are revolutionary and recent compared to other common satellites traditionally used. The key differences between traditional and small satellites will be further elaborated in this study.[14]

2.1.7 'Developer'

The term developer is commonly used to refer to the entity that performs research and development work and builds[15] or manufactures a small satellite. The developer may be the owner and operator of the satellite; in other cases the developer may sell the satellite to another entity, which will be its operator and owner.

2.1.8 'Operator'

This term refers to an entity that operates a satellite or multiple satellites. The operator is not necessarily the satellite's developer[16] nor the entity that carried out its launch to outer space.

This term is defined in some national space laws,[17] and such entities are usually under an obligation to obtain the State's authorisation in order to operate their space objects. Further, the

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[11] For example, the BRITE-constellation is comprised out of five nano-satellites which are not CubeSats, see for further information sub-section 2.4.5 *infra* and the mission's website: http://www.brite-constellation.at/ .

[12] K Woellert et al, 'Cubesats: Cost-effective Science and Technology Platforms for Emerging and Developing Nations' (2011) 47 Advances in Space Research 663.

[13] SpaceWorks, '2017 Small Satellite Report: Trends and Market Observations' (2017) 5; available at: http://spaceworksforecast.com/ .

[14] See section 2.3 *infra*, and section 2 of chapter 4 in a narrower context relating to potential liability.

[15] Due to the nature of the technical work, the author believes that 'building' is more accurate than 'manufacturing', especially when considering CubeSats. In the case of the latter, the standard components are being stacked in a standard way and within the standard unit dimensions. Many of the components can be procured without the need to manufacture them in-house and, thus, most of the work would be assembling the CubeSat together. The element of 'development' in this case would also refer to the need to develop a specific software for the relevant CubeSat mission.

[16] See sub-section 2.1.7 *supra*.

[17] See for examples: Belgium- Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects, consolidated text as revised by the Law of 1 December 2013 (B.O.J. of 15 January 2014) Art. 3(2): '"operator" means the person that carries out or undertakes to carry out the activities referred to in this law, by ensuring, alone or jointly, the effective control of the space object. The activity carried out by an operator may be carried out pursuant to a specific contract for that purpose; In the case of a space object whose flight cannot be operated or which cannot be guided once it has been positioned in orbit, the operator is deemed to

term may be explicitly linked to the ability to command or control the space object in question.[18] Moreover, national legislation often prescribes that the operator is the non-governmental liable entity in case of damage being caused by its space object.[19]

2.1.9 'COTS'

This term is widely used in the space industry to refer to 'commercial off the shelf' satellite components. Small satellites have many such available components or 'sub-systems', some are even available for purchase online.[20] The availability of standard satellite components is one of the elements that aided the small satellites revolution,[21] as it is not common to find such availability for traditional satellites' components.[22]

2.1.10 'Piggy-back' launch

Small satellites are often launched into outer space while accommodated as part of the excess capacity of the launch vehicle. The entity which owns the main or 'primary payload' is the main customer for the launch, and any additional mass that the launch vehicle can carry and deploy to space is secondary to such customer. The launch will not be carried out without the primary payload, and so, the secondary payload 'piggy-backs' on the launch opportunity, which was created for the primary payload.[23]

2.1.11 'Auxiliary payload'

'Auxiliary payload' or 'secondary payload' is a term often used in commercial launch agreements, referring to a small satellite or multiple small satellites. The term auxiliary payload

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be the person who has ordered the delivery in orbit of the space object.' Available at: http://www.belspo.be/belspo/space/doc/beLaw/Loi_en.pdf; Austria- Austrian Federal Law on the Authorisation of Space Activities and the Establishment of a National Space Registry (Austrian Outer Space Act, adopted by the National Council on 6 December 2011, entered into force on 28 December 2011) Art. 2(3): '"Operator": a natural or juridical person that carries out or undertakes to carry out space activities.' Available at: http://www.unoosa.org/documents/pdf/spacelaw/national/austria/austrian-outer-space-actE.pdf; Kazakhstan- Law of the Republic of Kazakhstan on Space Activities (No.528-IV of 6 January 2012) Art. 1(3) 'National operators of space systems- legal entities that carry out the management of space systems and their operations.' Available at: http://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/index.html .

[18] See definition under the Belgian law, ibid.

[19] While under international law the launching state or states are liable for such damage. Thus, national space laws set the states' right for recourse against the operators. See chapters 4 and 6 for further analysis of this subject.

[20] See for example the 'CubeSatShop': https://www.cubesatshop.com/ .

[21] O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 12.

[22] For further reading see: K Karvinen et al, *Using Hobby Prototyping Boards and Commercial-off-the-shelf (COTS) Components for Developing Low-cost, Fast-delivery Satellite Subsystems*, (2015) 4(1) Journal of Small Satellites 301, available at: http://www.jossonline.com/wp-content/uploads/2015/06/Using-hobby-prototyping-boards-and-commercial-off-the-shelf-components-for-developing-low-cost-and-fast-delivery-satellite-subsystems.pdf;
S Cole, *Small Satellites Increasingly Tapping COTS Components* (*Military Imbedded Systems*, 8 June 2015), available at: http://mil-embedded.com/articles/small-tapping-cots-components/; M Iriarte, *COTS in Space? Not So Fast, Say Some Rad-hard Designers* (*Military Imbedded Systems*, 15 June 2016), available at: http://mil-embedded.com/articles/cots-space-not-fast-say-rad-hard-designers/#at_pco=smlrebv-1.0&at_si=5915bcdf3beede4f&at_ab=per-2&at_pos=8&at_tot=8 .

[23] See further sub-section 2.5 *infra*.

is preferred since a secondary payload may still mean a traditional satellite, which is secondary to the primary payload being launched.[24]

2.1.12 Conclusions

Now that the above terms were defined in a basic manner, this study will continue to contextualise them by adding information about small satellites activities from different perspectives. The first perspective to be explored is the historical one.

2.2 Defining 'Small Satellites': A Historical Perspective

The famous *Sputnik-1*, the first satellite in history, was successfully launched by the former USSR in 1957 and with a mass of only 83.6 kilograms, and can be seen as the first 'small satellite' as well.[25]

The first amateur satellite, *OSCAR-1* was launched in 1961, with a mass of only 4.5 kilograms, and can be regarded as the first 'nano-satellite'.[26]

Many other historical satellites were small in mass, which may indeed trigger their classification as small satellites. In fact, the very first satellites were of a mass limited to tens of kilograms due to the lack of capability to launch heavier objects to outer space. As the time progressed and launch vehicles became capable to carry and lift heavier objects to outer space, scientist developed more and more sophisticated systems which were integrated into satellites, making them big and with high mass.[27]

In this section, I would like to argue that a 'small satellite' is more than a low mass satellite. To my opinion, one cannot appreciate the small satellites revolution while ignoring the other special technological characteristics these satellites share, as well as observing them within the context of their creators' work.[28]

As mentioned, generally, 'small satellites' refer to different kinds of satellites with a mass of less than 1,000 kilograms. Further sub-classifications include 'nano-satellites' towards the smallest end of the spectrum, typically at around 10 kilograms or less.[29]

[24] See further sub-section 2.5 *infra*.
[25] O Volynskaya and R Kasyanov, 'Launching Numerus Small Satellites- A Flourishing Business? The Case of the Russian Federation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 83.
[26] O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I. Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 8.
[27] RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 1.
[28] See section 3 *infra.*
[29] See sub-section 2.1.2. for further explanation about this terminology.

One of the key elements that made small satellites extremely popular derives from their standardisation. The standardisation element is most relevant to 'CubeSats', standardised small satellites, measured in 'cube' units.[30]

The genesis of such CubeSats is in leading academic institutions in the U.S.:

> The design specification introduced in 1999 by Bob Twiggs (formerly at Stanford) and Jordi Puig-Suari (Cal Poly San Luis Obispo), defines a 1U CubeSat structure as 10 cm on a side with a mass of no more than 1.33 kg.
>
> The introduction of the Poly Picosat Orbital Deployer (P-POD), capable of holding three 1U CubeSats or compatible combinations of them, has enabled frequent access to space for these secondary payloads on a large variety of launch vehicles.
>
> It is an enabling capability that has facilitated technology and science experiments from universities, government, and industry through NASA's CubeSat Launch Initiative (CLI), in collaboration with NASA Launch Services (NLS), as well as other launch providers with in the DOD and industry. Many of these secondary payload launches are available at no cost.[31]

Twiggs and *Puig-Suari* developed CubeSats since the traditional satellites' development process is very expensive and time consuming. This meant that their students and other scientists did not have the means to be involved in such a process and use such hardware for their scientific exploration.[32]

Since the CubeSat standard allowed for comparatively low-cost space research projects and engineering development activities, CubeSats became extremely popular within the academia worldwide, and later with governmental entities and the space industry:

> Cubesat technology development has been significantly accelerated in recent years, in universities as well as government and industry, by rapid advances in nano-, micro-, and miniature technologies in fields including telecommunications, (opto) electronics, materials, sensors, fluidics, and instrumentation. These advances have helped enable many small but remarkably capable autonomous instruments and systems to accomplish a variety of remote measurements and experiments in cubesats […].[33]

The first CubeSats were launched in 2003, and by 2012, 112 of them were launched to orbit. These satellites were developed and operated by nearly 80 organisations from 24 countries, and

[30] See sub-section 2.1.5. for further explanation about this terminology.
[31] Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science*, *Final Report* (2014) 15, available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf.
[32] K Woellert et al, *Cubesats: Cost-effective Science and Technology Platforms for Emerging and Developing Nations* (2011) 47 Advances in Space Research 663, 664.
[33] ibid.

were launched onboard 29 rockets. The developers were universities, national space and defence agencies, private companies, and non-profit organisations.[34]

During 2013 the first CubeSat, which was developed by high school students, was launched making another historical landmark.[35] Other CubeSats projects were crowdfunded using web-platforms in a truly remarkable innovative manner.[36]

Currently, small satellites in general and CubeSats in particular, are employed by commercial entities seeking to offer certain satellite-based services. Many such entities are planning large small satellites constellations, ranging from tens to thousands of small satellites per constellation.[37]

The shift to commercial uses and the growing complexity of small satellites' missions, means improving the technology's reliability:

> Most CubeSats are built from COTS components, but as sophistication grows custom, radiation hardened, and military-grade parts are being used for these systems.
>
> This is partially in response to concerns regarding reliability of these spacecraft, but also driven by a rapidly growing interest to apply them for military and industrial use as well as technology improvements associated with commercial development of specialised CubeSat components.[38]

Another trend that emerges as part of the need to include more sophisticated payloads relates to the size of the satellites:

> 2016 saw sizeable growth in the 11–50 kg range, indicative of an overall market trend of growing mass sizes to accommodate more demanding payloads and new applications.[39]

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[34] M Swartwout, *The First One Hundred CubeSats: A Statistical Look* (2013) 2(2) Journal of Small Satellites 213, 214; available at: http://www.jossonline.com/wp-content/uploads/2014/12/0202-The-First-One-Hundred-Cubesats.pdf .

[35] L Kratochwill, *First Satellite Built By High School Students Launches Tonight* (*Popular Science*, 19 November 2013); available at: http://www.popsci.com/article/science/first-satellite-built-high-school-students-launches-tonight.

[36] N Palkovitz, *Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*, IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014); N Palkovitz, *Will YOU Own the Next Space Project?* (*Leiden Law Blog*, 17 August 2017); available at: http://leidenlawblog.nl/articles/will-you-own-the-next-space-project; P Platzer and K Klausner, 'Crowdfunding for Small Satellites' in I. Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 349.

[37] C Dillow, *Here's Why Small Satellites Are So Big Right Now* (*Fortune*, 4 August 2015); available at: http://fortune.com/2015/08/04/small-satellites-newspace/; For further information on constellations see sub-section 2.6 *infra*.

[38] Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science, Final Report* (2014) 16, available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf.

[39] SpaceWorks, *2017 Small Satellite Report: Trends and Market Observations* (2017) 17; available at: http://spaceworksforecast.com/ .

The capability to launch multiple small satellites at the same launch also developed over the years. On the 15th of February 2017, the Indian Space Research Organisation (ISRO) successfully launched a total of 104 satellites in one launch.[40] 101 of these satellites were small satellites, which were integrated and manifested by ISL- Innovative Space Logistics B.V., a Dutch company specialising in small satellites launches.[41]

In summary, CubeSats first emerged as a low-cost simplified satellite model aimed to improve access to outer space. As such, they were first adopted by universities for scientific and educational purposes. With time, CubeSats and other small satellites became more sophisticated and thus, attractive to the space industry, as well as to governmental organisations, for various applications.[42]

2.3 Defining 'Small Satellites': A Comparative Perspective

2.3.1 Methodology

This section aims to provide a concise comparative overview on the key differences between traditional and small satellites. This overview is meant to differentiate these types of satellites for the purpose of defining and characterising small satellites. Comprehensive analysis relating to the legal and regulatory challenges introduced by these differences will be presented in the following chapters of this study.

2.3.2 Design Philosophy

Traditionally, the first stages of a satellite mission would mean designing a satellite-structure to include certain components needed for the specific mission. A small satellite developer will be designing components and at times adjust original mission objectives to fit into the available standard structure.

2.3.3 Development Time

While traditionally, developing a satellite and its sub-systems, as well as testing them thoroughly, negotiating and financing its launch, and finally operating it, is a several years-long process, small satellites missions are proven to work on much shorter timeframes:

> One of the appealing aspects of CubeSats is the rapid sequence from mission conception through spacecraft development, launch, and operations. Typical CubeSat projects can move from idea to realization within 18-24 months.[43]

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[40] See details on ISRO's website: http://www.isro.gov.in/launcher/pslv-c37-cartosat-2-series-satellite

[41] See details on the company's website: https://www.isispace.nl/dutch-nanosatellite-company-gets-101-cubesats-launched-recordbreaking-pslv-launch/ . The author was involved in this activity as the legal adviser of the company.

[42] For the development of small satellites technology see: RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 15-20. For further information on small satellites applications see sub-section 2.4 *infra.*

[43] Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science*, *Final Report* (2014) 15, available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf .

To compare with a traditional satellite, as an example, *Envisat*- an ESA satellite, took over a decade to develop.[44]

2.3.4 Cost

Traditional satellites are extremely expensive to such extent, that they stay 'out-of-reach for most countries'.[45] Small satellites are generally known to be 'low-cost' satellites:

> They can also be developed for roughly one million US dollars, but many cost substantially less where the lowest known reported cost was thirty thousand dollars.[46]

Since small satellites have various possible uses and can be employed by various different players, exceptions can be found, especially when considering commercial complex missions:

> Some systems, however, can cost five to ten million dollars or more. This is all application dependent.[47]

2.3.5 Standardisation

While traditional satellites are not standardised as a concept, one of the most noticeable characteristics of CubeSats is the fact that their dimensions are standardised.[48] Standardisation is relevant to other small satellites that are not CubeSats as well, since they may include standard COTS components.[49] This means that small satellites, which are not standard by dimensions, may still include standardised technology.

2.3.6 Manoeuvrability

Traditional satellites usually have propellant systems which allow their operator to manoeuver them after they were deployed in their orbit. The case is different with most small satellites and especially with the smaller classes of these satellites. Since propellant systems are heavy, take up space and may be complex and costly, most small satellites lack them. This means that once the small satellite was deployed into orbit it will keep orbiting Earth subject to gravity and other environmental conditions, until it will naturally decay and re-enter into Earth's atmosphere, following its complete burn-up in most cases. Its operator will not be able to change its orbit significantly and rapidly. The fact that these satellites are practically non-manoeuvrable has potential implications on their operators' liability, since there is no possibility to move the satellite away from a collision course. This very important difference compared to traditional satellites, and especially Geostationary satellites, will be analysed in this study.[50]

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[44] For more information see the ESA website: https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/envisat/history .

[45] W Balogh, 'Capacity Building in Space Technology Development: The Role of the United Nations' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 28, 31.

[46] Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science, Final Report* (2014) 15-16; available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf .

[47] ibid.

[48] See sub-section 2.1.5 *supra*.

[49] See sub-section 2.1.9 *supra*.

[50] See chapter 4.

2.3.7 Manpower and Infrastructure

Generally, the process of developing, assembling, transporting and integrating traditional satellites requires more manpower and special infrastructure than in the case of small satellites.[51] To illustrate this, since small satellites are small in dimensions and are lightweight, engineers can work on them in the cleanroom on standard workbenches, unlike traditional satellites, which are large and heavy and thus require special infrastructure and equipment such as cranes for their assembly. While a small satellite would require a normal-size room as a cleanroom environment, a traditional satellite will require at least a hangar. A small satellite can be transported by one person using a suitcase-size ruggedised case, while a traditional satellite will require complex transport logistics.

2.3.8 Players

Since most space activities require special facilities, expertise, and are extremely costly, governmental agencies and commercial entities are the traditional players in the space sector. When considering small satellites, there are additional entities involved, such as: universities and academic institutes,[52] radio amateurs[53] and other non-profit organisations,[54] schools,[55] developing countries[56] or developed countries which are not space faring nations.[57]

2.3.9 Size/Dimensions/Mass

One of the most detectable differences between traditional satellites and small ones is size. Size is often connected to dimensions and mass. The classification of small satellites is according to their mass, and CubeSats have standard dimensions as well.[58] According to the common definitions, which are adopted in this study, traditional satellites begin at 1,000 kilograms,[59] much bigger and heavier than the small ones. For example, while a 1U CubeSat has a typical mass of 1.33 kilograms, ESA's *Envisat* is 8,100 kilograms in mass, and is huge compared to the CubeSat.[60]

2.3.10 Availability and Accessibility

The use of COTS components, piggy-back launch practices, limited manpower, and their short development time makes small satellites affordable and hence accessible to non-traditional players in the space industry. Other than cost, the fact that it is possible to purchase many

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[51] United Nations, Office for Outer Space Affairs and the International Telecommunication Union, *Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites* (2015) 2, available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2015_CRP17E.pdf .

[52] See sub-section 2.4.5 for examples.

[53] See sub-section 2.4.8 for examples.

[54] N Palkovitz, *Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*, IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014).

[55] See sub-section 2.4.8 for examples.

[56] W Balogh, 'Capacity Building in Space Technology Development: The Role of the United Nations' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 26; R Acevedo and R Beccera, 'Small Satellites as a Chance for Developing Countries' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 105.

[57] For example, the *BRITE* mission mentioned in sub-section 2.4.5 *infra*. In this case, the Austrian nano-satellite was the first Austrian satellite launched to space.

[58] See sub-section 2.1.5 *supra*.

[59] See sub-section 2.1.2 *supra*.

[60] See ESA's website for more information: http://www.esa.int/Our_Activities/Operations/Envisat .

components, and reserve a launch slot online[61] makes these satellites extremely accessible when compared with the traditional ones.

Further, since in many cases the technology is simpler as compared with traditional satellites, small satellites' components are often easier to export and are available for export to more countries.[62]

2.3.11 Launch Practices

While traditional satellites are often the primary payload to be launched, small satellites often tag-along to such launch in the Piggy-back launch practice. This practice will be further elaborated on below, together with other launch practices unique to small satellites.[63]

2.4 Small Satellites Applications

2.4.1 Use of Small Satellites

In order to better understand what small satellites are, this section will provide examples of their applications. Therefore, this section aims to provide information on the various uses small satellites have, as well as on their users.

For this purpose, the main applications were divided into categories, in order to provide a wide range of examples. Other possible categories, if any, are not meant to be excluded.

2.4.2 Earth Observation

Earth observation is one of the very most important satellite uses. In order to observe Earth from space, there is a need to integrate an electro-optic system (a camera) into the satellite. This is challenging in the case of small satellites, considering their limited size and mass.

Over the years, there have been academic projects that employed small satellites for earth observation,[64] but it was Planet Inc., a U.S. start-up, which succeeded to use CubeSats for this application commercially.[65] Each CubeSat is named a *Dove* and they are launched in clusters, each named a *Flock*.

On 15 February 2017, a *Flock* of 88 *Doves* was launched, extending Planet's satellite constellation. Moreover, Planet acquired Terra Bella from Google, which uses a bigger class of

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[61] See for example the CubeSatShop: https://www.cubesatshop.com/ and Rocket Lab's online launch booking system: https://www.rocketlabusa.com/book-my-launch/ .

[62] All depending on a case by case basis of course. See for further reading: M Trautinger, 'The Impact of Technology and Export Controls on Small Satellite Missions' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 286.

[63] See section 2.5 *infra*.

[64] See for an overview and examples: O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 14.

[65] Planet's website: https://www.planet.com/ .

small satellites for Earth observation.[66] According to *Forbes*, Planet has a total of 160 satellites in orbit, which provide images of Earth daily, with various instruments and data resolutions.[67]

Interestingly, this start-up was founded during 2010 and within only 7 years became the owner and operator of the largest satellite constellation to date:

> We started as a small team of physicists and engineers in a garage, using the cubesat form-factor to build our first Dove satellite. Just two years after our first satellite, Planet acquired BlackBridge and the RapidEye fleet of 5 satellites and imagery archive dating back to 2009 and now operates the largest constellation of Earth-imaging satellites...ever.[68]

2.4.3 Telecommunications

Currently, small satellites do not offer a complete alternative to traditional geostationary telecommunications satellites, however, they can certainly be applied for telecommunications purposes.

One popular application relates to Automatic Identification System (AIS) technology. Small satellites, carrying this technology on board, can receive and transmit information on the location of vessels at sea. This allows the operator to locate vessels anywhere on Earth and promote maritime safety. One of the leading start-ups that intends to use such technology commercially is Spire Global, which is to launch a small satellites constellation that will provide marine traffic data.[69]

Similarly, GomSpace, a Danish company, has launched the *GOM-X1* and *GOM-X3* CubeSats with automatic dependent surveillance broadcast (ADSB) technology, which can identify aircraft in flight.[70] After the tragic disappearance of Malaysia Air flight MH370, it became clear that such an ability to globally track aircraft is missing.[71]

Of course, marine and airspace tracking capabilities can be applied for civil uses as well as for military or defence purposes.[72]

Another example is Sky and Space Global, a U.K. limited company seeking to offer connectivity solutions to remote locations on Earth which are currently not connected:

> A constellation of Nano-Satellites (approximately 200), placed in carefully selected orbits giving equatorial coverage of the Earth, creating a global communication network for voice, data and instant messaging. Nano-Satellites are fully operational

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[66] A Knapp, *Google is Selling its Satellite Business Terra Bella to Satellite Startup Planet* (*Forbes*, 7 February 2017); available at: https://www.forbes.com/sites/alexknapp/2017/02/07/google-is-selling-its-satellite-business-terra-bella-to-satellite-startup-planet/#11feb5636231 .

[67] This figure includes the satellites owned by Planet and its subsidiaries, ibid.

[68] Planet's website: https://www.planet.com/company/ .

[69] Spire's website: https://spire.com/data/maritime/; https://spire.com/company/insights/news/constellation-small-satellites-set-improve-skill-w/ .

[70] GomSpace website: https://gomspace.com/gomx-3.aspx .

[71] As CNN reports: http://money.cnn.com/2017/04/19/news/companies/mh370-malaysia-airlines-tracks-planes-satellite/ .

[72] For examples of military applications see sub-section 2.4.7 *infra*.

> satellites with a mass of less than 10kg. Due to miniatuarization of technology Nano-Satellites are capable to provide accurate attitude and orbit control and communication services.[73]

Additionally, companies such as: Space X[74], OneWeb[75] and Samsung[76] are working on large small satellites constellations or 'mega-constellations' in order to make the internet available worldwide. Samsung explains the advantages of using small satellites as follows:

> Traditional satellite internet providers use geostationary satellites positioned much further from the earth's surface to provide access. The problem is that these services tend to be slow, expensive and have high latency. By using a large number of smaller and cheaper satellites floating closer to the planet, Khan and company hope to speed connections up significantly while also cutting costs.[77]

This chapter further elaborates on large and mega-constellations, as part of the foreseen future uses of small satellites.[78]

2.4.4 Technology Demonstrations

Small satellites can be used to test certain new components or technology, which is meant for use in small satellites and traditional satellites. The benefit of testing new technology using a simple small satellite rather than implementing such technology in a more complicated satellite relates to cost. If the new technology fails, the developer will suffer loss of funds and time, however, this loss would be far less dramatic when comparing it to losing a whole complex satellite mission due to failure of a certain component. In such a case, a small satellite will be designed to include the new technology and test it; this will also be the main objective of the satellite mission. In this way, the risks that are attached to the use of new technology with no flight heritage are being mitigated.

As an example, the U.S. Air Force makes use of small satellites for technology demonstration purposes.[79] Moreover, ESA's first nano-satellite *OPS-SAT* was launched to test and study new operation concepts as well as software and hardware.[80]

2.4.5 Astronomy and Atmospheric Science

The international scientific community has carried out astronomical research using multiple small satellites. The first example is the *BRITE* constellation,[81] consisting of 5 nano-satellites from Austria, Canada and Poland, which orbit the Earth since 2013. The constellation's mission

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[73] SSG's website: https://www.skyandspace.global/operations-overview/technology/ .
[74] Space X's website: http://www.spacex.com/ .
[75] OneWeb's website: http://oneweb.world/ .
[76] Samsung's website: http://www.samsung.com/ .
[77] K Finley, *Samsung Looks to Join the Satellite Internet Space Race* (*Wired*, 14 August 2015) available at: https://www.wired.com/2015/08/samsung-looks-join-satellite-internet-space-race/ .
[78] See section 2.6 *infra*.
[79] RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 16.
[80] ESA's website: http://www.esa.int/Our_Activities/Operations/OPS-SAT_Evolving_Software_Technology_for_Spacecraft_Operations .
[81] BRITE's website: http://www.brite-constellation.at/ .

objective is to 'observe the brightness variations of massive luminous stars' in order to promote scientific knowledge of stellar structure and the evolutionary status of starts.[82]

The second example is the *QB50* constellation, which includes approximately 50 CubeSats from different nations worldwide and is sponsored by the EU.[83] The mission objective is to:

> carry out atmospheric research within the lower thermosphere, between 200 - 380km altitude, which is the least explored layer of the atmosphere. To explore this region, atmospheric explorers were flown in the past in highly elliptical orbits (typically 200 km perigee, 3000 km apogee); they carried experiments for single-point, in-situ measurements but the time spent in the region of interest was only a few tens of minutes. By contrast, QB50 will provide multi-point, in-situ measurements for a time period on the order of months, instead of minutes.

The sensors on board the CubeSats will also provide valuable information about their re-entry process.[84] All the satellites are to be deployed during 2017. This mission is the product of an international collaboration at a wide scale, and thus, is important not only because of its scientific objectives.[85]

2.4.6 Bioscience and Pharmaceutical Research

Since there are some scientific benefits in testing biological processes in micro-gravity, there is a need to conduct bioscience experiments in such a special environment.[86] Micro-gravity exists in Earth's orbit, and thus, a miniaturised laboratory located on board a satellite would be ideal for such experiments. There is an interest to use a cost-effective satellite platform, which can include the lab, and for this reason, small satellites were chosen to host missions with the objective of promoting bioscience and pharmaceutical research.

NASA launched several small satellites missions containing bacteria, fungi and other biological substances. For example, *GeneSat-1* is a 5 kilogram small satellite, which carried *E.Coli*

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[82] O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 16.
[83] See full mission objectives on the QB50 website: https://www.qb50.eu/index.php/project-description-obj .
[84] ibid.
[85] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195.
[86] See SpacePharma website for examples for the benefits of micro-gravity research, such as: 'Under microgravity conditions, cells spontaneously assemble into three-dimensional (3D) constructs, also called spheroids. Spheroids formed in microgravity are scaffold-free and are much larger compared to those created in normal gravity conditions. 3D cultures are a much more representative model of the in-vivo conditions such as cell-cell interaction, nutrient, metabolite and oxygen gradients, and drug penetration. As the success rate of new therapies translating from in vitro culture systems into the clinic is very low, 3D cell cultures has great potential for closing the gap and allowing much more reliable model for drug penetration, efficacy and toxicity testing; especially for new anticancer drugs development.' Other examples are related to protein crystallisation, stem cells, microbiology and fluid physics research: http://space4p.com/#/ .

bacteria in a small lab to test such bacteria in micro-gravity.[87] The information gathered from the mission promoted understanding of certain genetic processes relating to this bacteria.[88]

The small satellites industry is also working on facilitating experiments for the pharmaceutical industry. SpacePharma is a Swiss-Israeli start-up dedicated to this objective. The start-up developed its own 'lab on a chip', which is then integrated in a CubeSat and launched with experiments to outer space. *DIDO*, their first satellite, was launched in February 2017, carrying four experiments on board, and is considered to be a success.[89]

2.4.7 Military and Defence

Traditional surveillance and telecommunications satellites, used by militaries often have very large dimensions.[90] Small satellites can serve military objectives in other types of missions, rather than compete with the traditional satellites. One example is the concept of 'responsive space', which, *inter alia*, harnesses the special characteristics of small satellites in order to improve military capabilities and allow short response time to certain threats. In case of a military threat or another emergency, the military may benefit from deploying small satellites on a short notice in order to improve its intelligence relating to the situation in question.[91]

The U.S. Air Force has a special office, which is engaged in rapid-response space development, known as the Operationally Responsive Space Office (ORS).[92] The ORS has been employing small satellites successfully, and plans to continue to do so:

> Recognizing the innovation of the ORS-1 mission and its success, the ORS-1 team captured a number of 'Lessons Learned' which will be incorporated into future ORS missions. These include: TacSat-3, TacSat-4, and ORS-1 demonstrated that small satellites have military utility; refining requirements directly with warfighter results in out-of-the-box solutions that work; key stakeholders understand the acquisition, and operational requirements and manage to a 'good enough' mindset; a small, agile team – key to executing at a fast pace; adequate and stable funding absolute necessity – senior leadership buy-in and advocacy required; operational prototype capability costs significantly more than S&T demonstration; don't use 'Urgent Need' for technology development; and ORS-1 program constantly re-evaluated schedules, approaches, and objectives to explore all acceleration and recovery options.[93]

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[87] NASA's website: https://www.nasa.gov/centers/ames/missions/2007/genesat1.html .

[88] ibid; See for more examples for similar missions: O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation', in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 18.

[89] SpacePharma website: http://space4p.com/#/satellite .

[90] These satellites may even be as large as a house; see RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 14.

[91] RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 14.

[92] M Gruss, ORS Director: 'We're Not Here To Build Neat Toys' (*SpaceNews*, 10 March 2015); available at: http://spacenews.com/ors-director-were-not-here-to-build-neat-toys/ .

[93] T Davis, *Operationally Responsive Space- The Way Forward*, 29th Annual AIAA/USU Conference on Small Satellites (2015), available at: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3213&context=smallsat .

2.4.8 Education and Capacity Building

FUNcube-1 is an excellent example to how CubeSats can be applied for educational uses. In 2009 radio amateurs volunteering at AMSAT-UK and AMSAT-NL, both non-profit organisations, began to work on a new concept named the FUNcube Project. The first satellite, which was launched as a part of this project, was *FUNcube-1*, a 1U CubeSat with mass of less than 1 kilogram. It became the first satellite to have educational outreach to schools as its main mission objective:[94]

> FUNcube-1 (AO73) is a complete educational 1U CubeSat with the goal of enthusing and educating young people about radio, space, physics and electronics. FUNcube-1, now registered as a Dutch spacecraft, was successfully launched from Russia on a DNEPR rocket on Nov 21st 2013 and, after more than three years in orbit, continues to perform well. More than 1000 stations, including many at schools and colleges around the world, have received and decoded the telemetry.[95]

Schools are able to obtain a special dongle that connects to a regular personal computer and communicate with the satellite using the dongle.[96] Further, AMSAT-UK made classroom guides available online to guide teachers on how to teach scientific topics to children using the dongle, and suggested exercises to carry out in the classroom.[97]

The basic design of *FUNcube-1* was the starting point of other educational projects, as well as for capacity building ones. One example is the *Nayif-1* CubeSat (also known as *FUNcube-5*), the first small satellite from the UAE:

> Nayif-1 is a 1U Cubesat project that has been developed by the Emirates Institution for Advanced Science and Technology (EIAST) in partnership with students at the American University of Sharjah (AUS) This mission is intended to provide Emirati students with a tool to design and test systems in space. It carries a complete, and enhanced, FUNcube communications package to provide educational outreach telemetry and an amateur transponder. The FUNcube team has worked closely with the Emirati students, in collaboration with support partner, ISIS – Innovative Solutions In Space B.V. from the Netherlands, to develop this new system. Nayif-1 was successfully launched from India on Feb 15th 2017 together with 103 other spacecraft.[98]

Another example for a capacity building project is *ESTCube-1* the first Estonian satellite, which is a student satellite project lead by the University of Tartu, and supported by ESA via Plan for European Cooperating States (PECS).[99]

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[94] FUNcube website: https://funcube.org.uk/ .
[95] ibid.
[96] FUNcube Dongle website: http://www.funcubedongle.com/ .
[97] FUNcube website: https://funcube.org.uk/education-outreach/ .
[98] FUNcube website: https://funcube.org.uk/ .
[99] A Slavinskis et al, *ESTCube-1 In-Orbit Experience and Lessons Learned* (2015) 30(8) IEEE Aerospace and Electronic Systems Magazine 12, available at: https://drive.google.com/file/d/0B4mrmnzASbfwYlJiQUFHOVZOcUk/view .

Small satellites in general, and CubeSats in particular, proved to be so effective for educational and capacity building that the UN created a special program named: Basic Space Technology Initiative (BSTI) within the work of UN OOSA, which promotes small satellites projects in developing countries.[100]

Further, ESA's Fly Your Satellite! program is aimed to assist selected European universities to develop and launch their CubeSats.[101] ESA supports the students by granting them with 'access to state of the art test facilities; financial support to participate in workshops, training, and test sessions; sponsors their participation in the launch campaign; and offers them a launch opportunity.'[102]

Some States chose to launch mini-satellites as their first satellite project rather than very small CubeSats. Venezuela is one example, after launching an 880 kilograms telecommunications satellite named *VENESAT-1* in 2008.[103]

2.5 Launch Practices

2.5.1 Overview of Practices

Traditional satellites are launched using traditional launch methods. These include enormous rockets, or launch vehicles, capable of lifting tons of mass into outer space. Naturally, this results in high launch costs and only few launches per year, which are usually scheduled years in advance.

Since small satellites are light in mass, have very short development times and their operators cannot afford to pay for an entire launch vehicle, the industry developed special launch practices for small satellites.

This section will provide an overview of such practices, starting with the piggy-back launch. Thereafter, the practice of deploying small satellites from the International Space Station (ISS) will be outlined. Finally, the future of small satellites launches, which include dedicated small launch vehicles, will be presented.

[100] UN OOSA website: http://www.unoosa.org/oosa/ourwork/psa/bsti/ . For further reading on the history and creation of BSTI and about its activities, see W Balogh, 'Capacity Building in Space Technology Development: The Role of the United Nations' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 28..
[101] ESA's website- Fly Your Satellite! Program: http://www.esa.int/Education/CubeSats__Fly_Your_Satellite/Fly_Your_Satellite!_programme .
[102] ibid.
[103] R Acevedo and R Beccera, 'Small Satellites as a Chance for Developing Countries' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 105.

2.5.2 Piggy-back Launch

As mentioned in sub-sections 2.1.10 and 2.1.11, small satellites usually tag-along to a launch of a primary payload, as auxiliary payloads. This is the piggy-back launch practice, the most common one currently used for small satellites:

> A piggyback payload launch utilizes the excessive launch capability of the rocket to launch small satellites that are made by a private company or university.[104]

While the primary payload may have a special separation or deployment system, which is responsible to separate or eject the satellite from the rocket, small satellites and especially CubeSats have standardised deployers. This is a 'plug-in' solution, which makes the accommodation of small satellites as auxiliary payloads easier, and standard, regardless of on board which rocket they are launched from. The smaller deployers are often commercially called *PODs*:

> The formal definition of a CubeSat is a spacecraft that adheres to the CubeSat Design Specification developed by Cal Poly and Stanford (i.e., it fits inside the P-POD and follows the flight safety guidelines). However, there are other P-POD-equivalent interfaces, such as those developed by these organizations:
>
> • JAXA: J-POD and ISS-qualified S-POD
>
> • University of Toronto Space Flight Laboratory (SFL): T-POD and X-POD
>
> • U.S. Department of Defense: Space Shuttle Picosatellite Launcher (SSPL)
>
> • NASA: Nanosatellite Launch Adapter Systems (NLAS)
>
> • Innovative Solutions in Space (ISIS): ISIPOD.[105]

These *PODs*, which are currently available in larger configurations to cater to the market trend of using bigger small satellites for more complex missions,[106] work in the following manner:

> […] launch safety requirements are defined at the P-POD to launch vehicle interface providing a standard access platform for CubeSats across P-POD compatible launch vehicles.
>
> A spring plunger-based mechanism, once a deployment command is received, is used to eject the CubeSat(s) from the P-POD into orbit.[107]

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[104] This is how Japan Aerospace Exploration Agency (JAXA) defines the practice on its website, see: http://global.jaxa.jp/countdown/f15/overview/sub_payload_e.html

[105] M Swartwout, 'The First One Hundred CubeSats: A Statistical Look' (2013) 2(2) Journal of Small Satellites 213, 214, available at: http://www.jossonline.com/wp-content/uploads/2014/12/0202-The-First-One-Hundred-Cubesats.pdf.

[106] See for example the Quadpack on ISIS website: https://www.isispace.nl/product/quadpack-cubesat-deployer/.

[107] Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science*, *Final Report* (2014) 16, available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf.

Because of the standard interface, small satellites can be launched inboard many different launch vehicles, by northern American, European and Asian entities.[108] Most of these launch vehicles are governmentally owned and their main operator is a national space agency:

> The number of vehicles offering rideshares for nano/microsatellites is increasing, yet there is still a lack of dedicated commercial rideshare providers.[109]

The number of small satellites launches is increasing, with a dramatic increase in recent years:

> SpaceWorks Forecast projects 2017 will be a record year for nano/microsatellite launches, with 182 satellites expected to launch, representing an 80% increase from 2016.[110]

So far, 101 small satellites were already successfully launched on the 15th of February 2017, onboard the PSLV rocket, operated by ISRO.[111] The same vehicle will be launching more small satellites later in 2017. Thus, it seems like the estimate of 182 small satellites is viable considering there are additional launch vehicles scheduled to launch small satellites during 2017.

It also seems like the increase in number of small satellites launches will continue in the near future:

> Projections based on announced and future plans of developers and programs indicate nearly 2,400 nano/microsatellites will require a launch from 2017 through 2023.[112]

Another practice, which is part of piggy-back launches for small satellites, is having launch service brokers and integrators as intermediary entities between the small satellite developer or operator and the launch service provider, which owns the launch vehicle. Brokers are necessary since launch service providers often interface contractually directly with the big customers- the owners of the primary payload. The process of obtaining and coordinating auxiliary payload customers is not attractive to launch service providers, and thus, they prefer a single contractual interface to one broker, who then concludes launch contracts which each of its customers, the small satellite owners.

Currently there are only a few of such specialised brokers as such. One of the leading brokers is ISL- Innovative Space Logistics B.V. (ISL) a Dutch private entity.[113] This broker was responsible for the launch of 177 small satellites as of 01 June 2017. ISL has launched these satellites on board of 6 different launch vehicles on 12 launch campaigns.[114] Although this

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[108] For a list of launch vehicles and graphics of number of small satellites' launches, see: SpaceWorks, *2017 Small Satellite Report: Trends and Market Observations* (2017) 14, available at: http://spaceworksforecast.com/
[109] ibid.
[110] ibid., at 17.
[111] See page 11 *supra* for more information.
[112] SpaceWorks, *2017 Small Satellite Report: Trends and Market Observations* (2017) 9, available at: http://spaceworksforecast.com/.
[113] ISIS website: https://www.isispace.nl/launch-services/.
[114] ibid.

model seems similar to a travel agency for satellites, the brokers have to carry out technical work to ensure the deployment of the auxiliary payloads. Other established brokers are Spaceflight with 77 small satellites launched[115] and Tyvak with 155 small satellites launched[116] both U.S. companies.

2.5.3 ISS Deployment

The launch practice of deploying small satellites from the ISS is revolutionary. In this practice, the small satellite is launched as auxiliary payload on board a vehicle shuttling to the ISS. It is then handled by the astronauts on board the ISS and finally deployed from it, downwards, to a very low orbit around Earth, using a special deployer on board the ISS. The deployment is made from the *Kibo* module arm of the ISS.[117]

One of the leading commercial entities behind this practice is NanoRacks, a U.S. company that has its deployment system onboard the ISS:

> Early in the morning of May 26, 2017, NanoRacks successfully deployed the company's 171st CubeSat via the NanoRacks CubeSat Deployer (NRCSD) on the International Space Station (ISS), and the company's 182nd space station CubeSat deployed overall.[118]

Although most deployments were successful, the company encountered deployer failures in the past, which led to uncontrolled CubeSats deployment or failure to deploy in another case.[119] In order to overcome the technical failure a lengthy and complex repair campaign was required. Special hardware was launched to the ISS and astronauts on board executed the repairs.[120]

Further, there are some general limitations to this deployment practice:

Firstly, since astronauts are in contact with the small satellites on board the ISS, the payloads need to undergo further testing and verification processes to ensure they are safe. This may be considered as a burden, which is much less significant in the regular case of a piggy-back launch.[121]

Secondly, there are more constrains as to the maximal payload mass. The two biggest satellites, which were deployed from the ISS to date, were about 100 kilograms in mass.[122]

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[115] Spaceflight website: http://www.spaceflight.com/launch/.

[116] Tyvak website: http://www.tyvak.com/launch-services/.

[117] For images and more information see NanoRacks website: http://nanoracks.com/products/smallsat-deployment/ .

[118] NanoRacks website: http://nanoracks.com/largest-iss-cubesat-deployment/

[119] PB de Selding, 'NanoRacks Identifies Root Cause of ISS Cubesat Deployment Failures' (*SpaceNews*, 2 October 2014): http://spacenews.com/42073nanoracks-identifies-root-cause-of-iss-cubesat-deployment-failures/.

[120] J Foust, 'Astronauts Repair Space Station Satellite Deployer' (*SpaceNews*, 19 February 2015): http://spacenews.com/astronauts-repair-space-station-satellite-deployer/

[121] See for example: D Leone, 'FAA Aims To Make Tag-along Payloads a Lighter Burden for Launch Providers' (*SpaceNews*, 22 January 2015): http://spacenews.com/faa-aims-to-make-tag-along-payloads-a-lighter-burden-for-launchers/ .

[122] MP Hershey et al, *Solidifying Small Satellite Access to Orbit via the International Space Station (ISS):*

Thirdly, such deployment means achieving only low orbits, since the ISS already orbits at a fairly low orbit and the satellites are deployed downwards to orbits below the ISS.

Despite the limitations mentioned above, it seems that the demand for small satellites deployment from the ISS is higher than currently can be achieved, to the extent that the launch and deployment are considered to be a bottleneck for the small satellites industry.[123]

2.5.4 Dedicated Small Launch Vehicles

Since the piggy-back launch practice creates bottlenecks, meaning that a very large number of small satellites experience a long delay in their launch to space, and since the number of small satellites is increasing, making the demand to launch higher than the available launches, there is a need for additional launch capacity for these satellites:

> Compared to previous years, the SpaceWorks Forecast has been reduced by almost 20% to reflect the chronic delays experienced by launch providers and satellite operators:
>
> •Small satellite launch vehicles have been slow to materialize and delays of dedicated rideshare launches have resulted in a backlog of nano/microsatellites that will need a launch in 2017-2018
>
> •Concentration of launch opportunities on dedicated rideshare mission increases the impact of launch delays, highlighting the need for frequent, dedicated small satellite launch vehicles.[124]

This situation led several companies to develop small launch vehicles that will be dedicated to small satellites launches.[125] There are a number of companies that are working on the technology, however, none are capable to commercially launch yet.

One example is Rocket Lab, a start-up based in New Zealand, currently testing its *Electron* rocket. *Electron* is 17 meters long and capable to carry small satellites with mass up to 150 kilograms to a sun synchronised orbit (SSO) within the range of 150 and 500 kilometres.

The rocket was launched from New Zealand on the 25th of May 2017 and was only partially successful, as it did reach space at approximately 250 kilometres,[126] however, failed to

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Cyclops' Deployment of the Lonestar SmallSat from the ISS, 30th Annual AIAA/USU Conference on Small Satellites (2016), available at: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3339&context=smallsat ;
MP Hershey et al, *Paving the Way for Small Satellite Access to Orbit: Cyclops' Deployment of SpinSat, the Largest Satellite ever Deployed from the International Space Station*, 29th Annual AIAA/USU Conference on Small Satellites (2015), available at: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3175&context=smallsat .

[123] J Foust, 'Space Station's Commercial Users Hitting Bottlenecks' (*SpaceNews*, 27 February 2015): http://spacenews.com/space-stations-commercial-users-hitting-bottlenecks/ .

[124] SpaceWorks, *2017 Small Satellite Report: Trends and Market Observations* (2017) 17, available at: http://spaceworksforecast.com/.

[125] See for industry review of dedicated launch vehicles: C Niederstrasser, *Small Launch Vehicles – A 2015 State of the Industry Survey*, 29th Annual AIAA/USU Conference on Small Satellites (2015), available at: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3176&context=smallsat

[126] I Klotz, 'Rocket Lab Electron Booster Falls Short in Debut Test Launch' (*Space.com*, 25 May 2017):

accumulate sufficient speed to enter into orbit, which was set for 500 kilometres.[127] The company's website allows prospective launch customers to book launch capacity online while having imagery representation of the rocket's payload configuration.[128] The website also specifies that the price for the launch of a 1U CubeSat starts at 77,000 USD.[129]

Another example is Vector Space Systems, a U.S. based company, which develops the *Vector-R* and *Vector-H* rockets.[130] *Vector-R*, the smallest rocket out of the two, is only 13 meters long, and can carry up to 60 kilograms of payload to space.[131] It can reach a circular orbit of up to 1,000 kilometres.[132]

The rocket is intended to enter the market in 2018 and had its maiden test flight on the 3rd of May 2017 from Mojave, California.[133] The launch was reported to have been successful, although the company published only minimal technical information about the launch.[134]

While the two examples above use similar concepts as traditional large rockets, on a smaller scale, there are other concepts that aim to bring small satellites to space. Virgin Orbit a U.S. based company and part of the Virgin group, is developing air-launch capabilities for small payloads:

> We are in the final stages of testing and preparation for LauncherOne, a two-stage, expendable, LOX/RP-1 rocket that launches from our mobile air launch pad, a dedicated 747-400 carrier aircraft, called Cosmic Girl.
>
> Cosmic Girl will carry LauncherOne to at an altitude of approximately 35,000 feet before release for its rocket-powered flight to orbit. Starting each mission with an airplane rather than a traditional groundbased launch pad offers performance benefits in terms of payload capacity, but more importantly, air-launch offers an unparalleled level of flexibility.[135]

LauncherOne is capable of carrying 300 kilograms of payload to a 500 kilometres, SSO.[136]

The vast majority of small dedicated launch vehicles initiatives are non-European. In order to answer to the need for a small European launcher, a European project aimed to develop a small satellites launcher was launched on the 31st of May 2016, in The Hague. *SMILE*, which stands

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http://www.space.com/37003-rocket-lab-electron-booster-debut-launch-falls-short.html .

[127] ibid; S Clark, 'Rocket Lab Chief Says Maiden Launch Result Maintains Pace for Commercial Service' (*Spaceflight Now*, 30 May 2017): https://spaceflightnow.com/2017/05/30/rocket-lab-chief-says-maiden-launch-result-maintains-pace-for-commercial-service/.

[128] Rocket Lab website: https://www.rocketlabusa.com/book-my-launch/ .

[129] ibid.

[130] Vector Space Systems website: https://vectorspacesystems.com/technology/ .

[131] ibid.

[132] Vector Space Systems website: https://vectorspacesystems.com/vector-r/ .

[133] C Cofield, 'Vector Space Makes 1st Test Launch of Small-Satellite Rocket' (*Space.com*, 3 May 2017): http://www.space.com/36710-vector-space-test-launch-success.html .

[134] J Foust, 'Vector Tests Prototype Small Launch Vehicle' (*SpaceNews*, 3 May 2017): http://spacenews.com/vector-tests-prototype-small-launch-vehicle/

[135] Virgin Orbit website: https://virginorbit.com/ .

[136] ibid.

for: 'Small Innovative Launcher for Europe', is supported by the EU under the 'Horizon 2020' framework.[137]

It has a long list of 14 European partners, which consist of commercial companies and governmental institutes. The partners are based in The Netherlands, Germany, Spain, Greece, Romania, Norway and Denmark.[138]

While the three abovementioned launchers should become operational and enter the market shortly, *SMILE's* rocket design stage is due to be completed in 2018.[139]

Another example for a European initiative in this field is PLD Space which is a Spanish start-up aimed to offer launch services for small satellites.[140] Using their *Arion-2* launch vehicle, which is currently under development, the company sets their first test-flight to 2021, with the aim of carrying 50 kilograms to LEO at 400 kilometres.[141]

Zero 2 Infinity is a second Spanish start-up aimed to provide launch services for small satellites. Their *Bloostar* launch vehicle, which incorporates a balloon, will be able to carry 100 kilograms to LEO at 600 kilometres when its development would be completed.[142]

2.6 The Future of Small Satellites

2.6.1 Small Satellites as Leading Innovation

Apart from the upcoming new launch vehicles for small satellites described above, small satellites are leading further changes in the space industry. Two notable examples are: the use of a large number of small satellites in constellations; and further in the future, the use of small satellites in deep space missions.

2.6.2 Swarms, Constellations & 'Mega- Constellations'

Several commercial entities are basing their near-future business models on providing satellite services by employing a great number of small satellites. Each is a swarm or constellation of small satellites, with hundreds to thousands of satellites.[143]

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[137] SMILE website: http://www.small-launcher.eu/start-of-design-for-concept-small-innovative-launcher-for-europe-smile/ .
[138] SMILE website: http://www.small-launcher.eu/partners/ .
[139] SMILE website: http://www.small-launcher.eu/start-of-design-for-concept-small-innovative-launcher-for-europe-smile/.
[140] PLD Space's website: https://www.pldspace.com/ .
[141] PLD Space's website: https://www.pldspace.com/arion2.html .
[142] Zero 2 Infinity's website: http://www.zero2infinity.space/bloostar/launch-your-satellite/ .
[143] While a 'swarm' refers to a number of small satellites which are not capable of maneuvering, and a 'constellation' refers to a number of small satellites which are capable of maneuvering, the distinction between the two terms is not kept in many cases and the two terms are used interchangeably. For more information see: C Verhoeven, *Innovative Applications Pushing the Development of Small Satellite Technology: A vision on Extreme Miniaturization*, Small Satellites Tech, Business & Regulatory Industry Workshop, ESTEC, Noordwijk, The Netherlands (13 April 2017); available at: http://esamultimedia.esa.int/docs/ECSL/Tech_Chris_Verhoeven.pdf .

The largest planned mega-constellation to date is SpaceX's 4,425 small satellites constellation, which aims to 'rebuilding the internet in space'.[144] The number of satellites that will be launched to Low Earth Orbit (LEO) is bigger than the number of all other satellites orbiting in outer space to date, certainly a change in the magnitude of satellite activities. SpaceX already filed for a license with the U.S. Federal Communications Commission (FCC) in order to obtain governmental approval to operate the anticipated mega-constellation.[145]

Other examples are OneWeb,[146] Samsung,[147] Planet,[148] Sky and Space Global,[149] each a commercial entity with plans to launch and operate large small satellites constellations or swarms in LEO. It is noteworthy that the satellites' dimensions, mass and manoeuvring capabilities differ from one example to another.

The commercial utilisation of small satellites in these examples will clearly increase the number of small satellites manufactured and launched to outer space. A recent market analysis already detected the following:

> Commercial Earth observation and remote sensing constellations continue to make up a substantial portion of the market, encompassing 63% of all nano/microsatellites launched in 2016;[150]

Thousands of satellites launched in a relatively short time period, will certainly change the space industry, and may have legal and political implications.[151]

2.6.3 Small Satellites Beyond Earth's Orbit

Satellites orbit the Earth, that is, in most cases. Scientists and commercial companies are thinking of new ways to use small satellites, beyond Earth's orbit.

One example is the *OLFAR* mission, aiming to launch small satellites to Lunar orbit in order to gather scientific measurements and data. This project is a collaboration between universities, ESA and commercial entities. By deploying a swarm of small satellites around the Moon the

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[144] See for media reports about this project: Reuters, 'SpaceX Wants FCC Approval to Launch a Gigantic Satellite Internet Network' (*Fortune*, 17 November 2016): http://fortune.com/2016/11/17/spacex-satellite-network-fcc-global-internet/; D Messier, 'SpaceX Files for FCC Approval for 4,425 Satellite Global Broadband Constellation' (*Parabolic Arc*, 16 November 2016): http://www.parabolicarc.com/2016/11/16/spacex-files-fcc-approval-4425-satellite-global-broadband-constellation/; D Mosher, 'SpaceX Just Asked Permission to Launch 4,425 Satellites — More Than Orbit Earth Today' (*Business Insider*, 17 November 2016): https://www.businessinsider.nl/spacex-internet-satellite-constellation-2016-11/?international=true&r=US .

[145] ibid, see also FCC's website: http://licensing.fcc.gov/cgi-bin/ws.exe/prod/ib/forms/reports/swr031b.hts?q_set=V_SITE_ANTENNA_FREQ.file_numberC/File+Number/%3D/SATLOA2016111500118&prepare=&column=V_SITE_ANTENNA_FREQ.file_numberC/File+Number .

[146] OneWeb website: http://oneweb.world/#technology.

[147] K Finley, 'Samsung Looks to Join the Satellite Internet Space Race' (*Wired*, 14 August 2015): https://www.wired.com/2015/08/samsung-looks-join-satellite-internet-space-race/.

[148] Planet website: https://www.planet.com/company/approach/; see sub-section 2.4.2 *supra*.

[149] Sky and Space Global website: http://skyandspace.global/index.php/technology .

[150] SpaceWorks, *2017 Small Satellite Report: Trends and Market Observations* (2017) 17, available at: http://spaceworksforecast.com/.

[151] See for more information and analysis: N Palkovitz, *Dealing with the Regulatory Vacuum in LEO: New Insurance Solutions for Small Satellites Constellations*, IISL Proceedings of the 59th Colloquium on the Law of Outer Space, Guadalajara, Mexico (2017).

scientists are aiming to learn about the history of our universe- the 'astronomical dark ages'.[152] The need to go beyond Earth's orbit is explained as follows:

> Earth-bound astronomy in frequency bands below 30 MHz is practically impossible due to the instability and sometimes complete opaqueness of the ionosphere and the presence of man-made interference. One solution to overcome this is to have a space-based array of satellites that will observe these ultra-long wavelengths, process the information onboard, and then send it to a base station on Earth. The system will consist of a swarm of 50 to 1,000 identical nano-satellites (sensors) spread over kilometric distances that will orbit faraway from terrestrial radio frequency interference.[153]

The satellites will adhere to the CubeSat standard and use COTS technology:

> The CubeSat standard with the plethora of readily available Commercial Off The Shelf (COTS) hardware make adhering to this standard a valuable interest, especially regarding the design of the precursor missions discussed later.[154]

Going even further than the Moon, with the recent emergence of governmental and commercial initiatives in the field of asteroid mining, there are plans to deploy small satellites in orbit around asteroids.

A recent and impressive example of small satellites use in deep space is the *MarCO* mission to Mars. NASA launched the InSight Mars lander in May 2018, which landed on Mars on the 26th of November the same year. The lander carried two small satellites, each a 6U CubeSat, as secondary payloads and these were successfully deployed into Mars' orbit. The small satellites' mission was to provide NASA with real time communication during InSight's landing on Mars. This allowed NASA to monitor the landing process in real time instead of waiting for several hours to know if the spacecraft landed successfully on Mars. It was reported that the satellites were also able to collect scientific data during their mission.[155]

This revolutionary mission shows that small satellites can be successfully used in deep space, and make a significant contribution to human exploration and use of outer space.

3. The Small Satellites Revolution- A Need for Specific Regulation?

[152] University of Twente, Centre for Array Technology: https://www.utwente.nl/ctit/cat/Projects/OLFAR/.
[153] ibid.
[154] S. Engelen et al, *The Road to OLFAR - A Roadmap to Interferometric Long-Wavelength Radio Astronomy Using Miniaturized Distributed Space Systems*, 64th International Astronautical Congress, Beijing, China (2013); available at: http://ens.ewi.tudelft.nl/pubs/engelen2013iac.pdf .
[155] J Foust, 'MarCO Success Vindicates Use of Cubesats on Deep Space Missions' (*Space News*, 26 November 2018): https://spacenews.com/marco-success-vindicates-use-of-cubesats-on-deep-space-missions/ .

The information presented in the second section of this chapter may be summarised as follows:

> CubeSats have allowed the creation of an entire spaceflight subculture.[156]

Indeed, the change in design philosophy, technology, commercial availability, short development times, reduced cost, significant miniaturisation, standardisation of satellites and their popularity, truly revolutionised the space industry.[157]

Such revolution is not limited to the elements described in the paragraph above. The fact that small satellites increased the number of both governmental and non-governmental entities who are capable to carry out activities in outer space makes them revolutionary. This process is often referred to as the 'democratisation of space'.[158]

Furthermore, concepts such as online crowdfunding for satellites missions, or satellites that are built by school children, meant that small satellites made space accessible to non-professionals, and on an individual level.[159]

These notions are innovative and clearly very different from the notions, which were common half a century ago, when the Outer Space Treaty,[160] the most important legal instrument that regulates space activities, came into force.

Subsequently, one may wonder whether the revolution in the industrial and technological domains merits a regulatory revolution as well, or at least, specific regulation which may accommodate the case of small satellites operations.

This question shall be at the core of this study, examining the current regulatory situation vis-à-vis small satellites, while considering their unique characteristics and differences as compared to traditional satellites.

In this sense, there is a need to keep the non-legal information in this chapter in mind, to allow for a meaningful analysis of the legal and regulatory situation, and to foresee what kind of challenges lie in the future.

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[156] 'History of the CubeSat' (*Space Daily* (report by staff writers), 23 August 2016): http://www.spacedaily.com/reports/History_of_the_CubeSat_999.html.

[157] See for further information: Keck Institute for Space Studies, California Institute of Technology Pasadena, *Small Satellites*: *A Revolution in Space Science, Final Report* (2014), available at: http://kiss.caltech.edu/study/smallsat/KISS-SmallSat-FinalReport.pdf.

[158] D Baiocchi and W Welser, 'The Democratization of Space' (2015) 94 Foreign Affairs 98; K Finley, 'Why the Space Democratization Movement Blows My Mind' (*Tech Crunch*, 1 September 2012): https://techcrunch.com/2012/09/01/why-the-space-democratization-movement-blows-my-mind/; R van Zyl, 'Cool Cubes are Changing the Way We Play in Space' (*The Conversation*, 18 May 2015): https://theconversation.com/cool-cubes-are-changing-the-way-we-play-in-space-41621.

[159] N Palkovitz, *Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*, IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014); N. Palkovitz, 'Will YOU Own the Next Space Project?' (*Leiden Law Blog*, 17 August 2017): http://leidenlawblog.nl/articles/will-you-own-the-next-space-project; P Platzer and K Klausner, 'Crowdfunding for Small Satellites' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 349.

[160] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967 610 *U.N.T.S.* 205.

The question presented herein has recently taken the form of a discussion in international forums, such as the United Nations, and occupies national regulators as well. As *Freeland* writes in his short article: 'Space Treaties are a Challenge to Launching Small Satellites in Orbit':

> The requirement that owners of nanosats clear the same regulatory hurdles as apply to the established players has given rise to considerable discussion and suggestions for reform.[161]

With the key facts laid down in this first chapter, this study will turn to explore the presented questions and contribute to the international discussion at hand.

4. Conclusions

This chapter took an interdisciplinary approach aimed at providing the reader with a comprehensive picture of what small satellites are, and in what way they revolutionised the space industry.

Key terminology was defined for the purpose of this study; small satellites were contextualised by looking at their history; the special characteristics of these satellites were presented while juxtaposed with traditional satellites; examples were given to illustrate what kind of satellite applications could be carried out using small satellites, and who are the entities behind such applications; unique launch practices were outlined; and finally, small satellites were contextualised by looking into their future.

The most important finding of this chapter can be formulated as follows: *small satellites are more than small-sized spacecraft*; the persons behind them succeeded to harness their technological advantages to create a new way of carrying out accessible, fast and low-cost satellite missions. This process boosted the democratisation of space, by enabling non-traditional space-sector players to become space-faring entities.

With this realisation, the next step in this study will be to explore the domain of international space law, which is the *lex specialis* of public international law regulating activities in outer space.

Accordingly, chapter 2 will explore the status of small satellites vis-à-vis international space law in an introductory manner, examining which provisions are applicable to small satellites activities, and what kind of legal issues the traditional definitions pose when considering novel small satellites activities. This will include an assessment of how the *lex specialis* corresponds to small satellites activities.

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[161] S Freeland, 'Space Treaties are a Challenge to Launching Small Satellites in Orbit' (*The Conversation*, 16 April 2015): http://theconversation.com/space-treaties-are-a-challenge-to-launching-small-satellites-in-orbit-37971.

Further, the international discussion about small satellites regulation shall be presented in order to understand in what ways stakeholders believe the existing law should apply to small satellites, and whether there is a need to therefore change the law, or create new legal instruments which will focus on regulating small satellites activities.

The following chapters will focus on key legal concepts in international space law, such as: State responsibility, liability and registration of space objects at the international level, and finally, at the national level. All in order to comprehensively assess whether there is a need for special regulatory treatment of small satellites activities.

Chapter 2: Small Satellites Activities Within the Framework of International Space Law and Recent Regulatory Developments

1. Introduction

The first chapter of this study introduced small satellites and their associated activities, and explained which elements made small satellites revolutionary in the realm of space activities.

In this second chapter, small satellites will be introduced in relation to the legal framework of existing international space law and upcoming norms aimed to govern small satellites activities. The latter are currently under discussion at international forums.

The applicability of international-space-treaty-law to small satellites activities is fundamental to understanding the international legal framework governing such activities. This is due to the fact that, to date, there are no judicial products, such as ICJ cases or proceedings of other international tribunals, which concern small satellites activities. Further, customary international law relating to satellite activities is not clearly established yet, and certainly not for small satellites activities specifically, given they have only been carried out for less than two decades. This means that the UN space treaties[1] are the most relevant primary source of international law available.

Therefore, the greater part of this chapter shall be dedicated to examining small satellites activities in light of the applicable UN space treaties. Firstly, the relations between such activities and key relevant provisions of the Outer Space Treaty will be analysed. Secondly, the applicability of relevant provisions of the remaining UN space treaties will be analysed. Thirdly, small satellites activities will be examined vis-à-vis the existing relevant definitions in the UN space treaties, while explaining the legal challenges innovative small satellites pose to traditional treaty provisions.

[1] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, (1967) 610 *U.N.T.S.* 205 (Hereinafter: 'Outer Space Treaty'); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, (1968) 672 *U.N.T.S.* 119 (Hereinafter: 'Rescue Agreement'). Convention on International Liability for Damage Caused by Space Objects, (1972) 961 *U.N.T.S.* 187 (Hereinafter: 'Liability Convention'); Convention on Registration of Objects Launched into Outer Space, (1975) 1023 *U.N.T.S.* 15 (Hereinafter: 'Registration Convention'); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, (1979) 1363 *U.N.T.S.* 3 (Hereinafter: 'Moon Agreement'). The five treaties are collectively referred to as the 'UN space treaties'.

Accordingly, the second section of this chapter shall focus on answering the following questions: *Which international space law provisions apply to small satellites activities? And in what ways do small satellites activities challenge such provisions?*

The following section of this chapter, will present the current discussion relating to small satellites activities in international forums. Such discussions may form binding international law or soft law, which will govern small satellites activities specifically, in the future. The recent work of the following international bodies shall be presented: firstly, the United Nations Office for Outer Space Affairs (UNOOSA), and specifically its Committee on the Peaceful Uses of Outer Space (COPUOS) and its legal sub-committee.[2] Secondly, the Inter-Agency Space Debris Coordination Committee (IADC).[3] And thirdly, the International Telecommunication Union (ITU) and the ITU World Radio Conference (WRC).[4]

The importance of the work of the abovementioned bodies lies in the fact that it reflects the matters, which the international community finds most critical to the development of small satellites activities, meaning areas that may require specific regulation of such activities. Furthermore, the discussions complement topics that are not addressed in the UN space treaties.

All the above will be the basis for understanding the legal challenges concerning small satellites activities and the possible need to find new international norms in order to specifically regulate small satellites, beyond the existing UN space treaties.

2. Small Satellites and International Space Law- Applicability and Challenges

2.1 Applicability

Since small satellites are different from traditional satellites in many ways, some scholars, including the author, chose to reaffirm the fact that international space law applies to all types of satellites or 'space objects'[5] on an equal basis:

[2] UNOOSA's website: http://www.unoosa.org/. Note: all the links provided in the notes of this chapter were last visited on 1st October 2017.
[3] IADC's website: http://www.iadc-online.org/ .
[4] ITU's website: http://www.itu.int/en/Pages/default.aspx .
[5] See for definition and applicability of this term to small satellites sub-section 2.3.3 *infra*.

> None of the international space law treaties differentiates between space objects according to their dimensions.[6]
>
> Under international law, small satellite missions are not treated any differently than other space activities.[7]

It seems that there is no scholarly difficulty in reaching the conclusion that existing treaty law applies to small satellites in the same manner it applies to traditional satellites.

Practically, since many small satellites missions were carried out by start-ups, technical universities and non-space-faring nations as a capacity building activity,[8] there was a clear lack of awareness to existing international space law, and to the fact it applies to 'small' and 'simple' missions using small satellites. Some international bodies took efforts to make clear that the law's applicability does not depend on the magnitude of the space activity in question.[9]

Thus, currently, the applicability of the UN space treaties to small satellites is not a cause for disagreement.

This section will explore the relations between the relevant provisions of the UN space treaties and small satellites activities, while identifying legal challenges relating to the treaties' application, which will be further analysed in the following chapters of this study.

2.2 Small Satellites Under the Outer Space Treaty

The Outer Space Treaty is considered to be the *magna carta* of international space law. It is the first treaty out of the five UN space treaties, and the one, which outlines the international regime for space activities in the broadest manner. It is also the most popular one, with 105 ratifications by States, as at January 2017.[10]

This subsection shall review the provisions of the Treaty in the context of small satellites activities, and determine to what extent small satellites activities are in line with such provisions. Provisions

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[6] N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws, and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47, 48.

[7] LJ Smith and Z Valic, *A Regulatory Roadmap for Small Satellites*, 4S Symposium, Slovenia (05 June 2012), at 5; See also: RS Jakhu and JN Pelton, *Small Satellites and their Regulation* (Springer 2014) 43.

[8] See chapter 1, sub-section 2.4.8 for examples.

[9] For further writing concerning this problem see: N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566; See section 3 for international efforts to raise awareness and enhance compliance in this context.

[10] Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to activities in outer space as at 1 January 2017, UN Doc. A/AC.105/C.2/2017/CRP.7 (2017); available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf .

relating to human spaceflight, dispute resolution and other topics that are not relevant to assessing small satellites activities, will not be analysed.

Article I of the Outer Space Treaty embodies key principles of space activities, as they were envisaged by the member States of UN COPOUS.[11]

> Article I
>
> The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.
>
> Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.
>
> There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.

Small satellites activities usually serve the interests in Article I, to a very high degree.

The activities are carried out by various States and are more diversified compared to traditional satellites activities.[12] It is probably the space activity that promotes non-discriminatory space exploration the most. This is the case since small satellites technology is affordable and extremely accessible compared to traditional satellites activities, and of course, compared to human spaceflight activities.[13]

UNOOSA has recognised that small satellites are an effective capacity-building tool and promotes the exchange of information and development of small satellites activities. UNOOSA does this especially with developing countries and non-space-faring-nations in mind. The Basic Space Technology Initiative (BSTI) program is the best testimony to such practice.[14]

Moreover, small satellites promote free scientific investigation of outer space, since small satellites are frequently used by universities and research institutes in missions aimed to unlock the mysteries

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[11] For further reading see: S Hobe, B Schmit-Tedd and K Schrogl (eds), *Cologne Commentary on Space Law* (vol. I Outer Space Treaty 27; Carl Heymanns Verlag 2009) (hereinafter: 'CoCoSL'); N Jasentuliyana, 'Article I of the Outer Space Treaty Revisited' (1989) 17/2 Journal of Space Law 129; UNGA Res. 51/122 Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of all States, Taking into Particular Account the Needs of Developing Countries (13 December 1996).

[12] For information and examples see chapter 1, sub-sections 2.3.8 and 2.4.8.

[13] For more information see chapter 1, section 2.3.

[14] UNOOSA website: http://www.unoosa.org/oosa/ourwork/psa/bsti/. For further reading on the history and creation of BSTI and about its activities see: W Balogh, 'Capacity Building in Space Technology Development: The Role of the United Nations' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 28.

of our universe. They are also used to test new technologies in the space environment, which allow the technological development of mankind in its quest to explore outer space.[15]

Since CubeSats are standardised to a great extent, they are excellent cooperation enablers. The QB50 project is an example of a vast international cooperation that uses CubeSats for scientific exploration of outer space as well as technology demonstration.[16]

The BRITE constellation is another example for international cooperation in scientific exploration using nano-satellites. The constellation includes satellites from Canada, Poland and Austria and its mission is to carry out scientific measurements of stars' brightness.[17]

These types of activities truly implement the objectives in Article I of the Outer Space Treaty using small satellites. Therefore, it is concluded that small satellites activities fulfil the interests outlined by Article I.

The second Article of the Outer Space Treaty sets the non-appropriation principle:

> Article II
>
> Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

Small satellites activities do not seem to challenge the non-appropriation principle and thus, are in line with Article II.

The third Article of the Outer Space Treaty applies general international law on space activities and outlines related key principles in a somewhat repetitive manner to Article I:

> Article III
>
> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.

As mentioned above,[18] small satellites activities do promote international cooperation in space. There is no evidence that the activities challenge the provisions of the UN Charter either. Therefore,

[15] For information and examples see chapter 1, section 2.4.
[16] See chapter 1, section 2.4 for more details and the Project's website: https://www.qb50.eu/ .
[17] See chapter 1, section 2.4 for more details, and the Project's website: http://www.brite-constellation.at/ .
[18] See *supra* in this section 2.2.

it is concluded that small satellites activities conform to the legal framework introduced by Article III.

The fourth Article of the Outer Space Treaty elaborates on the de-weaponisation of outer space. Its first paragraph is potentially relevant to satellites activities:

> Article IV
>
> States Partis to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

A small satellite, which orbits Earth while carrying nuclear weapons or other weapons of mass destruction, would be contrary to Article IV.[19] Since small satellites are small and light, and their power budget is rather limited, it is improbable that such satellites will be chosen to carry powerful weapons in orbit.[20] Therefore, the likelihood of a small satellite mission that would violate Article IV is rather low.

Chapter 3 of this study comprehensively analyses small satellites activities in light of Article VI, which elaborates a specific State responsibility regime for space activities.[21]

> Article VI
>
> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the Moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

[19] Currently there is no one internationally agreed definition to the term 'weapons of mass destruction', however several legal instruments use this term, which refers to nuclear, biological and chemical weapons: *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, I.C.J. Reports (1996) 226; see discussion at paras. 35, 55, and 57-58.

[20] See chapter 1, section 2.3, for the special characteristics of small satellites compared with those of traditional satellites.

[21] See for analysis of the difference between State responsibility under Article VI and in general international law, chapter 3, section 2.2.

For the purpose of the assessment in this section, it is submitted that small satellites activities are in line with Article VI, as is any other satellite activity, as long as the 'appropriate State'[22] ensures that the 'national activity'[23] is in line with the provisions of the Outer Space Treaty.

In cases where the activity is carried out by non-governmental organisations, the appropriate State must authorise and continuously supervise it. In many cases, such authorisation and supervision requirements take the form of domestic space legislation, which sets license criteria.[24]

The seventh Article of the Outer Space Treaty sets forth the general liability regime for space activities. This regime is further developed by the Liability Convention.

> Article VII
>
> Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

Chapter 4 of this study analyses the developed provisions relating to liability in the context of small satellite activities. Small satellites activities pose a challenge in connection to the phrase: 'procures the launching'.[25]

Since small satellites operators are often non-governmental entities, and since they often sign launch contracts for piggy-back launches with third parties such as launch brokers,[26] the connection between a 'State Party' and the launch procurement process is severed.[27]

The Outer Space Treaty does not define the level of involvement that a State has to take in launch procurement to become liable for damage caused by the launched object, and thus, each State may interpret its obligations in a different manner. This is an unwanted situation as the rationale behind Article VII is to set a uniform and certain international liability regime.[28] While some States see their international obligations under Article VI, prescribing State responsibility, as sufficient to establish liability per Article VII, other States separate these two legal matters.[29]

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[22] See further, chapter 3 subsection 2.1.2.
[23] See further, subsection 2.3.4 *infra* and chapter 3, subsection 2.1.1.
[24] For general State practice in this context see: *CoCoSL* 117-122.
[25] See chapter 4, section 3.4.
[26] See chapter 1, sub-section 2.5.2.
[27] See chapter 4, section 3.4.
[28] *CoCoSL*, 129.
[29] For the case of The Netherlands as an example see: N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566.

To this end, it may be challenging to identify and determine the State or States that may be liable for damage caused by a small satellite. In addition, it may be difficult for an operator to find the State that is legally entitled to claim damage from other States in the case that a small satellite is damaged and compensation is due.[30]

The eighth Article of the Outer Space Treaty sets forth the obligation to register space objects and clarifies that States have jurisdiction and control over such registered objects:

> Article VIII
>
> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

The Registration Convention includes further details relating to this topic and its provisions are analysed in chapter 5 of this study, in the context of small satellites' registration. For the purpose of the assessment in this section, the obligation to register small satellites is the same as the obligation to register any other satellites or space objects. While this is the case, there are some inconsistencies in State practice relating to the registration of small satellites.[31]

One of the difficulties originates from the legal relations between Articles VI, VII and VII of the Outer Space Treaty.[32] The partial separation that the Treaty sets between State responsibility per Article VI, liability per Article VII and jurisdiction and control per Article VIII combined with the non-governmental nature of small satellites activities, has again led to different interpretations and *opinio juris* with respect to a State's obligation to register small satellites with the UN as prescribed by the Registration Convention.[33]

The ninth Article of the Outer Space Treaty includes several different obligations relating to the protection of the outer space environment. Most are not relevant to small satellites activities, for example, provisions on inter-planetary contamination. The first sentence of the Article may be relevant to small satellite activities:

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[30] See chapter 4.
[31] N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566; T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 187-194.
[32] *CoCoSL,* 115-116.
[33] See *supra* note 29.

Article IX

> In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty.

As mentioned with respect to Article I, small satellites activities promote international cooperation in space, and therefore, the first element of this provision will generally be met by small satellites activities.[34]

The second element of paying 'due regard to the corresponding interests of all other States Parties to the Treaty' is vague and abstract.[35] As such, it is difficult to determine what kind of space activity corresponds to the potentially various interests of over than 100 State parties.

Other branches of public international law may shed light on the notion of conducting activities with 'due regard'. This notion exists in public international air law, as included in the Chicago Convention,[36] specifically relating to safety; in international maritime law, when referring to the high seas, as embodied in UNCLOS[37]; and in the context of environmental law in the Stockholm Declaration on Human Environment.[38]

Additionally, the Outer Space Treaty, including Article IX, was a product of the geo-political situation at the time of the Cold War and in the lead-up to the highly anticipated first Lunar landing.[39] The emphasis on the need to take into account interests of all other States parties to the Treaty protected most of the States parties, since only a few of them were space-faring half a century ago.[40] Additionally, the principle of due regard was linked to the concept of *res communis omnium*.[41]

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[34] See for example Article I in this section.
[35] *CoCoSL*, 170, 175-176.
[36] Convention on International Civil Aviation, 1944 15 *U.N.T.S.* 295.
[37] United Nations Convention on the Law of the Sea, 1982 1833 *U.N.T.S.* 3.
[38] Declaration of the United Nations Conference on the Human Environment U.N. Doc. A/Conf.48/14/Rev. 1 (1973); 11 ILM 1416 (1972).
[39] J Gabrynowicz, '*Article IX of the Outer Space Treaty: Context and Considerations*' 5th E. Galloway Symposium on Critical Issues in Space Law (Washington, 2 December 2010), available at: http://www.olemiss.edu/programs/spacelaw/events/pdfs/2010/galloway-gabrynowicz-presentation-2010.pdf.
[40] L Tennen and PM Sterns, '*Consideration of 'Heavenly Matters' and the Evolution of Article IX'* 5th E. Galloway Symposium on Critical Issues in Space Law, slide 26 (Washington, 2 December 2010), available at: http://www.olemiss.edu/programs/spacelaw/events/pdfs/2010/galloway-sterns-tennen-presentation-2010.pdf .
[41] S Marchisio, '*Article IX of the Outer Space Treaty: An Overview*' The Fifth Eilene M. Galloway Symposium on Critical Issues in Space Law: Panel – Art. IX Background, 5th E. Galloway Symposium on Critical Issues in Space Law (Washington, 2 December 2010).

On the one hand, it is reasonable to argue that since small satellites missions are very diverse, and originate from a large number of States, they meet the objective set by this provision.

On the other hand, since the context of Article XI is environmental,[42] and since small satellites numbers are increasing rapidly,[43] the creation of space debris is a concern. Arguably, the sustainable use of certain popular orbits may be a common interest to all State parties to the Treaty.

Scholars agree that the provisions of Article IX are rather weak, and in any case do not create any absolute obligations.[44] Thus, Article IX should be read in conjunction with Article I of the Outer Space Treaty, which stipulates the freedom of exploration and use of outer space. The latter freedom or right is not absolute either: it is limited by other provisions of the Treaty, most significantly in the context of non-peaceful use of outer space, as clearly provided under Article IV.[45]

Therefore, the freedom of exploration in Article I must be balanced with the guideline to pay due regard to a wide range of interests other States may have, some in the environmental context. The author had previously phrased this dilemma as follows:

> Taking the above into mind, the following question arises: would it be beneficial to limit the freedom of exploration and use in order to promote environmental protection of outer space?
>
> On the one hand, studies have shown that we are facing risks of over congesting certain orbits by creating space debris. These risks are connected to the safety of astronauts (as vividly illustrated by the film Gravity), potential liabilities in collision cases, and generally, to the sustainability of the outer space environment. On the other hand, the existing international legal framework for space activities generally favours the freedom of exploration and use, and includes only a set of non-binding guidelines that expressly promote environmental interests in space.[46]

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[42] *CoCoSL* 176-179.

[43] See chapter 1, sub-section 2.6.2; N Palkovitz, '*Dealing with the Regulatory Vacuum in LEO: New Insurance Solutions for Small Satellites Constellations*' IISL Proceedings of the 59th Colloquium on the Law of Outer Space (2017) 419 .

[44] See for example: PJ Blount, '*Renovating Space: The Future of International Space Law*' (2012) 40/1 Denver Journal of International Law and Policy 515, 525; MC Mineiro, '*FY-1C and USA-193 ASAT Intercepts: An Assessment of Legal Obligations Under Article IX of the Outer Space Treaty*' (2008) 34/2 Journal of Space Law 321.

[45] *CoCoSL* 27; N Palkovitz, '*Exploring the Boundaries of Free Exploration and Use of Outer Space –Article IX and the Principle of Due Regard, Some Contemporary Considerations*' IISL Proceedings of 57th Colloquium on the Law of Outer Space (2015) 93.

[46] N Palkovitz, 'Gaining Freedom, Losing Space' (*Leiden Law Blog*, 26 August 2014), available at: http://leidenlawblog.nl/articles/gaining-freedom-losing-space .

The author argues that the legal ambiguity presented by the above analysis exists in a broader context than small satellites activities, since the problem of space debris was introduced to the scientific community prior to the genesis of modern small satellites activities.[47]

Arguably, if it were to be accepted that traditional satellites activities are not in line with the provisions of Article IX, small satellites activities would also be considered to be incompatible. While this is evidently not the case, over the years legal instruments have been drafted in order to attempt to reach an appropriate balance between Articles I and IX. Nevertheless, none of the instruments are primary sources of international law and are instead generally considered 'soft law'. The most cited example is the IADC Space Debris Mitigation Guidelines.[48]

With the realisation that the IADC Guidelines were not updated to deal with very large numbers of small satellites in LEO, the IADC is currently discussing the need to have specific guidelines, which aim to limit debris creation by small satellites activities. This interesting discussion will be addressed in subsection 3.3, below.

Regardless of the specific guidelines, which may materialise as soft law, it would be hard to argue that small satellites activities are in violation of binding treaty law, namely, Article IX.[49]

To conclude this subsection, small satellites activities are generally in line with the provisions of the Outer Space Treaty, albeit States differ in the way in which they implement the provisions. The next subsection will outline the legal link between small satellites activities and the remaining four UN space treaties.

2.3 Small Satellites and the Other UN Space Treaties

The next UN space treaty, which entered into force only one year following the Outer Space Treaty, is the Rescue Agreement.[50] The most important objective of this instrument is to protect astronauts in case they fall into foreign hands. Since the Rescue Agreement was drafted during the Cold War era, both superpowers wanted to make sure their astronauts would not be treated as war prisoners in case they land in hostile territories, and that their safe return would be ensured.[51] Other than the protection and return of astronauts, there are obligations relating to the return of space objects,

[47] The theory of NASA's scientist, DJ Kessler, which is widely known as the 'Kessler Syndrome', was published in 1978, decades before the modern concept of small satellites saw light. For more information about the Kessler Syndrome see: M La Vone, 'The Kessler Syndrome: 10 Interesting and Disturbing Facts' (*Space Safety Magazine*, 15 September 2014): http://www.spacesafetymagazine.com/space-debris/kessler-syndrome/ .

[48] Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (2002, as revised in 2007), IADC-02-01, Revision 1 (Hereinafter: 'IADC Guidelines').

[49] See chapter 4, subsection 3.3.2 for legally-constructing the violation of IADC Guidelines as a trigger for liability in the context of small satellites.

[50] *Supra* note 1.

[51] For further reading see: G Lafferranderie and S Marchisio (ed), *The Astronauts and Rescue Agreement: Lessons Learned* (ECSL/ESA Publication 2011).

including their remains after re-entry to Earth.[52] Since most small satellites are low in mass and are not designed to survive re-entry to Earth, they usually burn in the atmosphere.[53] As such, it is unlikely that States will invoke the provisions of the Rescue Agreement in the context of small satellites.

The Liability Convention[54] is the third UN space treaty that came into force. As mentioned in the previous subsection, relating to Article VII of the Outer Space Treaty, small satellites activities challenge the concept of State-launch procurement and hence, the concept of the 'launching State'. Further, the Convention sets two different liability regimes for damage caused by space objects, Article II prescribes absolute liability for damage caused on Earth and in the airspace, while Article III prescribes fault liability for damage which was caused in outer space. Chapter 4 of this study analyses the difference between these two standards of liability, and evaluates their relevance and applicability to damage caused by and to small satellites. In summary, damage according to Article II is less relevant for small satellites, and damage according to Article III is the most relevant, since the probable risks connected to small satellites activities are related to collisions in outer space. This means that fault liability is the legal standard that applies. As the author elaborates in chapter 4, there is a great uncertainty in relation to the kind of events that establish 'fault' in the context of Article III. The author concludes that since the language of the Convention is due for clarification, and since currently there are no ICJ cases or other relevant judicial decisions which clarify the term 'fault', parties that rely on Article III in the context of small satellites activities may not reach a legal indication as to which party is obliged to compensate the other for the damage which was caused.[55]

In this sense, it is concluded that applying the Liability Convention to small satellites activities may not be legally effective, at least until further interpretation is available through the development of case law or customary law.[56]

The Registration Convention[57] is the fourth UN space treaty to enter into force. As mentioned in the previous sub-section relating to Article VIII of the Outer Space Treaty, there are inconsistencies relating to the registration of small satellites in practice. The challenges which result from these inconsistencies are further elaborated in chapter 5 of this study. For now, it is sufficient to state that the nexus created by Article II of the Registration Convention, between the 'launching State' and 'State of registry', is a cause for confusion and discrepancies in the case of small satellites activities. At times, States that are parties to the Registration Convention are reluctant to properly register small satellites under their jurisdiction, arguing that while they accept international responsibility for the satellite in question, they are not a 'launching State' and thus, should not register it with the

[52] See Art. 5 of the Rescue Agreement.
[53] See chapter 4, section 3.1.
[54] *Supra* note 1.
[55] See conclusions of chapter 4.
[56] ibid.
[57] *Supra* note 1.

UN.[58] Another example is the opposite case, where a State accepts to register small satellites even when a certain satellite is not owned by a State national, and therefore, presumably is not naturally subject to its jurisdiction and control.[59]

To conclude, while small satellites should be registered just like traditional satellites, the practices related to their launch challenge the legal links between responsibility, liability and jurisdiction and control in the context of the duty to internationally register them.

The fifth, and so far last UN space treaty is the Moon Agreement.[60] This Agreement is the least popular out of the five treaties and has only 17 ratifications as of January 2017.[61] Small satellites have yet to reach the Moon, or other celestial bodies, even though there are missions aspiring to deploy small satellites in Lunar orbits.[62] Regardless, it seems that the Moon Agreement will not apply to small satellites as they will not be active on the Lunar surface and it is unlikely that they will cause a change to the Lunar environment by orbiting it and collecting data.[63]

To conclude this subsection, small satellites activities are generally in line with the provisions of the UN space treaties, but much like in the case of the Outer Space Treaty, the treaties' provisions suits traditional governmental space missions better than commercial small satellites missions. The provisions of the Liability Convention are the most challenging to implement in this context, as will be elaborated in chapter 4 of this study.

The next subsection will examine the challenges in applying key notions of the UN space treaties to small satellites missions.

2.4 Challenges in the Application of Key Notions of the UN Space Treaties to Small Satellites Activities

2.3.1 Key notions- an overview

The following terms and phrases are brought in this subsection since they are relevant to more than one treaty provision. These are key notions with cross-treaty relevance in the context of space activities in general, and small satellites in particular. Some notions should be read in the same way

[58] For the case of The Netherlands as an example see: N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566.
[59] For the case of Belgium as an example see: JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195.
[60] *Supra* note 1.
[61] Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to activities in outer space as at 1 January 2017, UN Doc. A/AC.105/C.2/2017/CRP.7 (2017); available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf .
[62] See chapter 1, subsection 2.6.3.
[63] See Art. 7 of the Moon Agreement.

with relation to any and all space activities, such as 'outer space', while others invite specific interpretation which take practices connected to small satellites activities in particular, such as 'launch'.

The legal uncertainty around these terms and notions are not limited to the case of small satellite activities:

> Clarifications concerning the interpretation of several other notions contained in the OST are also needed. With regard to the concept of 'national' activity in outer space, in Art. VI, the practice of States shows that without a rigid definition in the Treaty of 1967, States are free to interpret the concept of national activities in a broader sense, which includes not only activities carried out by nationals, but also activities carried out from their territory by foreigners. Another aspect concerns the identification of the appropriate state, that is to say, the State has an obligation to authorize and supervise continuously the national activities of private entities in outer space. Not to speak of the notion of 'space object'.[64]

2.3.2 'Outer Space'

Even though the term 'outer space' is used in the UN space treaties, there is no legally accepted definition of where outer space is, or at least, where it begins. Discussions related to the definition and delimitation of outer space are on-going at COPUOS, and have been so for decades, and vast scholarly work was written on the topic.[65] In light of this, it is clear that the boundary question exceeds the scope of the intended examination in this section.

Small satellites are typically deployed into Low Earth Orbit (LEO), and hence, the lower potential orbits around Earth are relevant. Since the satellites do achieve orbit around Earth and maintain it, they are assumed to be somewhere outside of Earth's atmosphere, and hence, in outer space. This

[64] S Marchisio, 'Contribution of Space Law and Policy to Space Governance and Space Security in the 21th Century' 10th United Nations Workshop on Space Law, Vienna, 5-8 September 2016, Opening Panel: Welcome Addresses and Key Note Speeches Space Law and Governance, available at: http://www.unoosa.org/pdf/SLW2016/Opening/2. Marchisio MARCHISIO 10th United Nations Workshop on Space Law.pdf.

[65] See for examples: O de Oliveira Bittencourt Neto, *Defining the Limits of Outer Space for Regulatory Purposes* (Springer 2015); B Cheng, *Studies in International Space Law* (Clarendon Press 1997) 425; B Cheng, 'The legal Regime of Airspace and Outer Space; The Boundary Problem, Functionalism versus Spatialism: The Major Premises' (1980) 5 Annals of Air and Space Law 323; M Benko and E Plescher, *Space Law- Reconsidering the Definition/Delimitation Question and the Passage of Spacecraft through Foreign Airspace* (eleven international publishing 2013) 41; S Hobe and J Cloppenburg, *Towards a New Aerospace Convention?- Selected Legal Issues of 'Space Tourism'* IISL Proceedings of the 47th Colloquium on the Law of Outer Space (2005) 377; S Freeland, *The Impact of Space Tourism on the International Law,* IISL Proceedings of the 48th Colloquium on the Law of Outer Space (2006) 187.

is the reason that scholars do not see the boundary question as a legal challenge in the context of satellite activities in general.[66]

Therefore, as long as the satellites maintain orbit around Earth it is concluded they are in space, without the need to further investigate where outer space begins.

2.3.3 Small Satellites as 'Space Objects'

The term 'space object' includes two words. 'Space' with reference to 'outer space' as was addressed above, and 'object', as shall be addressed herein. The Outer Space Treaty includes the following wording: 'launching of an *object* into outer space' to describe, for example, a small satellite launch.[67] Similarly, 'A State Party to the Treaty on whose registry an *object* launched into outer space is carried shall retain jurisdiction and control over such *object*'.[68]

The Rescue Agreement has the terminology of a 'space object', which may be regarded as a more specific term than just any kind of 'object', which found its way to outer space.[69] Moreover, the Agreement uses the words 'a space object or its component parts' to describe the kind of items a State must return to its launching authority.[70]

The Liability Convention includes a definition of the term":

> 'The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.'[71]

The Registration Convention includes the same term and repeats the definition above as it appears in the Liability Convention.[72]

Therefore, in order to determine whether these legal instruments apply to small satellites activities, there is a need to examine whether small satellites are 'objects launched into outer space' and whether they are 'space objects'.

It would be difficult to argue that a small satellite is not an object. Its presence in 'outer space' poses the question addressed in the subsection above, that is, where is outer space? Regardless of the exact answer, it is argued that since the activities in question depend on a satellite's ability

[66] And some have already concluded the same, particularly in the case of small satellites: F von der Dunk, 'Liability for Damage Caused by Small Satellites- A Non-issue?' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 154.
[67] Art. VII Outer Space Treaty.
[68] Art. VIII Outer Space Treaty.
[69] Art. 5 Rescue Agreement.
[70] ibid.
[71] Art. I(ii)(d) Liability Convention.
[72] Art. I(ii)(b) Registration Convention.

to enter into Earth's orbit, and maintain such orbit for a minimal period of time, it would only be reasonable to conclude that such an orbiting object is in outer space.[73]

Further, small satellites are arguably 'space objects'. Although the term's definition is tautological, since it was established that they are objects, and their active life cycle is in orbit, which is outside of Earth and hence in outer space, there should be no difficulty in agreeing that they are included in such definition.

Subsequently, the UN space treaties apply to small satellites, as they are space objects. Scholars agree with this conclusion, and there is no evidence to support the contrary.[74]

2.3.4 Small Satellites Operations as 'Activities' and 'National Activities'

Article VI of the Outer Space Treaty, which introduces the *lex specialis* relating to State responsibility, stipulates:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space […]

Firstly, there is a need to assess what is regarded as 'activities in outer space' in the context of small satellites operations. The main difficulty is that most small satellites are non-manoeuvrable, and hence, orbit Earth in a manner that excludes the possibility of changing their orbit significantly and effectively after their deployment. This is in contrast to most traditional satellites, which include propellant systems, allowing their operators to change or adjust their orbits.[75] It was suggested that space activities are associated with elements such as control or navigation of a certain space object.[76]

Since the Outer Space Treaty does not define the term 'space activities', and since the notion of State responsibility for space activities was not developed in a following treaty, this term is subject to interpretation by State parties, as reflected in their national space laws. With the emergence of small satellites operations in the Netherlands and Belgium, both States amended or extended the scope of their already existing national space acts to include 'unguided satellites' under the respective acts. This was done since the legislators had initially understood that a State is responsible, and therefore, should regulate by domestic law, space activities which include guidance of space objects. They therefore, concluded that unguided objects were excluded from

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[73] Since the laws of physics do not allow for objects to orbit around Earth in a manner that satellites do, unless these objects are positioned outside of Earth.

[74] LJ Smith and Z Valic, *A Regulatory Roadmap for Small Satellites*, 4S Symposium, Slovenia (05 June 2012), at 5; See also: RS Jakhu and JN Pelton, *Small Satellites and their Regulation* (Springer 2014) 43; F von der Dunk, 'Liability for Damage Caused by Small Satellites- A Non-issue?' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 154, 157-158 and note 15; N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws, and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* I. Marboe (Brill Nijhoff 2016) 47, 48.

[75] For more information see: chapter 1, sub-section 2.3.6 and chapter 4, section 2.

[76] See for example a list of space activities: 'The operation and control of a satellite […]' *CoCoSL*,109.

the original versions of their acts.[77] These interesting case studies illustrate the difficulties in applying key space treaties' provisions to small satellites activities, and the need to adapt legal instruments as technology progresses and insight is gained.

The additional legal complication originates from the term 'national' in Article VI. As mentioned in subsection 2.2, the non-governmental nature of small satellites activities, combined with their launch practices, may challenge the notion of the 'appropriate State' which is the State internationally responsible for small satellites activities of its nationals. This problem worsens when considering international-collaborative small satellites missions. These difficulties will be further addressed in chapter 3 of this study.[78]

For the purpose of this section, it is submitted that small satellites operations should be considered as space activities. Firstly, the UN space treaties do not exclude certain satellite activities from their scope. Secondly, some historical satellites were 'unguided' or non- manoeuvrable, and it was never doubted whether they were included in the scope of Article VI. Thirdly, and most importantly, the rationale behind Article VI is to establish a strong link of responsibility between State parties and their activities in space, whether these are performed by the States directly, or by non-governmental organisations carrying their nationality.[79] In light of the foregoing, there is no legal sense in excluding small satellites operations from the scope of Article VI.

2.3.5 The 'Launching' of Small Satellites into Outer Space

As mentioned in chapter 1 of this study, small satellites have special launch practices, which were developed to accommodate market needs.[80] The piggy-back practice, where small satellites are launched as auxiliary payloads, is innovative in launch logistics, accessibility and affordability terms; however, the launch itself is done in a very traditional way on board a launch vehicle. In this sense, the 'launching' of small satellites is not very different to the launching of traditional satellites and it may be reasonably concluded that this practice does not challenge the notion of 'launching' objects into outer space as provided by the UN space treaties.

On the other hand, the practice of launching small satellites to the ISS and deploying them into space in a separate activity may be legally-challenging in this context.[81] This is because at the first stage the satellites are launched to the ISS on a launch vehicle and at the second stage they are deployed from the ISS to outer space. Are both activities part of the 'launching' phase? Perhaps

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[77] N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566; N Palkovitz and T Masson-Zwaan, *Small but on the Radar: The Regulatory Evolution of Small Satellites in The Netherlands*, IISL Proceedings of the 58th Colloquium on the Law of Outer Space 601, under section 4 'Regulatory Changes' (2016); JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195.

[78] Chapter 3, section 2.1.

[79] For legal analysis of State responsibility in international space law and its strength compared to State responsibility in general international law, see chapter 3 section 2.2.

[80] Chapter 1, section 2.5.

[81] ibid.

once the satellites have departed Earth their launching phase has terminated and any subsequent action, such as their deployment, should be considered under different wording?

These questions introduce legal implication relating to liability,[82] however, it is submitted that since the satellites are being launched to the ISS, which is in outer space, and subsequently deployed 'freely' to orbit in outer space as well, it would not make sense to exclude this launch practice as a 'launch' as provided in the UN space treaties. In other words, even if it is not clear when the launch phase ends, the fact that there is a 'launch' is sufficient to determine that small satellites fall under the treaty provisions which relate to the launching of space objects into outer space.

2.5 Intermediary Conclusions

Small satellites activities do not violate the spirit and provisions of the UN space treaties. However, it is clear that some practices relating to small satellites do challenge traditional concepts, which the treaties include.

The option to amend the treaties in order to better adjust some provisions is not a practical one. Further, there is no real need to do so since their provisions are general enough to regulate small satellites activities, even if not in an ideal manner.

Instead of putting all the attention on the primary source of applicable law, that is, the UN space treaties, current discussions in international forums aim to create supplemental legal instruments or soft law to capture the regulatory needs in a more agile manner and address the special characteristics of small satellites activities.

The next section will therefore present the current examination and efforts of international bodies to deal with the special characteristics of small satellites activities, in legal territories, which exceed the scope of the UN space treaties.

3 Small Satellites and the Regulatory Discussion at International Forums

3.1 Overview

This section aims to present the current on-going discussions relating to the need to regulate small satellites activities further to existing international law. Special treatment to small satellites

[82] F von der Dunk, 'Liability for Damage Caused by Small Satellites- A Non-issue?' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 154, 158-161.

operators, space debris mitigation and remediation and ITU radio frequency allocation regimes are not addressed in the UN space treaties. Nevertheless, these topics are imperative to the comprehensive regulation of small satellites activities, and therefore, will be analysed in this section.

Three important international forums will be addressed, as they are most relevant to small satellites activities and already host discussions concerning them. These are: UNOOSA and specifically COPUOS and its legal subcommittee, the same birth place of the UN space treaties; the Inter-Agency Space Debris Coordination Committee (IADC), which created the widely-adopted Space Debris Mitigation Guidelines;[83] and, the ITU and specifically the ITU World Radio Conferences (WRC), which has had small satellites frequency allocation procedures on its agenda in recent years, and is expected to continue the discussions in the next WRC.

3.2 United Nations Office for Outer Space Affairs and Committee on the Peaceful Uses of Outer Space

The United Nations Office for Outer Space Affairs (UNOOSA) started with a small expert unit within the UN Secretariat to service the *ad hoc* Committee on the Peaceful Uses of Outer Space (COPUOS), established by the General Assembly in its resolution 1348 (XIII) of 13 December 1958.[84]

COPUOS' responsibilities are to:

> 'Consider the activities and resources of the United Nations, the specialized agencies and other international bodies relating to the peaceful uses of outer space, organizational arrangements to facilitate international cooperation in this field within the framework of the United Nations and legal problems which might arise in programmes to explore outer space.'[85]

In 1958 COPUOS had 18 member States, and currently has over 84 member States.[86] COPUOS usually drafts, negotiates and adopts treaties by consensus, which means that relevant treaty wording is revised by the member States until all the members consent to it.[87]

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[83] Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (2002, as revised in 2007), IADC-02-01, Revision 1 (Hereinafter: 'IADC Guidelines').
[84] UNGA Res. 1348 (XIII) Question of the Peaceful Use of Outer Space (13 December 1958), available at: https://documents-dds-ny.un.org/doc/RESOLUTION/GEN/NR0/747/92/IMG/NR074792.pdf?OpenElement.
For further information see UNOOSA's website: http://www.unoosa.org/oosa/en/aboutus/history/index.html.
[85] UNOOSA's website: http://www.unoosa.org/oosa/en/ourwork/copuos/history.html .
[86] UNOOSA's website- membership evolution:
http://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html .
[87] For more information about this process see: RG Steinhardt, 'Outer Space' in O Schachter and CC Joyner (eds), *United Nations Legal Order* (vol. 2; CUP 1995) 753, 759.

COPUOS has two subcommittees, the first is the 'Scientific and Technical' one and the second is the 'Legal' one.[88] The Legal Subcommittee is the birthplace of the UN space treaties, and many outer space related UN Resolutions, and hence it is important in the context of reviewing the international regulatory discussion on small satellites activities.

In 2014 the Legal Subcommittee hosted an IISL[89]/ECSL[90] Symposium titled: 'Regulatory Needs for Very Small Satellites'.[91] This event helped to raise awareness among COPUOS delegates of small satellites activities, and the regulatory challenges they pose. In many ways, this occasion marked the start of the international discussion at COPUOS regarding the regulation of small satellites activities.

In the following year, and in parallel to discussions at the ITU,[92] UNOOSA, at the request of COPUOS, and the ITU jointly issued a document titled: 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites'. It was presented to COPUOS delegates at the Fifty-fourth session of the Legal Subcommittee.[93]

The document does not provide any new ways to treat small satellites' registration or radio frequency notification, but rather, guides new actors, operators and regulators on these matters referring to existing laws and regulations, to encourage awareness and compliance.

The scope of the document was defined as follows:

> For the launch and operation of satellites, certain requirements under international law exist. These include:
>
> 1. Notification and recording of the radio frequencies used by a satellite at the International Telecommunication Union (ITU);
>
> 2. Consideration of space debris mitigation measures in the design and operation of a satellite;
>
> 3. Registration of a satellite with the Secretary-General of the United Nations.
>
> Presently, a legal or regulatory definition of a small satellite does not exist. The information in this handout relates to all satellites, including small and very small satellites. Under the United Nations treaties, principles and resolutions relating to

[88] UNOOSA's website: http://www.unoosa.org/oosa/en/ourwork/copuos/comm-subcomms.html .
[89] IISL website: https://iislweb.org/ .
[90] ECSL website: http://www.esa.int/About_Us/ECSL_European_Centre_for_Space_Law .
[91] The Symposium's presentations and additional information are available on UNOOSA's website: http://www.unoosa.org/oosa/en/ourwork/copuos/lsc/2014/symposium.html .
[92] See section 3.4, *infra*.
[93] UNOOSA and ITU, 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites' UN Doc. A/AC.105/C.2/2015/CRP.17 (13 April 2015), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2015_CRP17E.pdf .

> international space law, the term ‘space object’ refers to satellites, launch vehicles and their component parts.
>
> The ITU Radio Regulations refers to spacecraft (RR No. 1.178) as ‘a man-made vehicle which is intended to go beyond the major portion of the Earth's atmosphere’; also to satellite (RR No. 1.179) as ‘a body which revolves around another body of preponderant mass and which has a motion primarily and permanently determined by the force of attraction of that other body’.
>
> This handout serves as a guideline for small satellite developers and operators on issues related to registration, authorization, debris mitigation and frequency management of small and very small satellites.[94]

The document highlights certain provisions and notions of international space law, and includes practical, easy to implement recommendations, such as:

> Legal issues relating to responsibility and liability at a national and international level should be considered at the ‘Project Definition’ stage of a satellite mission design process.[95]
>
> Implementation of space debris mitigation measures should be considered at the ‘Preliminary Design Review’ stage, especially for missions that require deorbiting/passivation of onboard systems during the mission termination phase.[96]
>
> IMPORTANT: Registration information submitted directly to the United Nations by national agencies, private corporations, academic institutions or individuals will not be considered valid submissions. Only information provided through Diplomatic Missions accredited to the United Nations will be considered valid registration submissions.[97]

The reminder of the document includes a digest of relevant provisions of the ITU Radio Regulations and related ITU procedures.[98]

To conclude, the described efforts were first aimed to raise awareness and guide operators and regulators as to what the current legal and regulatory situation governing small satellites activities is, as well as to provide recommendations to increase compliance as far as small satellites’ registration with the UN and frequency notification with the ITU goes.

The second step was examining whether the current regulatory situation is well adjusted to successfully deal with current and upcoming small satellites activities. This examination was

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[94] ibid, at 2-3.
[95] ibid, at 3.
[96] ibid, at 4.
[97] ibid, at 6.
[98] For more information relating to the ITU and its Radio Regulations see subsection 3.4 *infra*.

promoted at the COPUOS Legal Subcommittee by adopting agenda item 13, in 2016: 'General exchange of views on the application of international law to small satellite activities.' As part of this agenda item a questionnaire was drafted for distribution to member States, titled: 'Questionnaire on the application of international law to small satellite activities.'[99] The questionnaire was adopted and presented at the Fifty-sixth session of the Legal Subcommittee, held in April 2017. The document presents 6 questions to COPUOS member States:

1. Overview of Activities on Small Satellites

1.1 Are small satellites serving the needs of your society? Has your country determined whether small satellites could serve an identified technological or development need?

1.2 Is your country involved in small satellites activities such as designing, manufacturing, launching and operating? If so, please list any projects, as appropriate. If not, are there any future plans?

1.3 Is there a focal point in your country responsible for coordinating small satellites activities as part of your national space activities?

2. Licensing

2.1 Do you have a legal or regulatory framework to supervise any aspect of small satellite activities in your country? If so, are they general acts or specific rules?

3. Responsibility and Liability

3.1 How are liability and insurance requirements enforced on an operator in your country, for a small satellite under your country's responsibility in the event that 'damage' occurs on the surface of Earth, to aircraft in flight, or to another space object in orbit?

4. Launching State and Liability

4.1 Since small satellites are not always deployed into orbit with dedicated rockets as in the case of larger satellites, there is the need for clarification in the understanding of the definition of 'launch'. When a launch of a small satellites requires two steps, first, launching from a site to an orbit and, second, deploying the small satellite to another orbit, in your view would the first step be regarded as the 'launch' within the meaning of the United Nations treaties on outer space?

[99] UNOOSA, 'Draft Questionnaire on the Application of International Law to Small Satellite Activities' UN Doc. A/AC.105/C.2/2017/CRP.11 (27 March 2017), available at: http://www.unoosa.org/res/oosadoc/data/documents/2017/aac_105c_22017crp/aac_105c_22017crp_11_0_html/AC105_C2_2017_CRP11E.pdf .

4.2 Do you think there should be a new, or different, international regulatory approach to address small satellite operations?

5. Registration

5.1 Does your country have a practice of registering small satellites? If so, does your country have a practice of updating the status of small satellites? Is there any legislation or regulation in your country that requires non-governmental entities to submit to the government information for the purpose of registration, including updating of the status of small satellites they operate?

6. Space Debris

6.1 Could the notion of 'damage' be used to cover loss resulting from a manoeuvre performed by an operational space object in order to avoid collision with a space object not complying with the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space?

6.2 Do you think there is a need for a specific orbit for small satellites and megaconstellations?

These questions will be examined in the present study as well, and especially noting question 4.2 regarding the need to find different ways to internationally regulate small satellites activities. Since the procedures at COPUOS are lengthy, the author hopes to contribute to the discussion and perhaps help to shape any future conclusions this draft questionnaire may lead to.

International regulatory aspects of small satellites activities are also under discussion in the context of a Working Group of the COPUOS Scientific and Technical Subcommittee on the 'long-term sustainability of outer space activities.' The Working Group drafted a set of 'Guidelines for the long-term sustainability of outer space activities.' The guidelines were approved by approved by the Scientific and Technical Subcommittee of COPUOS in February 2018.[100] Guideline B.8 addresses approaches to the design and operation of 'small-size space objects':

Guideline B.8

Design and operation of space objects regardless of their physical and operational characteristics

1. States and international intergovernmental organizations are encouraged to promote design approaches that increase the trackability of space objects, regardless of their physical and operational characteristics, including small-size space objects, and those that are difficult to track throughout their orbital lifetime, as well as facilitate the accurate and

[100] J Foust, 'UN committee approves space sustainability guidelines' (*SpaceNews*, 15 February 2018); available at: https://spacenews.com/un-committee-approves-space-sustainability-guidelines/ .

precise determination of their position in orbit. Such design solutions could include the use of appropriate on-board technology.

2. States and international intergovernmental organizations should encourage manufacturers and operators of space objects, regardless of their physical and operational characteristics, to design such objects to implement applicable international and national space debris mitigation standards and/or guidelines in order to limit the long-term presence of space objects in protected regions of outer space after the end of their mission. States and international intergovernmental organizations are encouraged to share their experiences and information on the operation and end-of-life disposal of space objects, in furtherance of the long-term sustainability of space activities.

3. Due to the importance of small-size space objects to all space programmes, in particular, for developing countries and emerging spacefaring countries, the implementation of the present guideline supports the development of space programmes, including the launching and operation of small-size space objects or any other space objects that are difficult to track, in a way that promotes the long-term sustainability of outer space activities.[101]

The text touches upon several identified regulatory challenges relating to small satellites in the context of space debris and State responsibility as an international law mechanism to ensure compliance with debris mitigation norms, and other relevant provisions of international space law. Finally, it emphasises the international collaborative nature of small satellites missions and the challenge of finding the responsible State or States for such missions.[102]

It remains to be seen to what extent these non-binding guidelines will be observed by States in practice.

The discussion on small satellites in the realm of space debris and sustainability leads to further examination of the international discussion at the IADC in the next subsection.

3.3 Inter-Agency Space Debris Coordination Committee

The Inter-Agency Space Debris Coordination Committee (IADC) is an international governmental forum for the worldwide coordination of activities related to the issues of man-made and natural

[101] See: UNOOSA 'Guidelines for the Long-term Sustainability of Outer Space Activities- Conference room paper by the Chair of the Working Group on the Long-term Sustainability of Outer Space Activities' UN Doc. A/AC.105/2018/CRP.20 (27 June 2018) at 15, available at: http://www.unoosa.org/res/oosadoc/data/documents/2018/aac_1052018crp/aac_1052018crp_20_0_html/AC105_2018_CRP20E.pdf .

[102] These challenges will be legally analysed in chapter 3 of this study.

debris in space.[103] Its members are representatives of space agencies, and it was founded in 1993.[104] The IADC is one of the most important entities that generate international guidelines designed to deal with the ever-increasing space debris problem. The Space Debris Mitigation Guidelines drafted by the IADC are widely accepted as a non-legally binding set of standards and best practices for debris mitigation.[105]

After becoming aware of initiatives to launch multiple small satellites constellations to LEO, the IADC released a 'Statement on Large Constellations of Satellites in Low Earth Orbit', in September 2017.

The most dramatic finding in the statement is the concern that the existing Space Debris Mitigation Guidelines may not be sufficient in order to deal with the many foreseen satellites in LEO:

> At this initial stage, it is clear that the significant numbers of satellites envisaged in the planned constellation architectures represent a step change in the number of satellites operating in the low Earth orbit regime, and may question the validity of the assumptions used to derive the existing space debris mitigation guidelines (e.g. launch traffic models and the numbers of objects in orbit). There is also a question regarding the robustness of the existing debris mitigation guidelines to effectively manage the new constellations and their impact on the orbital environment in a sustainable manner (e.g. limit residence times in orbit).[106]

The statement also specifies preliminary space debris considerations for the development of large constellations of satellites in LEO.[107] These considerations bear many similarities to the existing IADC Guidelines, and repeat the need to limit spacecraft lifetime to no more than 25 years, avoid potential spacecraft breakups, and de-orbit spacecraft so they re-enter Earth while taking measures so that damage to persons or property will not be caused.[108]

An important consideration is the following:

> In developing the design and mission profile of a spacecraft or orbital stage, a program or project should estimate and limit the probability of accidental collision with known

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[103] IADC website: https://www.iadc-online.org/ .

[104] IADC website- members: https://www.iadc-online.org/index.cgi?item=members. The members are: Agenzia Spaziale Italiana (ASI), Centre National d'Etudes Spatiales (CNES), China National Space Administration (CNSA), Canadian Space Agency (CSA), German Aerospace Center (DLR), European Space Agency (ESA), Indian Space Research Organisation (ISRO), Japan Aerospace Exploration Agency (JAXA), Korea Aerospace Research Institute (KARI), National Aeronautics and Space Administration (NASA), Russian Federal Space Agency (ROSCOSMOS), State Space Agency of Ukraine (SSAU), and the United Kingdom Space Agency (UKSA).

[105] Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (2002, as revised in 2007), IADC-02-01, Revision 1 (Hereinafter: 'IADC Guidelines').

[106] *IADC Statement on Large Constellations of Satellites in Low Earth Orbit* issued by the IADC steering group IADC-15-03 September 2017, at 6, available at: http://www.iadc-online.org/Documents/IADC-15-03%20Megaconstellation%20Statement.pdf .

[107] ibid, at 5-6.

[108] ibid.

objects during the spacecraft or orbital stage's orbital lifetime. If reliable orbital data is available, avoidance manoeuvres for spacecraft and co-ordination of launch windows may be considered if the collision risk is not considered negligible.

To date, there is no binding legal instrument that specifies such duty. As elaborated in section 2 of this chapter, the UN space treaties do not limit or oblige States to carry out such specific efforts to avoid collisions. It remains to be seen whether this statement and considerations will take a more binding form and be considered as soft law at the least. If they do, it seems that small satellites operators would be under such duties, and possibly liable by negligence in the case that they failed to coordinate the launch of their satellites and a collision occurred. This potential emerging duty may also have great implications on the application of the Liability Convention in cases where uncoordinated launches cause collisions in LEO.[109]

While the above-mentioned statement refrains from using the term 'small satellites', the IADC has presented its new agenda items at COPUOS in February 2017, this time naming the large constellations problem interchangeably with the proliferation of small satellites.[110] The new item was presented as follows:

Small Satellites and Large Constellations

New Action Item agreed in Houston involving WG2/WG4:

– Identify the trend in the proliferation of small satellites and review plans for large constellations.

– Determine the potential inadequacies of the existing IADC Space Debris Mitigation Guidelines for the proliferation of small satellites and those large constellations.

– Consider the potential risks presented by such systems.

– Propose possible additional measures to mitigate the identified risks.

– Work is ongoing and will take several years to complete.[111]

To summarise, it is clear that there is awareness of the challenges that large numbers of small satellites pose in connection with space debris mitigation efforts. As is evident, this subject is only at its first stages of technical investigation, and it is foreseen that the work of the relevant IADC working groups will carry on for some years.

[109] For the legal challenges connected to the application of the Liability Convention on small satellites activities see chapter 4 of this study.
[110] H Krag, '*The Inter-Agency Space Debris Coordination Committee (IADC) − An overview of the IADC annual activities*', 54th Session of the Scientific and Technical Subcommittee United Nations Committee on the Peaceful Uses of Outer Space (01 February 2017), available at: http://www.iadc-online.org/index.cgi?item=docs_pub .
[111] ibid, slide 16.

3.4 International Telecommunication Union

The International Telecommunication Union (ITU) is a UN specialised agency for information and communication technologies. Part of the ITU's responsibilities is to allocate certain radio frequency bands for various purposes, including satellites communication. As such, it is the exclusive authorised international entity to allocate these communication bands.

In the past years the ITU observed a number of challenges in the context of small satellites. One of the main matters was lack of small satellite operators' compliance with the ITU Radio Regulations[112] and their associated procedures. Since many small satellites projects are based on low-cost and fast development themes, the operators found some of the ITU frequency notification and coordination procedures to be too lengthy, bureaucratically cumbersome and expensive. Since there are relaxed and simplified procedures available to amateur satellite missions, small satellites operators soon began to adopt these practices. While this accommodates the case of radio-amateur satellite missions, many of the notifications originated from operators carrying out other types of satellite missions, which were not of the amateur kind. This led the ITU to start raising awareness among small satellites operators and regulators, so that the limited allocated amateur frequencies would not be abused.[113]

[112] The Radio Regulations, edition of 2016, contains the complete texts of the Radio Regulations as adopted by the World Radiocommunication Conference (Geneva, 1995) (WRC-95), subsequently revised and approved by the World Radiocommunication Conference (Geneva, 1997) (WRC-97), the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000), the World Radiocommunication Conference (Geneva, 2003) (WRC-03), the World Radiocommunication Conference (Geneva, 2007) (WRC-07), the World Radiocommunication Conference (Geneva, 2012) (WRC-12) and the World Radiocommunication Conference (Geneva, 2015) (WRC-15), available at: http://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REG-RR-2016&media=electronic .
The following terms, which are included in ITU referenced resolutions in this section, have the following meaning according to the Radio Regulations: 'Geosynchronous satellite': An earth satellite whose period of revolution is equal to the period of rotation of the Earth about its axis. (Radio Regulations No. 1.188); 'Geostationary satellite': A geosynchronous satellite whose circular and direct orbit lies in the plane of the Earth's equator and which thus remains fixed relative to the Earth; by extension, a geosynchronous satellite which remains approximately fixed relative to the Earth. (Radio Regulations No. 1.189); 'Geostationary-satellite orbit': The orbit of a geosynchronous satellite whose circular and direct orbit lies in the plane of the Earth's equator. (Radio Regulations No. 1.190).

[113] See text of: Resolution 659 (WRC-15), '*Studies to accommodate requirements in the space operation service for non-geostationary satellites with short duration missions'* (Geneva, 2015) at 1 under (g): 'some non-amateur satellites have used frequencies for telemetry, tracking and command in the frequency bands 144-146 MHz and 435-438 MHz which are allocated to the amateur-satellite service, and that such use is not in accordance with Nos. 1.56 and 1.57'. The full text of the resolution is available at: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000C0007PDFE.pdf; For further reading see: A Matas et al, 'The ITU Radio Regulations Related to Small Satellites' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 237.

In 2015 the ITU Radiocommunication Assembly adopted the Resolution on 'Improving the dissemination of knowledge concerning the applicable regulatory procedures for small satellites, including nanosatellites and picosatellites.'[114] It was resolved:

> to develop material, such as Recommendations, Reports or a Handbook on small satellites (in particular, satellites whose mass is less than 100 kg), containing detailed information that would help to improve knowledge of the applicable procedures for submitting filings of satellite networks to ITU.[115]

Accordingly, the ITU increased its activities aimed to raise awareness among the small satellites community and regulators. As mentioned above, UNOOSA and the ITU issued a document titled: 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites'.[116] Tutorials and supporting documents addressed to small satellites operators and radio amateurs were made available at the ITU's website.[117] Further, reports and studies were carried out by the ITU to study the challenges that small satellites pose and ways to improve compliance with the Radio Regulations in this context.[118]

Moreover, ITU symposiums and workshops targeting the small satellites industry were launched. The first event was the 'ITU Symposium and Workshop on small satellite regulation and communication systems' which was held in Prague, Czech Republic, 2-4 March 2015.[119]

The event hosted the adoption of the 'Prague Declaration on Small Satellite Regulation and Communication Systems':

> Recognizing
>
> - the increasingly growing interest by universities, educational and research institutes, governments, private industry, space agencies and radio amateurs, in utilizing the potential benefit offered by small satellites, in particular nano satellites and pico satellites;
>
> - the urgent need for the small satellite community adherence to international laws, regulations and procedures, in particular those established by the UN General

[114] Resolution ITU-R 68 (2015), '*Improving the Dissemination of Knowledge Concerning the Applicable Regulatory Procedures for Small Satellites, Including Nanosatellites and Picosatellites*', available at: http://www.itu.int/en/ITU-R/space/Documents/R-RES-R.68-2015-PDF-E.pdf .
[115] ibid, second page.
[116] See section 3.2, *supra*.
[117] ITU's website, Amateur-satellite service regulatory documents: http://www.itu.int/en/ITU-R/space/Pages/SupportAmateur.aspx .
[118] Report ITU-R SA.2312-0, '*Characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites'*, SA Series Space applications and meteorology (September, 2014); Report ITU-R SA.2348-0, '*Current practice and procedures for notifying space networks currently applicable to nanosatellites and picosatellites'* SA Series Space applications and meteorology, (May 2015).
[119] ITU's website, news room: http://www.itu.int/net/pressoffice/press_releases/2015/CM04.aspx#.WbKB_cgjGUk .

Assembly, the UN COPUOS and ITU in respect to registration of objects launched into outer space, radiofrequency coordination and registration of satellite network frequency assignments, and compliance with the space debris mitigation guidelines;

- the importance for small satellite community to be prepared for implementing existing and newly developing recommendations and practices supporting the long-term sustainability of outer space activities,

Noting, the specific nature of small satellite space stations in the amateur-satellite service and the frequency coordination process within the International Amateur Radio Union (IARU) to avoid harmful interference to amateur and amateur-satellite stations,

Confirm and strengthen, the importance of implementing national legal and regulatory frameworks in conformity with the above international instruments, clearly defining rights and obligations of every stakeholder participating in small satellite initiatives,

Urge, the small satellite community to comply with the applicable international and national laws, regulations and procedures, indispensable to guarantee the long-term sustainability of small satellite projects, the avoidance of harmful interference and proper management of space debris,

Recommend, to continue capacity-building activities on small satellite regulation and communication systems, by regularly organizing symposia and workshops, including the use of web-based training tools, and by providing handbooks, guidelines and support, to facilitate the accomplishment of the above. [120]

This declaration does not suggest any new norms or standards for small satellites missions; it simply enhances stakeholders' awareness to the existing problems related to frequency usage by small satellites operators, and urges them to comply with existing laws.

The second event was the Small Satellite Symposium and Workshop on small satellite regulation and communication systems, which was held in Santiago, Chile, 7-9 November 2016. This event aimed to cover the following subjects:

Sustainable development of small satellite systems; The Outer Space Legal Regime; The ITU Radio Regulations and the WRC-15 outcomes related to small satellites; Authorization of small satellites under National Space Legislation; Small satellites projects in the region; and Advance future small satellite systems.[121]

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[120] '*Prague Declaration on Small Satellite Regulation and Communication Systems'* ITU Symposium and Workshop on small satellite regulation and communication systems, Prague, Czech Republic, 2-4 March 2015, available at: http://www.itu.int/en/ITU-R/space/workshops/2015-prague-small-sat/Documents/Prague%20Declaration.pdf .

[121] ITU's website- ITU Symposium and Workshop on small satellite regulation and communication systems, Santiago de Chile, Chile, 7-9 November 2016: http://www.itu.int/en/ITU-R/space/workshops/2016-small-sat/Pages/default.aspx .

In parallel, additional efforts took place at the ITU WRC. The WRC are held every three to four years and they are the forums to review and revise the Radio Regulations which is the international treaty governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits. Revisions are made on the basis of agenda items, which are set by the ITU Council, and these items are established four to six years in advance of the relevant WRC.[122]

In 2012 the WRC adopted a Resolution titled 'Regulatory aspects for nanosatellites and picosatellites':

> resolves to invite WRC-18, to consider whether modifications to the regulatory procedures for notifying satellite networks are needed to facilitate the deployment and operation of nanosatellites and picosatellites, and to take the appropriate actions,
>
> invites ITU-R, to examine the procedures for notifying space networks and consider possible modifications to enable the deployment and operation of nanosatellites and picosatellites, taking into account the short development time, short mission time and unique orbital characteristics,
>
> instructs the Director of the Radiocommunication Bureau, to report to WRC-15 on the results of these studies.[123]

The next WRC held in 2015 adopted the view that there is no need for special regulatory procedures to facilitate the deployment and operation of nano- and pico-satellites within the context of the ITU.[124] Instead, Resolution 659 (WRC-15) was adopted to perform: 'Studies to accommodate requirements in the space operation service for non-geostationary satellites with short duration missions'.[125]

This means that instead of developing new and specific regulations or procedures for small satellites missions, it was decided to leave the regulatory situation as it is, and study the subject further. Therefore, the course of action that was chosen was, not to amend the Radio Regulations in order to better accommodate small satellites activities, but rather to study ways to accommodate these activities by technical frequency allocation solutions:

> resolves to invite the 2019 World Radiocommunication Conference, to consider the results of ITU-R studies and take necessary action, as appropriate, provided that the

[122] http://www.itu.int/en/ITU-R/conferences/wrc/Pages/default.aspx .
[123] Resolution 757 (WRC-12) '*Regulatory Aspects for Nanosatellites and Picosatellites*' (Geneva, 2012), available at: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000A0025PDFE.pdf .
[124] For further information see: A Matas, '*Small Satellite Regulation WRC-15 Outcome and Results of the ITU-R WP7B Studies'* Small Satellite Symposium, Santiago, Chile, 7-9 November 2016, slide 11, available at: http://www.itu.int/en/ITU-R/space/AmateurDoc/ITU-small_sat-WRC-15.pdf .
[125] Resolution 659 (WRC-15), '*Studies to accommodate requirements in the space operation service for non-geostationary satellites with short duration missions'* (Geneva, 2015), available at: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A00000C0007PDFE.pdf .

results of the studies referred to in invites ITU-R below are complete and agreed by ITU-R study groups, invites ITU-R,

1. to study the spectrum requirements for telemetry, tracking and command in the space operation service for the growing number of non-GSO satellites with short duration missions, taking into account No. 1.23;
2. to assess the suitability of existing allocations to the space operation service in the frequency range below 1 GHz, taking into account recognizing a) and current use;
3. if studies of the current allocations to the space operations service indicate that requirements cannot be met under invites ITU-R 1 and 2, to conduct sharing and compatibility studies, and study mitigation techniques to protect the incumbent services, both in-band as well as in adjacent bands, in order to consider possible new allocations or an upgrade of the existing allocations to the space operation service within the frequency ranges 150.05-174 MHz and 400.15-420 MHz.[126]

The next WRC will be held in 2019, on which occasion international discussions within the context of the ITU under agenda item 1.7 will continue. Such discussions include the spectrum needs for telemetry, tracking and command in the space operation service for non-geostationary satellites with short duration missions, assessing the suitability of existing allocations to the space operation service and, if necessary, considering new allocations in accordance with Resolution 659 (WRC-15). These actions were assigned to Working Group 7B.[127]

This examination showed that the ITU members preferred to err on the side of caution when given the opportunity to decide to create new regulation and ITU procedures for small satellites radio frequency allocation. It remains to be seen whether a new frequency allocation will be decided for small satellites, after the WRC of 2019.

3.5 Intermediary Conclusions and Future International Regulatory Discussions

In seems that the awareness of small satellites activities and the question of their regulation was brought to international forums in recent years. The UN COPUOS, IADC and the ITU are the most relevant international bodies that may affect such regulation substantially.

The terminology for ‘small satellites’ is different when examining international forums as done in this section 3. The different terminology reflects the different perspective each organisation has, and the changing scope of the discussions regarding small satellites regulation.

[126] ibid, at 380.
[127] The Working Group’s schedule is available at the ITU’s website: http://www.itu.int/en/ITU-R/study-groups/rsg7/rwp7b/Pages/default.aspx.

Will the discussions in such forums and work of the mentioned working groups lead to new duties or obligations? Will these potential duties apply solely to the operations of small satellites, thus, making them unique in the context of international space law? The answers to these questions lie in the future.

One thing is certain, small satellites technology is already in use for the last decade and the plans for large constellations and new launch vehicles are already being executed. Therefore, it is reasonable to assume that any new legal norms, which the current discussion may lead to, would apply to a next generation of small satellites operations since international law-making in the mentioned forums is a lengthy process.

4 Conclusions

The second section of this chapter may be concluded as follows: *Nothing in small satellites operations is contrary to the existing binding UN space treaties, as small satellites are treated as 'space objects' under these treaties*.

Nevertheless, the introductory examination points out that these treaties do not fit ideally to small satellites activities, and there are challenges in applying them. This finding will be further analysed in depth regarding international State responsibility, liability and registration of space objects in the following chapters of this study.

An additional difficulty stems from the fact that the treaties do not address important interests such as sustainability, while it is clear that multiple small satellites constellations in LEO will have a negative effect on the future of the sustainable use of this region. The sustainability of outer space is an overall challenge to the space industry, and in any case, is yet to be based on international legally-binding norms. Therefore, the study will focus on the challenges posed by applying existing international law to small satellites activities, in order to answer the questions at the core of this study. Matters relating to sustainability will be further addressed only as far as they promote the investigation of the main research question of this study.

These two observations, relating to the difficulty in applying existing space treaty-law to small satellites activities, and the need to legally address matters such as sustainability, space debris mitigation and ITU radio frequency allocations for small satellites missions, may already indicate a need to approach small satellites activities in a special manner from the international regulatory point of view. And indeed, as seen in section 3 of this chapter, international forums are at the inception of evaluating this exact need, each from its own perspective.

As matters related to State responsibility have been identified as potential legal obstacles to non-governmental or multinational small satellites projects, and as State responsibility is such a

fundamental concept in general international law, and *lex specialis*, the next chapter will examine the current legal environment relating to State responsibility for small satellites activities. This examination will address the question of the need to regulate small satellites activities in a special way as far as State responsibility goes, and thus, will bring this study one step further towards finding the answers to the questions presented.

Chapter 3: State Responsibility for Non-Governmental Space Activities Employing Small Satellites

1. Introduction

Following the first chapter of this study, which elaborated on the small satellites market and the special characteristics typical to small satellite missions as opposed to traditional satellite missions, and the second chapter, which introduced small satellites in the context of international space law, the current third chapter will focus on legal questions relating to State responsibility for small satellite activities.

State responsibility is especially important considering that the small satellites market includes many non-governmental entities that carry out space activities. Such entities are private commercial corporations, educational institutes, non-profit organisations and consortia of such. While these entities are often in the spotlight when reflecting on small satellites activities, according to Article VI of the Outer Space Treaty[1] the 'appropriate State party' would be the one that is internationally responsible for the activities of the mentioned non-governmental entities. In other words, only States are subject directly to international space law, and thus, have the obligation to ensure the compliance of their nationals with the same legal framework, according to Article VI.

In order to provide a comprehensive analysis of the legal questions arising from State responsibility for the performance of small satellites activities, which are carried out by non-governmental entities, this chapter shall firstly outline the regime of State responsibility pursuant to Article VI of the Outer Space Treaty. Further, the chapter will focus on distinguishing State responsibility in international space law from State responsibility

[1] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, (1967) 610 *U.N.T.S.* 205. (Hereinafter: 'Outer Space Treaty').

according to general international law. Moreover, responsibility and liability will be distinguished in the context of international space law.

After examining the legal foundations of State responsibility for national activities conducted in outer space, this chapter shall present and analyse case studies relating to State responsibility in the context of small satellites activities. The case studies will illustrate how the general questions and findings of the previous section are expressed in practice.

The conclusions drawn from the mentioned sections will be gathered and presented in the final concluding section of this chapter.

2. State Responsibility under International Space Law

2.1 Presenting and Analysing Article VI of the Outer Space Treaty

Article VI of the Outer Space Treaty provides the following:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Due to the opposite policies advocated by the big space faring nations on the one hand,[2] and the need for Article VI to be generally accepted on the other hand,[3] many key terms in Article VI were left undefined.[4] As no case law is available, there is a genuine need to interpret these terms. Legal scholars have offered their views on the pivotal questions arising with respect to Article VI, as will be presented in this section.

2.1.1 Defining 'National Activities'

A definition of the term 'national activities' cannot be found in the Outer Space Treaty. The Moon Agreement, 1979[5] may shed a light over this term, notwithstanding its limited acceptance by the international community.[6]

Article 14(1) of the latter Agreement provides a connection between national activities and jurisdiction of the State of nationality:

> States Parties to this Agreement shall bear international responsibility for national activities on the Moon, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in this Agreement. States Parties shall ensure that non-governmental entities *under their jurisdiction* shall engage in activities on the Moon only under the authority and continuing supervision of the appropriate State Party.[7]

Such a connection was established under Principle 8 of UNGA Resolution 37/92 as well, by the repetition of the phrase 'under their jurisdiction'.[8] Similarly to Article VI, UNGA

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[2] Whereas the USSR objected the idea of private commercial activities in outer space, the USA supported such private activities. See: Union of Soviet Socialist Republics: Draft Declaration of the Basic Principles Governing the Activities of States Pertaining to the Exploration and Use of Outer Space, UN Doc A/AC.105/C.2/L.1 (06 June 1962) para 7; CW Jenks, *Space Law* (Stevens and Sons 1965) 210.

[3] Since the United Nations Committee on the Peaceful Uses of Outer Space (hereinafter: UN COPUOS) is working on basis of consensus, see: S Hobe, B Schmidt-Tedd and K-U Schrogl (eds.), *Cologne Commentary on Space Law* (vol. I Outer Space Treaty; Berliner Wissenschafts-Verlag 2009) 4. (Hereinafter: 'CoCoSL').

[4] F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 1, 9.

[5] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1979 1363 *U.N.T.S.* 3.

[6] As at January 2017, only 17 States ratified and 4 signed the Moon Agreement, 1979; see: Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2017, UN Doc. A/AC.105/C.2/2017/CRP.7 (2017) 12 ; available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf .

[7] Emphasis added.

[8] UNGA Res. 37/92 Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (10 December 1982) Principle 8: 'State Responsibility- States should bear international responsibility for activities in the field of international direct television broadcasting by satellite carried out by

Resolution 41/65 includes the wording: 'their activities', however, it does not link the concept of responsibility with jurisdiction.[9]

The lack of definition or use of the mentioned term and the absence of case law left the way open for States to interpret the provisions of Article VI. In the absence of clear State practice and *opinio juris* it is difficult to establish that there is a customary norm, which could clarify the vagueness with respect to the issue of national activities in outer space.[10] For these reasons, interpretations made by scholars are of great importance in the current context.[11] There are three main interpretations suggested by scholars, which reflect three different approaches to understanding 'national activities':

The first approach focuses on the meaning of 'national' as an expression of a natural person or a legal entity that are considered to be nationals of a certain State, therefore, 'national activities' are activities carried out by the nationals of the State.[12]

As the main focus of the current study is placed on private entities, one of the crucial questions is: what are the criteria to establish the 'nationality' of a private company in the context of State responsibility under Article VI? The answer to the latter question depends mainly on domestic laws, rather than international treaty law.[13]

In summary, the first approach identifies nationality as the sole requirement to make an attribution between certain space activities to a certain 'appropriate State'.

The second approach links State responsibility to liability. It interprets 'national activities' using the provisions of Article VII of the Outer Space Treaty, linking the responsible State to

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them or under their jurisdiction and for the conformity of any such activities with the principles set forth in this document.'

[9] UNGA Res. 41/65 Principles relating to Remote Sensing of the Earth from Space (3 December 1986) Principle XIV: 'In compliance with article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, States operating remote sensing satellites shall bear international responsibility for their activities and assure that such activities are conducted in accordance with these principles and the norms of international law, irrespective of whether such activities are carried out by governmental or non-governmental entities or through international organizations to which such States are parties. This principle is without prejudice to the applicability of the norms of international law on State responsibility for remote sensing activities.'

[10] For the emergence and relevance of customary law in international space law see: B Cheng, 'United Nations Resolutions on Outer Space: "Instant" International Customary Law?' (1965) 5 Indian Journal of International Law 35.

[11] In the meaning of Article 38(1)(d) of The Statute of The International Court of Justice 3 Bevans 1179; 59 Stat. 1031; T.S. 993; 39 AJIL Supp. 215 (1945) 'subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law'.

[12] F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 12.

[13] See further *infra* section 3.

the liable State. Therefore, according to this approach the responsible State has to be a 'launching State'.[14] This approach does not acknowledge the differences between Articles VI and VII.[15]

Although responsibility and liability may be logically linked, practical difficulties may arise when contemplating space activities. Cases in which the State that is responsible for the activity, on the account of the operator's nationality, however, cannot be regarded as one of the 'launching States' as per Article VII, are good examples.

To illustrate this, in case a private satellite operator purchases a satellite in orbit for commercial use, the new 'appropriate State' responsible would not necessarily be a launching State, but would, nevertheless, be obligated to continuously supervise said activities pursuant to Article VI.

Further, State responsibility can be shifted from one State to another as a result of bankruptcy of the satellite operator. Relocation of the headquarters of a company, in certain cases where domestic law dictates the domicile as a criterion of nationality, may affect the attribution of responsibility to a certain State as well at the international level.[16]

Therefore, the weakness of the second approach lies in the fact that 'activities' under Article VI is a broader term than 'launching' under Article VII.[17] Furthermore, it is reasonable to assume that the drafters of the Outer Space Treaty did not mean to create the same mechanism of attribution under two different Articles.[18]

The third approach focuses on the link between the 'national activities' and the ability of the State to authorise and supervise said activities, hence, to exercise its jurisdiction.[19] Under this approach, a State will be responsible for the activities it has an ability to control, by legal means, in the sense that the State has an ability to authorise and supervise the operator's activities. In other words, a State will be responsible for those activities over which it has jurisdiction.[20] The

[14] F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 12, 13.
[15] For this subject see discussion *infra* section 2.3.
[16] See examples for territorial applicability of national space laws in: Schematic Overview of National Regulatory Frameworks for Space Activities, UN Doc. A/AC.105/C.2/2012/CRP.8 (16.03.2012), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2012_CRP08E.pdf .
[17] F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 13.
[18] See: *CoCoSL*, 112 para. 42; F von der Dunk, *Liability versus Responsibility in Space Law: Misconception or Misconstruction?*, Proceedings of the Thirty-Fourth Colloquium on the Law of Outer Space (1992) 363-371.
[19] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 608.
[20] F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011), 13-15.

link between the provisions of Article VI and the concept of jurisdiction exists in the Moon Agreement and in UNGA Resolution 37/92 as elaborated above.[21]

Further, general international law includes the concept of the 'genuine link' as pronounced by the ICJ in the *Nottebohm case*. The ICJ had rendered that:

> According to the practice of States, to arbitral and judicial decisions and to the opinions of writers, nationality is a legal bond having as its basis a social fact of attachment, a genuine connection of existence, interests and sentiments, together with the existence of reciprocal rights and duties. It may be said to constitute the juridical expression of the fact that the individual upon whom it is conferred, either directly by the law or as the result of an act of the authorities, is in fact more closely connected with the population of the State conferring nationality than with that of any other State.[22]

The text above is valuable to understanding what is the 'link' which establishes 'nationality', as renderings of the ICJ are a source of international law, however, in the context of the current examination, relating to State responsibility for national activities in outer space, a difficulty arises. *Nottebohm* was an individual, while space activities are usually carried out by governmental or non-governmental entities. Thus, the concepts of genuine link and effective nationality must be differentiated. Scholars have noted this difficulty:

> Undoubtedly, corporate nationality, too, should be regulated internationally in some contexts. But it is incongruous to say that a corporate entity's nationality, which international law generally regards as that of its state of incorporation, relates to 'a social fact of attachment,' bonds of allegiance, or a 'genuine connection of existence, interests and sentiments.' It is more likely to relate to management's perception of the jurisdiction's tax laws. Still, the genuine link became a kind of mantra. Despite the majority's effort to limit its decision to the circumstances of Nottebohm, the genuine link theory 'radiated throughout the international law of nationality'.[23]

[21] See *supra* in this section 2.1.1.
[22] *Nottebohm (Liechtenstein v Guatemala)*, I.C.J. reports (1955) 4, at 23.
[23] RD Sloane, 'Breaking the Genuine Link' (2009) 50 Harvard International Law Journal 26.

In the landmark *Barcelona Traction* case[24] the ICJ was of the opinion that the place of the entity's incorporation and headquarters are important criteria, which could indicate an attribution of actions made by a private entity to a certain State.[25]

The author submits that the findings in the *Barcelona Traction* case offer a better analogy to the case of State responsibility and Article VI. Therefore, the place of incorporation and domicile of the entity in question should be considered when attributing certain space activities to a certain State, as it may be challenging to apply the criteria cited in the *Nottebohm* case to establish nationality.

Another complicating factor in general international law derives from the concept of jurisdiction. A State may exercise its jurisdiction over activities, which are performed in its territory under the doctrine of 'territorial jurisdiction', and in case an individual or a legal entity are nationals of such State- 'personal jurisdiction'.[26]

This may result in more than one responsible State according to Article VI. That is, in cases where entities under the personal jurisdiction of State X are performing activities which fall under the territorial jurisdiction of State Y.[27]

Much like in the second approach, linking responsibility to liability, the problem pertaining to the identification of nationality in cases of private entities is not solved. Which State should be responsible in case of concurrent jurisdictions?

The concept of jurisdiction of the State and actual ability to carry out activities is very similar to the notion under Article VIII of the Outer Space Treaty, since according to it, the State of registry retains its jurisdiction and control over a space object by registering it, applying its nationality. In such a case, the registering State enjoys a 'quasi-territorial jurisdiction' over a

[24] Case Concerning the *Barcelona Traction Light Power Company, Limited (Belgium v Spain)*, I.C.J. Reports (1970) at 4.
[25] In the context of the right of such state to argue for international diplomatic protection with respect to its nationals.
[26] For these concepts in the general context of international law see: MN Shaw, *International Law* (6th edn; CUP 2008) 652-658, 659-666.
[27] National space laws may apply to entities incorporated under a certain nationality, and to activities carried out by foreign entities from the territory of a certain State and hence the difficulty. For examples related to applicability criteria of national space laws see: Schematic Overview of National Regulatory Frameworks for Space Activities, UN Doc. A/AC.105/C.2/2012/CRP.8 (16 March 2012), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2012_CRP08E.pdf .

registered space object.[28] Therefore, the third approach suggests that the obligations under Articles VI and VIII of the Outer Space Treaty are bound together.[29]

2.1.2 Defining the 'Appropriate State'

The drafting history of Article VI shows that the term 'appropriate State' came to replace the term 'State concerned' in the drafting process.[30] The appearance of the term in a singular form raised questions, namely: could there be more than one responsible State that has an obligation to authorise and supervise the national space activities? In case there are two or more responsible States, which will be the single most appropriate one?[31]

Cheng suggested that since 'State' is in singular form, there can be only one appropriate State, which is responsible to the national activities in outer space. This interpretation finds support in the provisions of Article VIII of the Outer Space Treaty, which compels the relevant States to choose a single State to be the State of registry and to exercise jurisdiction and control over the space object in question.[32] As mentioned in the previous section, it was suggested by *Cheng* that in order to comply with the provisions of Article VI, a State would have to retain effective jurisdiction and control over the space object. In this respect, the element of jurisdiction can be seen as the link between Article VI and VIII. Following this line of interpretation, the appropriate State of Article VI is no other than the State of registry of Article VIII.[33]

In practice, it is possible for more than one State to be responsible for an activity in outer space, for instance, when small satellites of operators of different nationalities function as one satellite constellation, under a single mission.[34]

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[28] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 622-626; F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 16-17.

[29] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 608-612; F von der Dunk, 'The Origins of Authorization: Article VI of the Outer Space Treaty' in F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 16-17.

[30] See the text of Art. VI on page 3 in in *Letter Dated 16 June 1966 from the Permanent Representative of the Union of Soviet Socialist Republic to the United Nations Addressed to the Secretary-General,* UN Doc. A/6325 (16 June 1966), available at: http://www.unoosa.org/pdf/gadocs/A_6352E.pdf; See the text of Art. VI on page 3 in *Letter Dated 11 July 1966 Addressed to the Chairman of the Legal Sub-committee by the Representative of the USSR*, UN Doc. A/AC.105/C.2/L.13 (11 July 1966), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_L013E.pdf .

[31] B Cheng, 'Article VI of the Outer Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State"' (1998) 26(1) Journal of Space Law 7, 13-14, 30.

[32] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 609.

[33] ibid.

[34] See *infra* for an analysis of the QB50 project, section 3.2.

Support for several appropriate States could be found in the notion of 'launching States' as provided by Article VII of the Outer Space Treaty and the Liability Convention.[35] Since responsibility and liability may be conceptually linked in case where damage was caused by a space object,[36] it is possible for several States to be liable for the performance of a space activity according to the provisions of Article VII and the Liability Convention.

Furthermore, the liable launching State may wish to exercise jurisdiction and control, in the meaning of Article VIII of the Outer Space Treaty, in the form of authorisation and supervision in order to secure their interests, since they are regarded as potentially liable for damage caused in connection with the space activity.[37]

Moreover, it is concluded that when determining the link between the appropriate State and the State of registry of a space object, the same State of registry has to be one of the launching States of the space object in question, since the State of registry must be one of the launching States according to the wording of Article II of the Registration Convention,[38] which provides:

> 1. When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary General of the United Nations of the establishment of such a registry.
>
> 2. *Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article*, bearing in mind the provisions of article VIII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and without prejudice to appropriate agreements concluded or to be concluded among the launching States on jurisdiction and control over the space object and over any personnel thereof.
>
> 3. The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned.

[35] Convention on International Liability for Damage Caused by Space Objects, 1972 961 *U.N.T.S.* 187 (hereinafter: 'Liability Convention').
[36] See section 2.3 *infra* for the international legal relations between the concepts of State responsibility and liability.
[37] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 609.
[38] Convention on Registration of Objects Launched into Outer Space, (1975) 1023 *U.N.T.S.* 15 (hereinafter: 'Registration Convention'). See: *CoCoSL* at 112-114, 117.

In light of the foregoing, it is submitted that the link between the responsible State and the launching State, under the notion of the 'appropriate State' may cause discrepancies in practice, as already been evidenced in the context of small satellites activities.[39]

This legal arrangement does not reflect the reality in cases of transfer of ownership in a space object after it was launched, since the responsible State changes, while the launching States remain the same original States which were involved in the launch of the space object.[40] Moreover, it is submitted that in some cases the identity of the operating State, which should be considered as the responsible State under Article VI, will not be the same as the launching State(s), especially when private multi-national entities are concerned.[41]

Therefore, the appropriate State does not necessarily have to be one of the launching States, or the State of registry.[42] As the reality of innovative space activities dictates cooperation between nationals of different States, under diverse forms of incorporation and execution in several locations, the appropriate State should be, simply, the State which holds the appropriate lawful means-rights under domestic laws and obligations under the space treaties and international law to authorise and supervise the relevant activity effectively.[43]

As the author previously argued in subsection 2.1.1. above, one of the key criteria in the case of non-governmental entities should be the place of incorporation and domicile, as these indicate the domestic laws the entity is subject to. In this sense, our times may dictate the need to look for the *most* appropriate State.[44]

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[39] See N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws, and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 51-55.

[40] See further: S Aoki, '*Satellite Ownership Transfers and the Liability of the Launching States'*, IISL Symposium, Transfer of ownership of space objects: issues of responsibility, liability and registration, Vienna (19 March 2012), available at: http://www.oosa.unvienna.org/pdf/pres/lsc2012/symp-03E.pdf; M Gerhard, 'Transfer of Operation and Control with Respect to Space Objects- Problem of Responsibility and Liability of States' (2002) 51 Zeitschrift fur Luft- und Weltraumrecht 571; A Kerrest, '*Remarks on the Notion of Launching State'*, Proceedings of the 42nd Colloquium on the Law of Outer Space (1999) 308, 309.

[41] This is especially relevant to small satellites as will be shown in section 3 *infra*.

[42] For discussion relating to the flexibility in interpretation of the term, see: KH Bockstiegel, '*The Term 'Appropriate State' in International Space Law'*, Proceedings of the Thirty-Seventh Colloquium on the Law of Outer Space (1995) 77, 79.

[43] Under practical terms this might mean the State which has the most practical- commercial links to the space venture, which, when reduced to legal terms, result in more than merely contractual relations.

[44] The issue of determining which State is the most appropriate one will be illustrated and developed in section 3 *infra*.

This argument could be supported by the fact that the drafters of the Outer Space Treaty could have expressly linked the appropriate State responsible under Article VI to the liable State(s) under Article VII or VIII, however, chose not to do so.[45]

To conclude, when providing answers to these questions, it is important to recall the rationale behind Article VI:

> What must be kept in mind is that the purpose of Article VI is to provide for control by the State that is responsible, which is the main subject of this article.[46]

2.1.3 Defining 'Activities in Outer Space'

Space activities are usually associated with control or remote navigation of the space object in question, in outer space.[47] In that sense, an 'activity' is required to have some sort of an 'active' element. In reality there are activities in orbit, which may be remotely controlled to a very limited extent. Such would be the case of non-manoeuvrable small satellites.[48]

A narrow interpretation of the term 'activities' may result in lack of a State's obligation to authorise and supervise a certain space venture. This was in the case of small satellites activities in the Netherlands, which ultimately led to adjusting the scope of its domestic Space Act with the introduction of the notion of 'unguided-satellites'.[49]

Therefore, it is suggested that a wide interpretation for the expression: 'activities in outer space' is required, in order to ensure that all space related activities fall under the relevant provisions of international space law, when applying national space law on them.

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[45] In contrast to the link clearly established between the State of registry under Article VIII and the liable-launching State under Article VII, as expressed in Article II of the Registration Convention. See for further discussion: *CoCoSL*, 115-116.

[46] T Masson-Zwaan, 'Article VI of the Outer Space Treaty and Private Human Access to Space', Proceedings of the International Institute of Space Law (2008) 536; AIAA, (2009) see under section 8 subsection: 'Appropriate State party'.

[47] See for example a list of space activities: 'The operation and control of a satellite […]' *CoCoSL* at 109.

[48] As will be elaborated further in section 3.3 *infra*; see chapter 1, subsection 2.3.6.

[49] As will be elaborated further in section 3.3 *infra*; N Palkovitz and T Masson-Zwaan, '*Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws'*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566; N Palkovitz and T Masson-Zwaan, '*Small but on the Radar: The Regulatory Evolution of Small Satellites in The Netherlands*', IISL Proceedings of the 58th Colloquium on the Law of Outer Space 601, under section 4 'Regulatory Changes' (2016).

Without the need to define or list 'activities in outer space', the author is of the opinion that the term should include the launch and operations of any type of satellite, regardless of its size or manoeuvrability capabilities.

2.2 Distinguishing Between State Responsibility in the Context of *Lex Specialis* and Under General International Law

It is accepted both in international law in general, and in international space law in particular, that a State is responsible for the acts of its organs and agents.[50] For instance, the activities of a State's space agency will be attributed to the State, establishing State responsibility. The present study will focus on state responsibility with respect to private entities, which are not State organs, an attribution which is more complex to legally establish.[51]

In this respect, *Cheng* noted the innovative character of attribution as reflected under Article VI of the Outer Space Treaty[52]:

> […] Article VI is not merely innovatory. It is almost revolutionary. Under it, it appears that States have assumed direct State responsibility for non-governmental national space activities. This means that everything that is done by such non-governmental entities is deemed to be an act imputable to the State as if it were its own act, for which it bears direct responsibility.[53]

The *lex specialis* (international space law) presents a stronger attribution mechanism than the one provided by general international law. To elaborate, it has to be established, under general international law, that an act of a private entity breached a 'principle, or standard, of general international law, or relevant treaty provisions, on the part of the State.'[54]

[50] For the comparison of State responsibility under general international law and under Article VI of the Outer Space Treaty see: I Brownlie, *System of the Law of Nations: State Responsibility* (Part 1; OUP 1983) 131-158.
[51] ibid at 159-166.
[52] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 606; B Cheng, 'Article VI of the Outer Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State"' (1998) 26(1) Journal of Space Law 7, 15.
[53] B Cheng, 'Article VI of the Outer Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State"' (1998) 26(1) Journal of Space Law 7, 14-15.
[54] I Brownlie, *System of the Law of Nations: State Responsibility* (Part 1; OUP 1983) 159.

When examining the possible rules of attribution under the International Law Commission's Draft Articles on State Responsibility[55], an attribution to an action that was made by a 'purely' private entity seems difficult to establish. If the action could be considered as including an element of governmental authority however, attribution could be made pursuant to Article 5 of the ILCDARS:

> The conduct of a person or entity which is not an organ of the State under article 4 but which is empowered by the law of that State to exercise elements of the governmental authority shall be considered an act of the State under international law, provided the person or entity is acting in that capacity in the particular instance.

The most evident example of such a case is the privatisation of a governmental space company, which is private on the one hand, however continues to perform activities that are perceived as governmental ones on the other hand[56]:

> The generic term 'entity' reflects the wide variety of bodies which, though not organs, may be empowered by the law of a State to exercise elements of governmental authority. They may include public corporations, semipublic entities, public agencies of various kinds *and even, in special cases, private companies*, provided that in each case the entity is empowered by the law of the State to exercise functions of a public character normally exercised by State organs, and the conduct of the entity relates to the exercise of the governmental authority concerned.[57]
>
> […]
>
> Article 5 does not attempt to identify precisely the scope of 'governmental authority' for the purpose of attribution of the conduct of an entity to the State. Beyond a certain limit, what is regarded as 'governmental' depends on the particular society, its history and traditions. Of particular importance will be not just the content of the powers, but the way they are conferred on an entity, the purposes for which they are to be exercised and the extent to which the entity is accountable to government for their exercise.

[55] International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts, *Official Records of the General Assembly*, Fifty-sixth session, Supplement No. 10 (A/56/10), chp.IV.E.1 (2001) (hereinafter: 'ILCDARS').
[56] See International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts with Commentaries, *Yearbook of the International Law Commission* (2001) vol. II, Part Two at 43, para 2. (Hereinafter: 'ILC Commentary').
[57] ibid, at 43, emphasis added.

> These are essentially questions of the application of a general standard to varied circumstances.[58]

Similarly, under other Articles of the ILCDARS, the involvement of the State in a certain conduct is needed in order to attribute the activity to that State in case of private entities.[59]

Article VI is applicable to 'national activities in outer space' without framing them under any territorial boundaries. Subsequently, certain States chose to apply their national space laws in their territory, as well as to nationals performing activities abroad.[60]

Interestingly, in this respect, Article VI is an exception to the general rule under international law:

> In general a state is not under a duty to control the activities of private individuals (being its nationals) beyond the bounds of state territory. Thus, a state is not responsible for the delinquencies of vessels flying its flag or otherwise controlled by its nationals; and there is no responsibility for the wrongdoing of investors and others abroad *vis-à-vis* the host state. However, it is possible to prescribe duties to control such activities by convention. Thus, in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space of 1967 Article 6 provides as follows: [Brownlie quotes Article VI of the Outer Space Treaty].[61]

To conclude, State responsibility is a well-established concept in general international law. The work of the UN's International Law Commission as reflected in the *ILC Commentary*, gathering juridical decisions of the PCIJ, ICJ and other relevant international tribunals clarifies the elements needed in order to attribute wrongful acts to States.

Scholars agree that the attribution mechanism presented by Article VI of the Outer Space Treaty is different than the one embodied in the ILCDARS. The attribution is not limited by any parameters found in Article VI, and thus, the State is strongly linked to space activities by its nationals.

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[58] ILC Commentary at 43, para 6.

[59] The example of Article 5 of the ILCDARS seems like the most reasonable one to apply, however, under some situations attribution could be made to a conduct done with the direction or control of the State under Article 8. Alternatively, regardless of the situation, a State can assume responsibility for acts of natural and legal persons on a voluntary basis pursuant to Article 11 of the ILCDARS.

[60] For an overview of applicability of national space legislation see: Schematic Overview of National Regulatory Frameworks for Space Activities, UN Doc. A/AC.105/C.2/2012/CRP.8 (16 March 2012), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2012_CRP08E.pdf .

[61] I Brownlie, *System of the Law of Nations: State Responsibility* (Part 1; OUP 1983) 165-166. Comment added.

Since Article VI was not subject to scrutiny by an international tribunal yet, it seems that the element of 'nationality', as analysed in subsection 2.1.1 above, is sufficient to confer international responsibility for acts of non-governmental entities to their national States.

2.3 Distinguishing Between State Responsibility and Liability

General international law may link State responsibility with the duty to grant reparations in case damage was caused. Article 31 of the ILCDARS embodies such notion, and the ILC Commentary cites the PCIJ's *Factory at Chorzów* case, in order to explain the concepts of international responsibility and liability:

> It is a principle of international law that the breach of an engagement involves an obligation to make reparation in an adequate form. Reparation therefore is the indispensable complement of a failure to apply a convention and there is no necessity for this to be stated in the convention itself. Differences relating to reparations, which may be due by reason of failure to apply a convention, are consequently differences relating to its application.[62]

Additionally, the *Rainbow Warrior* arbitration clarified that:

> Unlawful action against non-material interests, such as acts affecting the honor, dignity or prestige of a State, entitle the victim State to receive adequate reparation, even if those acts have not resulted in a pecuniary or material loss for the claimant State.[63]

The authors of the *ILC Commentary* conclude that the concept of reparations due to State responsibility in international law is rather broad, since, as evidenced by the *Rainbow Warrior* arbitration, it is not restricted to damage in the form of pecuniary or material loss:

> Accordingly, article 31 defines 'injury' in a broad and inclusive way, leaving it to the primary obligations to specify what is required in each case.[64]

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[62] *Factory at Chorzów*, Jurisdiction, Judgment No. 8, 1927, P.C.I.J., Series A, No. 9, p. 21; and *ibid*, Merits, Judgment No. 13, 1928, P.C.I.J., Series A, No. 17, p 29. See full discussion at ILC Commentary, 91.
[63] Case concerning the difference between New Zealand and France concerning the interpretation or application of two agreements concluded on 9 July 1986 between the two States and which related to the problems arising from the Rainbow Warrior affair, UNRIAA, vol. XX (Sales No. E/F.93.V.3) (1990) 215 and 267, para 109.
[64] ILC Commentary 92, para 8.

For the purpose of this study, it is important to distinguish 'responsibility' under Article VI of the Outer Space Treaty from 'liability' under Article VII of the same. In this respect *Cheng* notes:

> In case of a breach of a legal rule causing damage to another, legal responsibility entails a legal obligation incumbent on the author of the breach to make integral reparation to the victim for the damage so caused in order to restore the position to what it probably would have been had the breach not taken place. The author of the breach becomes 'liable' for the damage.[65]

In light of the above, it is clarified that 'responsibility' provides the attribution of an act or omission to a certain State. Should such act or omission cause damage, the responsible State will be liable for providing reparations. This notion finds support in general international law, as shown with respect to the ILCDARS.

Furthermore, State responsibility may be relevant even in situations not leading to liability, hence in cases of breach of duty, which did not cause any damage:

> Responsibility and breaches of obligation do not necessarily involve the payment of compensation, especially when no damage has been caused. This can occur, for instance, under Article VI of the 1967 Space Treaty, if a contracting State fails to subject its non-governmental entities carrying on space activities to authorization and continuing supervision, and no damage has occurred to any of the other contracting States or their nationals. Reparation can take many forms, such as for example assurances of non-repetition. The other States may well just ask for such an assurance. In fact, if no damage or any other adverse effect has occurred to any of the other contracting Parties or their nationals, the other States may not even take the trouble of raising the issue, unless they see some national interests in doing so.[66]

Thus, there is a difference between the two legal terms. One of the difficulties is that while the difference in terminology is evident in English, the French language for example, does not distinguish between the two concepts and uses the word '*responsabilité*' to describe both

[65] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 603-604, referring to the distinction between responsibility and liability as made in the *Chorzow Factory Case*, PCIJ A. 17 29, 47 (1928). See further ILC Commentary 92, para. 7.

[66] B Cheng, 'Article VI of the Outer Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State"' (1998) 26(1) Journal of Space Law 7, 9. In this respect, a State may assume responsibility due to diplomatic rationales.

responsibility and liability under Articles VI and VII of the Outer Space Treaty.[67] Similarly, the Spanish and Chinese versions use the same word in Articles VI and VII referring to both responsibility and liability.[68] The English, French, Spanish and Chinese texts are equally authentic according to Article XVII(1).

Scholars have noted that the responsible State should be at least one of the launching States under Article VII, hence, a liable State.[69] The latter interpretation offers a coherent approach, and applies the connection between responsibility and liability in line with international law. On the other hand, since the connection was not made explicitly under international space law, and considering the four categories of the 'launching State' under Article VII,[70] this approach may be challenged by complex collaborations of multi-national individuals or entities carrying out activities in outer space.[71]

In order to evaluate the differences between responsibility and liability, there is a need to examine the connection between authorisation under Article VI and liability under Article VII.[72] The first launching State under Article VII is a State that 'launches' an object into outer

[67] See wording of Articles VI and VII in the French version of the Outer Space Treaty, available: http://www.unoosa.org/pdf/gares/ARES_21_2222F.pdf .
'Article VI
Les États parties au Traité ont la responsabilité internationale des activités nationales dans l'espace extra-atmosphérique, y compris la Lune et les autres corps célestes, qu'elles soient entreprises par des organismes gouvernementaux ou par des entités non gouvernementales, et de veiller à ce que les activités nationales soient poursuivies conformément aux dispositions énoncées dans le présent Traité. Les activités des entités non gouvernementales dans l'espace extra-atmosphérique, y compris la Lune et les autres corps célestes, doivent faire l'objet d'une autorisation et d'une surveillance continue de la part de l'État approprié partie au Traité. En cas d'activités poursuivies par une organisation internationale dans l'espace extraatmosphérique, y compris la Lune et les autres corps célestes, la responsabilité du respect des dispositions du présent Traité incombera à cette organisation internationale et aux États parties au Traité qui font partie de ladite organisation.
Article VII
Tout État partie au Traité qui procède ou fait procéder au lancement d'un objet dans l'espace extra-atmosphérique, y compris la Lune et les autres corps célestes, et tout État partie dont le territoire ou les installations servent au lancement d'un objet, est responsable du point de vue international des dommages causés par ledit objet ou par ses éléments constitutifs, sur la Terre, dans l'atmosphère ou dans l'espace extraatmosphérique, y compris la Lune et les autres corps célestes, à un autre État partie au Traité ou aux personnes physiques ou morales qui relèvent de cet autre État.'
[68] See: *CoCoSL* at 104.
[69] See: *CoCoSL* at 112-114, 117; see discussion in section 2.1.2 *supra*.
[70] Article VII: 'Each State Party to the Treaty that *launches or procures* the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party *from whose territory or facility* an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.' Emphasis added.
[71] See section 3 *infra* for examples in the context of small satellites.
[72] Such examination is valid with respect to the Liability Convention, as far as the terms in Article VII of the Outer Space Treaty reflect in the former, see chapter 4, section 3.4 for a comprehensive examination of the term 'launching State' in the context of small satellites and the Liability Convention.

space.[73] Hence, the attribution of responsibility to the relevant State would be pursuant to the nationality of the private entity, which 'launches'.[74] As mentioned above, the nationality of a private entity is established pursuant to national laws, such as domestic corporate laws, and in international law, the place of incorporation was noted as an important criterion in establishing nationality.[75] Therefore, in order to authorise private space activities, the State would have to apply its domestic licensing system to any private entity that holds the nationality of that State.

The second launching State is a State that 'procures the launching of an object into outer space'.[76] Since 'procuring' a launch may practically mean several actions, such as providing funds in return for a launch service, the nationality of the procuring entity is the key criterion to establish a connection between responsibility and liability, however, in certain cases, referring to procurement as a financial action could lead to a situation in which a license would be needed for activities which are not 'space activities'.[77]

The third launching State is the State 'from whose territory' an object is launched. Therefore, in order to establish a connection between responsibility and liability, the territorial criterion is the most relevant one.

The fourth launching State is the State 'from whose facility' an object is launched. In this case the nationality of the owner of the launch facility is the most relevant criterion for establishing the connection between responsibility and liability, since the owner of the facility could theoretically hold a different nationality than the one connected to the territory from which the launch is performed.

In conclusion of this subsection, in order to establish a comprehensive legal connection between Articles VI and VII of the Outer Space Treaty, the national authorisation procedure should take into account the nationality of the relevant private entities involved in the space activity, as well as the location from which the launch is to be carried out.[78]

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[73] For the meaning of the term see: KH Bockstiegel, The Term 'Launching State' in International Space Law, IISL Proceedings of the Thirty-Seventh Colloquium on the Law of Outer Space (1995) 82.
[74] F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 22.
[75] See subsection 2.1.1 above for the full analysis.
[76] For the meaning of the term see: KH Bockstiegel, The Term 'Lunching State' in International Space Law, IISL Proceedings of the Thirty-Seventh Colloquium on the Law of Outer Space (1995) 80-81.
[77] See examples in: K Schrogl, 'A New Look on the Concept of the "Launching State"' (2002) 51(3) Zeitschrift für Luft und Weltraumrecht 359, 368; LJ Smith, A Kerrest and F Tronchetti, 'The Convention on International Liability for Damage Caused by Space Objects' in S Hobe, B Schmit-Tedd and K Schrogl (eds), *Cologne Commentary on Space Law* (vol. II 114; Heymanns Verlag 2013); F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 23.
[78] F von der Dunk (ed), *National Space Legislation in Europe* (Brill Nijhoff 2011) 24.

2.4 Intermediary Conclusions

Article VI was the subject of interpretation by scholars since it presents a special concept of State responsibility which is differentiated both from State responsibility in general international law and liability in international space law.

An additional legal element, which may shed a light on the meaning of some of Article's VI ambiguous terms, is State practice and *opinio juris,* as reflected in national space laws. This is since such laws are enacted by States to carry out their authorisation and supervision obligations pursuant to Article VI.

The next section will contribute to understanding State practice and *opinio juris* in the context of State responsibility for small satellites activities, by elaborating on three different case studies. The cases demonstrate that the legal uncertainty relating to the interpretation of Article VI is still very relevant when considering small satellites innovative activities.

3. State Responsibility for Small Satellites Activities- Case Studies

3.1 Overview

The previous section analysed theoretical legal challenges relating to the interpretation of Article VI of the Outer Space Treaty. This section shall illustrate how such legal challenges are expressed in practice, in connection to State responsibility for small satellites activities.

The following subsections include case studies, which show certain notions of Article VI that were subject to interpretation in a manner, which presents the legal uncertainty in applying Article VI.

The first case is of a multinational collaborative small satellites constellation named *'QB50'*. The case illustrates the difficulty in applying the notions of the 'appropriate State' and 'national activities' when considering a multinational project. Additionally, the case presents and analyses the interpretation of the abovementioned notions, as made by Belgium.

The second case elaborates on the circumstances that led The Netherlands to expand the applicability of its national space law, which originally did not include small satellites activities. The Dutch 'unguided satellites Decree' was created in order to include Dutch small satellites activities under the scope of its domestic space law, and hence, allow the State to be

internationally responsible for such. This case shows the importance of the interpretation that States gave to the notion of 'national activities in outer space' in their domestic law. Therefore, this case provides an interesting view on State practice and *opinio juris* as reflected in the context of Article VI and small satellites.

The third case presents crowd-funding web platforms as an instrument to structure and finance small satellites activities. The subsection analyses the difficulty in establishing what kind of individual involvement is required by State-nationals in order to establish the connection between a certain State and small satellites activities under Article VI.

The three mentioned case studies will contribute to understanding the challenges small satellites activities pose in connection to Article VI and State responsibility. This will bring this study another step forward in assessing whether small satellites activities should be treated differently than other space activities, under Article VI.

3.2 Multinational Small Satellites Constellation

Since CubeSats are standardised nano-satellites and since the standardisation model is very successful and recognised worldwide, the use of CubeSats opened the way for international collaborations in outer space.[79]

The *QB50* project is an impressive example of an international scientific mission, aiming to launch about 50 CubeSats which are provided by entities (mostly universities and research centres) from about 40 different nations. The project is funded by the EU as a 'FP7 Project', however, the participating entities are not limited to European nationalities.[80]

In summary, the project's objectives are:

> The QB50 mission will demonstrate the possibility of launching a network of 50 CubeSats built by Universities Teams all over the world as a primary payload on a low-cost launch vehicle to perform first-class science in the largely unexplored lower thermosphere.

[79] See chapter 1, subsection 2.3.5.
[80] For the full participation list see: https://www.qb50.eu/index.php/community; https://www.qb50.eu/index.php/precursor-amateur-radio-operator .

> Space agencies are not pursuing a multi-spacecraft network for in-situ measurements in the lower thermosphere because the cost of a network of 50 satellites built to industrial standards would be extremely high and not justifiable in view of the limited orbital lifetime. No atmospheric network mission for in-situ measurements has been carried out in the past or is planned for the future. A network of satellites for in-situ measurements in the lower thermosphere can only be realised by using very low-cost satellites, and CubeSats are the only realistic option.[81]

Although initially the intention was to launch all the satellites on a single launch, the satellites were launched during 2017 from several different locations and using different launch providers.[82] A preliminary precursor mission was successfully launched in June 2014.[83]

From the very beginning of the project it was clear that such vast collaboration using CubeSats would be legally challenging. One of the questions in that respect was: Which State or States should be identified as the 'appropriate State' which is internationally responsible for the space activity under Article VI of the Outer Space Treaty?

In this case, there was more than one possible answer; first, each State should be severally responsible for each entity that provided a CubeSat to the project, according to the entity's nationality. This approach sees each CubeSat on its own and not as a part of the international project. As a second option, one leading State shall be elected to serve as the primary State which will assume the legal obligations under international space law, viewing all 50 CubeSats as part of the satellite network for legal purposes.

The precursor mission, which was already launched in 2014, pushed the participants and their governments to opt for one of these options, and finally, the second was selected. Since the leading entity under the project's FP7 Consortium Agreement is located in Belgium, and since the European Commission which is located in Belgium as well, is specifically involved, the Belgian government decided to take responsibility for the project as a whole:

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[81] 'QB50 mission objectives' on the project's website: https://www.qb50.eu/index.php/project-description-obj .
[82] 'QB50 launch scenario' on the project's website: https://www.qb50.eu/index.php/project-description-obj/launch-scenario .
[83] For more information about this mission see: https://www.qb50.eu/index.php/news .

> Supervision of the activities is under the responsibility of Belgium, while other states whose institutes participate in the mission may consider themselves as launching states.[84]

Since most of the *QB50* satellites' operators are not present in Belgium, and thus, the command of the satellites is mostly done from outside of Belgium, the government had to revise the Belgium national space law so that the domestic law would be able to accommodate small satellites activities under the *QB50* mission.[85] The law was applicable to Belgian entities-operators, which 'command' a satellite, and the revised law made a shift from 'command' in its technical sense, to the entity which has the 'final authority' over the operational chain of command, thus introducing a legal criterion rather than a technical one.[86]

In the case of *QB50*, the Belgian *Von Karman Institute for Fluid Dynamics*[87] was contractually named as the leading entity of the mission in the Consortium Agreement held between the project members and the European Commission. The contract thus functioned as a legal tool, which identified one entity as project leader, whose nationality- based on incorporation and domicile, is Belgian and therefore, Belgium is the State internationally responsible for the satellite mission.[88]

When concluding his discussion of the *QB50* project, *Jean-Francois Mayence* of the Belgian Science Policy Office (BELSPO), makes the following observation:

> The QB50 mission shows that the long-lasting discussions about the actual meaning of space law concepts with regard to implementation of space activities regulation and state responsibility are still relevant.[89]

It remains to be seen whether other governments will be willing to adopt the Belgian approach in other small satellites collaborative projects that aim to launch a satellite constellation. Should clear State practice and *opinio juris* be derived in the future from such collaboration, it would

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[84] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 200.
[85] Law of 17 September 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects consolidated text as revised by the Law of 1 December 2013 (B.O.J. of 15 January 2014), available at: https://www.belspo.be/belspo/space/doc/beLaw/Loi_en.pdf .
[86] For full explanation of the revision process and rational see: JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 197-200.
[87] Von Karman Institute for Fluid Dynamics's website: https://www.vki.ac.be/ .
[88] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 197.
[89] ibid, at 202.

have a legal impact on the way Article VI of the Outer Space Treaty is interpreted. This conclusion is relevant with respect to identifying the appropriate-responsible State[90] as well as which space activities are 'national'.[91] To conclude, this case study shows an example of a very broad understanding of these two important notions.

3.3 'Unguided' Satellites

The Dutch 'Space Activities Act' was adopted in 2007 (hereinafter: 'Dutch SAA').[92] The Act came as a response for the need to regulate space activities in outer space performed by private entities in the Netherlands.[93]

In principle, national space laws should include space activities employing small satellites under their scope in order for the hosting State to fulfil its obligations under Article VI of the Outer Space Treaty.

Notwithstanding the fact that small satellites are 'space objects' under international space law,[94] and hence are subject to legal provisions on State liability,[95] the operation of such satellites was initially excluded from the scope of application of the Dutch SAA.

According to the Dutch SAA 'space activities' are:

> the launch, the flight operation or the guidance of space objects in outer space.

This definition is further elaborated in the Dutch SAA's explanatory memorandum:

> The term 'flight operation' is understood to mean the navigation, tracking and control of a space object during the flight phase, i.e. the phase between the launch of the space object and the time at which it takes up a position in outer space. Such activities can be performed from facilities, bases, earth stations or other control centres established on Dutch territory.

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[90] See also *supra* subsection 2.1.2.
[91] See *supra* subsection 2.1.1.
[92] Rules Concerning Space Activities and the Establishment of a Registry of Space Objects, 24 January 2007. An English translation is available at: http://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/netherlands/space_activities_actE.html .
[93] F von der Dunk, 'Regulation of Space Activities in the Netherlands: From Hugo Grotius to the High Ground of Outer Space' in RS Jakhu (ed), *National Regulation of Space Activities* (Springer 2010) 225-235, 244-245.
[94] See chapter 2, subsection 2.3.3; N Palkovitz and T Masson-Zwaan, '*Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566, 569.
[95] According to Article VII of the Outer Space Treaty and the Liability Convention.

> This likewise applies with regard to the guidance of space objects in outer space (outer-space activities in the broad sense). This includes all command and control activities in relation to a space object (usually a satellite) – e.g. the execution of major and minor manoeuvres designed to keep a satellite in its position in outer space or to adjust its position/orbit, checking that there is no space debris in the vicinity that might cause problems, and monitoring the fuel level of geostationary satellites, etc., so as to ensure that satellites can be decommissioned when they are no longer in use (by placing them into a 'decommissioning orbit' around 200 km higher than the geostationary orbit).[96]

The Dutch Ministry of Economic Affairs, which is in charge of the Dutch SAA and its application initially, adopted an interpretation that excluded small satellites from being considered as a space activity, since the satellites are not controllable in the sense of orbit correction, and hence cannot be 'guided' as the definition mentions.[97] The rationale behind such an interpretation was related to the fact that according to Article VI of the Outer Space Treaty, States will be responsible for activities in outer space, and lack of manoeuvrability or guidance means lack of activity in outer space. In that sense these satellites are simply not considered to be sufficiently 'active'.[98]

As previously analysed in the context of Dutch nano-satellites:

> The above-mentioned non-applicability of national space legislation to nano-satellites results in the lack of an obligation to obtain a license for conducting such 'inactive' space activities by Dutch private operators that launch their satellites from launchers abroad. In fact, currently The Netherlands does not consider itself as responsible for such space operations under Article VI of the Outer Space Treaty. They are not licensed, and are not 'authorized' and supervised'.[99]

[96] Explanatory Memorandum, Space Activities Act at 12 (13 June 2006) (English version).
[97] N Palkovitz and T Masson-Zwaan, '*Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566, 569 (2013).
[98] See *supra* section 2.1.3; T Masson-Zwaan, 'The (non-) Applicability of the Netherlands' Space Activities Act to certain 'Dutch' Space Activities', 6th Eilene Galloway Symposium, Washington D.C. (1 Dec. 2011) slide 11.
[99] N Palkovitz and T Masson-Zwaan, '*Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566, 571-572.

When the author first wrote about this legal problem in her master thesis during 2012, The Netherlands was considering ways to solve this situation.[100] As non-governmental small satellites activities became part of the reality in the Netherlands, the State observed the practical legal need to bring these activities under the scope of the Dutch SAA:

> In August 2012, the Dutch Minister for Economic Affairs, Agriculture and Infrastructure agreed to broaden the scope of the Dutch Act, so that guidance and operation of non-manoeuvrable nano-satellites from the Netherlands become a national space activity within the scope of the Dutch Act. The implementation of this decision to extend the application of the Dutch Act is currently underway.[101]

What pushed the Dutch Ministry to extend the application of the Dutch SAA was the fact that a private Dutch small satellite company, ISIS- Innovative Solutions In Space B.V., was planning to launch its first CubeSat. The company approached the Ministry asking for instruction relating to licensing under the Dutch SAA as part of the non-technical preparations for the launch of the satellite. Only then it became clear that the Ministry did not foresee licensing of small non-guided satellites under the Dutch SAA.[102]

The specific launch became even more relevant vis-à-vis the Dutch SAA, since additionally to the company's CubeSat- *'TRITON-1'* there were two more Dutch CubeSats on board the same launch vehicle. *'Delfi n3Xt'* owned by the Technical University of Delft and *'FUNcube'* owned by AMSAT-NL (which is part of the vast worldwide association of the radio communication amateurs' organisation), meant that three Dutch unguided CubeSats were about to be launched.

At that point of time there was about one year remaining before the planned launch, and it slowly became clear that an administrative solution, which has to be approved by the Dutch Parliament, could not be reached in time. Therefore, the discussion shifted from licensing the space activities according to the Dutch SAA, to finding an *ad hoc* legal solution, which would mean governmental authorisation of the launch, without obtaining a license *per se*.

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[100] A Visser, Agentschap Telecom, Ministerie van Economische Zaken, Landbouw en Innovatie, Nano satellieten onder de Wet ruimtevaartactiviteiten (position of the Dutch telecommunications office with respect to authorization of space activities including nano-satellites) 16 April 2012.

[101] N Palkovitz and T Masson-Zwaan, '*Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566, 575.

[102] The author was the company's legal adviser during the launch preparations and licensing process, and therefore, was directly involved in and informed about the regulatory process.

The government then adopted the view that despite of the Dutch SAA's inapplicability, The Kingdom of The Netherlands would still be internationally responsible for the space activities, pursuant to Article VI of the Outer Space Treaty. With that in mind, the government did not accept its status as a 'launching State' of the satellites, pursuant to Article VII of the Outer Space Treaty and the Liability Convention.[103]

Following this view, the government issued an official document approving the launch of the three CubeSats, a short time before their launch. All three CubeSats were successfully launched in November 2013 from the Russian Federation.[104]

The regulatory process was still far from being complete. More than a year after the launch, the government issued a Decree extending the application of the Dutch SAA to unguided satellites as well, starting as of July 2015.[105]

The Explanatory Note published with the Decree made it clear that unguided satellites practically mean all classes of small satellites, including the popular CubeSats and nano-satellites.[106] The applicability of the Decree to the operation of these satellites will be established by the existence of a communication link between the operator in The Netherlands and the satellite:

> Finally, the Note provides a brief article-by article explanation. With regard to Article 1, the rationale for the Decree is again explained. Unguided satellites cannot perform manoeuvres to maintain or change their orbital position. As small satellites are mostly launched to LEO, operators of small-unguided satellites do not have to file for orbital slot allocation with the ITU; however, there is a need to coordinate the use of certain radio frequencies (filing rights). In order to obtain those rights, the ITU Radio Regulations require that the transmitter of an unguided satellite can be switched on and off via telecommand, to prevent interference or detect and solve other problems. For

[103] A Visser, Agentschap Telecom, Ministerie van Economische Zaken, Landbouw en Innovatie, Nano satellieten onder de Wet ruimtevaartactiviteiten (position of the Dutch telecommunications office with respect to authorization of space activities including nano-satellites) 16 April 2012; Note verbale dated 29 July 2003 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General UNGA Doc. A/AC.105/806. See section 2.3 *supra* for the difference between responsibility and liability in that context.

[104] For further reading see: N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws, and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47, 51-55.

[105] Staatsblad van het Koninkrijk der Nederlanden 2015 18, Besluit van 19 januari 2015, houdende uitbreiding van de toepassing van de Wet ruimtevaartactiviteiten op het beheren van ongeleide satellieten (Besluit ongeleide satellieten). Available at: https://zoek.officielebekendmakingen.nl/stb-2015-18.html .

[106] ibid.

> this purpose it is necessary to establish a communication link, and if that is managed from The Netherlands, the operation of unguided satellites will from now on fall under the scope of the Dutch Space Activities Act.[107]

The government made a request that the operators of the Dutch CubeSats launched during 2013 apply for a proper license under the supplemented SAA in September 2015. The licenses, which were granted after an audit process, include a retroactive authorisation of the 2013 launch as well as for potential future launches of new small satellites attributed to the specific Dutch operator.

To conclude, the regulatory starting point in the Netherlands was that small satellites activities are excluded from its national space law, since these activities do not meet the criteria of guidance according to the Dutch SAA's definitions. With the practical need to regulate these activities, the Dutch SAA was finally extended to include small satellites activities under the domestic authorisation process, complying with Article VI of the Outer Space Treaty on State responsibility.

This will ensure that future planned small satellite activities in The Netherlands will be properly licensed under known criteria eliminating the operator's regulatory uncertainty:

> The next section of the Explanatory Note deals more specifically with unguided satellites. It argues that legal clarity will contribute to a favourable and stable climate for private parties, and will help promote innovation; thus, extending the scope of the Act will provide assurance to stakeholders. No manoeuvres can be performed to keep unguided satellites in their orbital position or to manoeuver them. Their limited communication capabilities imply that the current generation of unguided satellites operates mainly independently. An increase in the number of unguided satellite applications from The Netherlands is expected; currently about ten market players are active in this field. In the short-term, three licence applications are expected, and two more in the medium term.[108]

[107] N Palkovitz and T Masson-Zwaan, '*Small but on the Radar: The Regulatory Evolution of Small Satellites in The Netherlands*', IISL Proceedings of the 58th Colloquium on the Law of Outer Space (2016) 601, 609.
[108] ibid, at 608.

3.4 Crowd-Funded Small Satellites Activities

Web platforms such as 'Kickstarter'[109] and 'Indiegogo'[110] host many space projects. The platforms works with an on-line based crowd-funding system. The entrepreneur publicly presents a certain project and the amount he or she is hoping to raise for a certain activity, and offer small tokens of gratitude in return to a pledge. The website gains a certain percentage out of the funds collected. Typically, projects are funded by micro-donations, scaling to $10-100. This means many individual donors that are based worldwide.[111]

Some examples of CubeSats projects on Kickstarter are: '*ArduSat*', the initiators asked to raise $35,000 and with the donations of 676 backers managed to finally raise $106,330[112]; '*KickSat*' which wanted to raise $30,000 and finally raised $74,586 with the help of 315 backers[113]; and '*SkyCube*' which had the goal to raise $82,500 and raised $116,890 with donations from 2,711 backers.[114]

Sums of $100k may not seem very significant in the context of traditional space projects, but they may be enough to procure CubeSat hardware or even finance the launch of a CubeSat. The innovation here stems from the fact that a certain satellite, or its launch, were financed by hundreds of individual persons, rather than a single investor.

While such micro-investments may not become subject to judicial scrutiny enquiring their relevance to the obligations under Article VI of the Outer Space Treaty, this case boldly demonstrates just how privatised space activities became in recent years.

The author had previously noted the following legal challenges that raise from crowd-funding satellites activities:

> Firstly, identifying the 'appropriate state', which is the state that the 'national activities in outer space' can be attributed to, may become a difficult task. Secondly,

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[109] Kickstarter: http://www.kickstarter.com/hello?ref=nav.
[110] Indiegogo: http://www.indiegogo.com/learn-how-to-raise-money-for-a-campaign.
[111] N Palkovitz, '*Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*', IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014) 61, 63. For further reading see: P Platzer and K Klausner, 'Crowdfunding for Small Satellites' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 349; J Foust, 'Crowdfunding Space' (*The Space Review*, 15 April 2013) available at: http://www.thespacereview.com/article/2279/1.
[112] Kickstarter, ArduSat project: https://www.kickstarter.com/projects/575960623/ardusat-your-arduino-experiment-in-space?ref=live.
[113] Kickstarter, KickSat project: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space?ref=history.
[114] Kickstarter, SkyCube project: https://www.kickstarter.com/projects/880837561/skycube-the-first-satellite-launched-by-you.

the same 'appropriate state' must authorize and continuingly supervise the activities.

By way of example, in a possible case of a launch of a small satellite, the activity may be initiated by a non-governmental entity (commercial, a non-profit organization, an association, a non-incorporated group of individuals and so on). In some cases, these entities are comprised of individuals of different nationalities. This raises the following questions:

- Which state would be the appropriate one to authorize and continuingly supervise the activities?
- What should be the case in the situation where all national states involved have not yet enacted a domestic space law?
- What should be the case when the activity is subject to more than one licensing regime?[115]

Additional challenges stem from the structure of donations, and individual involvement of private persons. The idea of breaching the obligations under Article VI, by acting in violation of a contract was expressed by *Cheng*:

More difficult is the question whether the international responsibility of the States Parties extends to non-governmental entities' failures to comply with rules of private law, including contractual obligations, such as for example those relating to intellectual or industrial property. Is such responsibility precluded by the qualification that the States Parties have assumed only international responsibility, and therefore not responsibility under municipal law? Or does the qualification international, on the contrary, only make it clear that the contracting States are responsible directly to one another in respect of their non-governmental activities, under both international law and municipal law? And, if the State is responsible under Article VI, does this responsibility arise the moment the breach occurs under municipal law, or only after the exhaustion of local remedies not only against the private entity concerned, but also against the State allegedly responsible? One may wonder whether Article VI intends to go as far as making the contracting States

[115] N Palkovitz, '*Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*', IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014) 61, 68.

> directly responsible for all breaches of private law and private law obligations by their non-governmental entities. However, the wording does not preclude this, and this is a point which is worthy of attention in any review of the 1967 Space Treaty, bearing in mind particularly the phenomenal development in private space activities since the beginning of the space age. [116]

In light of the argument presented by *Cheng*, it may be argued that private donations to a small satellite crowd-funded project may link States to a private conduct, which was endorsed by their nationals. This is since the wording of Article VI does not preclude such link, and does not provide clarification as to what kind of conduct may establish attribution between the individual and the State.

Additional questions which may arise from this line of thought:

> The Basic question is whether a donation financing the space activity may establish a relevant legal link between the donors and the activity? And between the state of nationality of such a donor to the activity? Other questions in this respect are:
>
> - Can a micro investment by a private entity in a space project trigger state responsibility by becoming a 'national activity' of the state?
> - If so, should changes be made to the criterion of nationality as attributing private space activities to the state? (e.g. by amending or supplementing the provisions of Article VI of the Outer Space Treaty)
> - Should states restrict the possibility of crowd-funding for space projects in order to avoid massive exposure to international responsibility, and possibly liability?
> - If so, on the basis of which criteria?[117]

Without the need to answer the above questions, this case study illustrates that small satellites are an expression of technological and financial innovation. While crowd-funding activities are not unique to small satellites projects, they offer much more to entrepreneurs looking to fund

[116] See: B Cheng, 'Article VI of the Outer Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State"' (1998) 26(1) Journal of Space Law 7, 16-18.

[117] N Palkovitz, '*Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*' IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014) 61, 69.

small satellites projects, than to the traditional space industry, since the scale of the collected amounts is rather low.

In the legal realm, this case shows that the wording of Article VI is still subject to many possible interoperations, and may be challenged with time, as space technology and financial structures evolve.

The lack of clear attribution criteria in Article VI which link the State and its nationals may create a legal challenge in practice, especially with the increasing privatisation of small satellites activities. This is, of course, in contrast to the attribution criteria, which exist in general international law.[118]

3.5 Conclusion of Case Studies

To conclude, small satellites activities challenge the boundaries of Article's VI applicability, as they take space activities deeper into the private domain.

Therefore, the three case studies offer a glance into practical legal challenges, while the first two cases show the solutions, which were implemented at a national level. In these cases, both Belgium and The Netherlands already had national space laws, which were adjusted. How would a similar challenge be solved in case the relevant appropriate State did not enact domestic space laws yet? This question supports the fact that Article VI will be subject to interpretations by national and international competent bodies in the future.

4. Conclusions

This chapter took a closer examination into the legal concept of State responsibility as provided by Article VI of the Outer Space Treaty.

Firstly, it examined the notions presented by Article VI in a general theoretical manner. This showed that notions under Article VI, such as: 'national activities', 'appropriate State' and 'activities in outer space', are subject to interpretation due to their vague nature and lack of definition in the Outer Space Treaty. General international law, in the form of ICJ cases,

[118] See *supra* section 2.2.

customary law, and scholarly work were all addressed in order to analyse and interpret Article VI, elaborating on the different possible approaches to its understanding.

The next step was to distinguish State responsibility in space law from State responsibility in general international law, as well as distinguishing responsibility under Article VI from liability under Article VII of the Outer Space Treaty.

The last section of this chapter illustrated that the legal uncertainty that stems from the vagueness of key notions in Article VI is reflected in the case of small satellites activities.

In answer to the main research question of this study, currently, small satellites activities are subject to the same international legal framework relevant to all space objects, however, *some States parties to the Outer Space Treaty have already recognised the need to adjust their national space laws in order to optimally regulate small satellites activities*.

In Belgium, the national law was adjusted to allow the State to be internationally responsible for the operations of a multinational constellation of small satellites. Therefore, this case evidences a very wide interpretation of the terms 'national activities' and 'appropriate State'.

In the Netherlands, the law was adjusted in order to regulate 'unguided satellites' which are practically Dutch CubeSats that were not subject to the law beforehand, due to the State's narrow interpretation of the notion of 'activities in outer space'.

It is desirable to include a wide definition of the term 'activities in outer space' in national space laws, to avoid a situation in which small satellites activities are excluded as a regulated space activity. This is important since Article VI of the Outer Space Treaty does not exclude certain space activities from its provisions.

Lastly, Crowd-funded small satellites activities illustrated the difficulty to understand the boundaries, or triggers, of State responsibility under Article VI, in case nationals are involved in space activities. The lack of clear attribution criteria between the State and its nationals potentially exposes crowd-funded small satellites missions to legal uncertainty relating to the identification of the 'appropriate' responsible State.

It seems that the case studies do not offer clear and coherent State practice, which can be deduced regarding State responsibility for small satellites activities. This may be sufficient to conclude that there is a need to further regulate matters relating to State responsibility in the

case of small satellites at the international level. Recalling chapter 2, it seems that several international forums are investigating this need, but are yet to reach conclusions.[119]

Meanwhile, one of the findings in this chapter is that *amending or adapting the scope of national space laws in order to better regulate small satellites activities is one way to deal with the lacunae of Article VI*. This is done on a State level and as each State may develop its own views relating to the interpretation of Article VI, the result may be inconsistencies and difficulty to find clear State practice and *opinio juris.* This will hinder the crystallisation of customary law, and thus, making the legal uncertainty perpetual, unless clarifications will be set at the international level.

In other words, *States parties to the Outer Space Treaty may overcome the legal uncertainty relating to State responsibility as per Article VI, while exposing small satellites operators to different nationality criteria, as per their national space laws. This solution is suboptimal since it promotes the regulation of international law matters such as State responsibility for space activities, through domestic law, in an unharmonised manner.*

This alone may justify the examination of possible legal measures, which would clarify the vague notions of Article VI with respect to small satellites activities.

State responsibility is only one legal pillar, which is provided by the Outer Space Treaty for the conduct of space activities. In chapter 4, the second pillar relating to liability will be examined. The specific risks and international liability regime applicable to small satellites activities will be elaborated, leading to a deeper examination of the need to further internationally regulate small satellites activities.

[119] See chapter 2, section 3.

Chapter 4: Liability for Damage Caused or Suffered by Small Satellites

1. Introduction

The core provisions of the Liability Convention, 1972[1] were set by Article VII of the Outer Space Treaty, 1967[2] and the earlier United Nations General Assembly Resolution on Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1963.[3]

The question of the Liability Convention's applicability and relevance was previously raised in the general context of damage caused by space objects,[4] as well as in the context of the Convention's unbinding dispute resolution procedure.[5] Generally, it seems that scholars agree that in a case where damage was caused by or to a space object that is owned by a non-governmental entity, the Convention may not be effective.[6] Moreover, history shows that up to date, States involved in an occurrence where damage was caused by space objects chose not to invoke the Convention in order to claim reparations.[7]

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[1] Convention on International Liability for Damage Caused by Space Objects, (1972) 961 *U.N.T.S.* 187 (hereinafter: 'Liability Convention' or 'Convention'); for drafting history see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 288-300.

[2] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, (1967) 610 *U.N.T.S.* 205 (hereinafter: 'Outer Space Treaty'); Article VII: 'Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space, including the moon and other celestial bodies.'

[3] UNGA Res. 1962 (XVIII) Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (13 December 1963); Principle 8: 'Each State which launches or procures the launching of an object into outer space, and each State from whose territory or facility an object is launched, is internationally liable for damage to a foreign State or to its natural or juridical persons by such object or its component parts on the earth, in air space, or in outer space.'

[4] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 199.

[5] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 113.

[6] LJ Smith, A Kerrest and F Tronchetti, 'The Convention on International Liability for Damage Caused by Space Objects' in S Hobe, B Schmidt-Tedd and K-U Schrogl (eds), *Cologne Commentary on Space Law* (vol. II; Carl Heymanns Verlag 2013) 222 (hereinafter: 'CoCoSL II').

[7] The view was expressed that the dispute between the USSR and Canada in connection to the re-entry of *Cosmos 954* (see *infra* note 10), which was resolved via diplomatic channels, is considered to be the only

Therefore, due to the fact that the Convention was never invoked nor was in the centre of a case before an international tribunal, the question of its applicability has yet to be answered in a substantive manner.

The lack of legal proceedings involving the Convention is also connected to the fact that damage caused by space objects is rather rare. Fortunately, most of the re-entries of space objects do not cause damage, or at least known damage.[8] Known collisions between space objects in outer space are not frequent either.[9] The two famous cases relating to damage caused by space objects are the re-entry of *Cosmos 954* into Canadian territory on the 24th of January 1978[10] and the collision between *Cosmos 2251* and *Iridium 33* on the 10th of February 2009.[11] A more recent collision, and the first one reported to involve a small satellite, is the collision between the first Ecuadorian satellite and the remains of a Russian rocket in May 2013.[12]

Bearing the above in mind, and considering the reality within today's space industry which includes the use of new space technology such as small satellites, the following questions arise: *will the Liability Convention be legally effective where damage was caused by or to small satellites?* And if not: *is there a justification to create a special liability regime where damage is cause by or to small satellites?* These questions are relevant to regulators, the private space industry, investors and the space insurance market.

In order to formulate an answer to the question of the effectiveness of the Convention relating to small satellites, firstly the special characteristics of space missions employing the latter satellites will be presented in section 2 of this chapter. This section will strictly focus on characteristics, which may influence liability.

Subsequently, section 3 of this chapter will include a legal analysis of the Convention's applicability and relevance to cases where damage was caused by or to a small satellite, while making reference to the *Cosmos 954* re-entry and the *Iridium-Cosmos* collision as the best available analogies, and analysing the case of the recent small satellite-debris collision.

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case where the Convention was invoked, see: F Lyall and PB Larsen, *Space Law a Treatise* (2nd edn; Routledge 2018) 118.

[8] ibid at 117-120.

[9] RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 263.

[10] See summary of facts: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 288.

[11] See RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 254; M Mejia-Kaiser, '*Collision Course: 2009 Iridium-Cosmos Crash*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 274.

[12] See: *infra* section 3.3.2.

Thereafter, section 4 of this chapter will elaborate on different types of insurance policies relevant to small satellites activities, giving emphasis to third party liability insurance, since it is directly connected to the liability regime specified in the Liability Convention.

Finally, conclusions relating to the probability of the applicability of the Convention, resulting in liability of a certain party will be presented in the context of small satellites activities. Suggestions to remedy some of the legal difficulties relating to the applicability of the Convention to small satellites activities will be made. This will shed a light on the need to possibly regulate small satellites activities in a special manner as far as liability to third parties under international law is concerned.

2. Special Characteristics of Small Satellites Relevant to Liability

Chapter 1 includes an elaborate description of small satellite characteristics and in what way they differ from 'traditional' satellites. Since some of these characteristics are relevant for establishing the launching States' liability pursuant to the Liability Convention in case of damage, this section will summarise such relevant characteristics as an integral part of the discussion on liability.[13]

In principle, none of the international space law treaties, including the Liability Convention, distinguish between space objects according to their dimensions.[14] In that sense the Liability Convention applies to small satellites in the same way it applies to other satellites. Going into a deeper analysis and considering practices in the small satellite industry, the reality seems more complex, due to the following reasons.

While traditional contemporary satellites are capable to perform manoeuvres in outer space, the smaller classes of small satellites, such as nano-satellites and CubeSats usually do not have this ability:

> One of the most notable differences between small satellites and traditional satellites is the lack of propellant systems on board the former. While currently propellant systems are being developed to be compatible with the CubeSat standard, the reality is that most of these satellites cannot be further maneuvered after their deployment.[15]

[13] See in more depth section 2.3 of chapter 1.
[14] LJ Smith and Z Valic, *A Regulatory Roadmap for Small Satellites*, 4S Symposium, Slovenia (05 June 2012), 5: 'Under international law, small satellite missions are not treated any differently than other space activities' See also: RS Jakhu and JN Pelton, *Small Satellites and their Regulation* (Springer 2014) 43
[15] N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 49.

This fact may affect the manner in which the Liability Convention may be applied to collision cases involving small satellites, as far as establishing 'fault' is concerned.[16]

The launch practices of small satellites differ from the traditional satellites' launch practices. Traditional satellites can weigh several tones, and thus they are launched on board a powerful rocket (a launch vehicle) into their orbit. As mentioned, small satellites have a mass smaller than one tonne, and the smaller classes typically weigh between 1 and 10 kilograms.

Since the launch vehicle can carry tons of weight to outer space, small satellites are usually added to a launch of a traditional heavy satellite as secondary payloads, which tag-along to the launch of the primary payload.[17] This means that the owners of the small satellites do not procure a large launch capacity, as the primary payload owner does.

As a consequence of 'tagging-along' or 'piggy-back' launching, the owners of the small satellites, which are launched as secondary payloads, depend on the launch of the primary payload. This is true for the launch date, delays, and the specific orbit the satellites will be inserted to. Unlike in the case of the primary payload customer who paid a large sum for the launch, secondary payloads are charged a fraction of the launch cost.

These facts amount to the practice of dependency of the small satellites owners on the primary launch customer, and if for whatever reason the former cannot comply with any of the launch requirements, the primary satellite may be launched leaving them behind. In that sense, the primary customer has a greater 'procurement power' since there will not be a launch without it, unlike the situation vis-à-vis small satellites owners. This practice may affect the manner in which the term 'launching State' is interpreted, and the Liability Convention applied, as far as 'procurement' is concerned.[18]

Standardised small satellites such as CubeSats are often composed of 'commercial of the shelf' (COTS) sub-systems, and therefore, designing, building and procuring a standard CubeSat is much simpler, quicker and far more affordable than traditional space hardware.[19] This low-cost model allows for diverse operators such as universities, research centres and other non-profit organisations to perform space activities, even if they lack vast

[16] See further *infra* sections 3.3.1 and 3.3.2.
[17] For an overview of launch options and practices see: UNISPACE III, Small Satellite Missions, Background paper 9, A/CONF.184/BP/9 (26 May 1998) 11-13.
[18] See further *infra* section 3.4.
[19] See further: N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 48. See for example an online shop offering such components: www.CubeSatShop.com (accessed Aug. 22, 2016).

financial resources.[20] This affects the ability of the operator to obtain (in terms of cost) third party liability insurance for the small satellite in question.[21]

To conclude, some of the specific launch and operation practices of small satellites differ from the ones of traditional satellites. This may have legal implications concerning liability.

Taking the above in mind, the next section will juxtapose these special characteristics with key provisions of the Liability Convention, examining the challenges that may rise when applying the Convention to small satellites activities.

3. Small Satellites and the Liability Convention

3.1 Differentiating Absolute, Strict and Fault Liability

Before elaborating on the specific case of small satellites, or even satellites in general, this section shall introduce the different liability standards, which the Liability Convention includes, namely, absolute, strict and fault liability. These liability standards are applicable to all 'space objects' as defined in Article I(d) of the Convention: 'The term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof.'[22] Therefore, the liability regimes in the Convention apply to all kinds of space objects, and do not distinguish between satellites and the International Space Station (ISS) for instance.

Examples of different risks and damage, which may trigger liability pursuant to Articles II and III of the Liability Convention, are elaborated in sections 3.2, 3.3 and 3.4 below in the context of small satellites.

3.1.1 Absolute and Strict Liability

The first liability standard is elaborated in Article II of the Convention, which prescribes absolute liability: 'A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight.'[23]

While Article II clearly states absolute liability as the applicable standard, Article VI.1 stipulates that: '[…] exoneration from absolute liability shall be granted to the extent that

[20] See further also in the context of crowed funding: N Palkovitz, '*Space Entrepreneurship and Space Law-Future Challenges and Potential Solutions*', IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014).
[21] See further *infra* section 4.
[22] For analysis on the relations between the term 'space objects' and small satellites see: chapter 2, subsection 2.3.3.
[23] For commentary see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 320-323.

a launching State establishes that the damage has resulted either wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents.'

The Convention itself does not include a definition of 'absolute liability' and therefore scholars expressed the view that in the case of Article VI.1, the Convention calls for 'strict liability', and not 'absolute liability'.[24]

The difference between 'absolute liability' and 'strict liability' in the context of the Convention can be summarised as follows:

> The terms 'strict liability' and 'absolute liability' are distinct. One absolutely liable for an activity has no defences, not even of force majeure, plaintiff contributory negligence, or intervening negligence of a third person. […] In contrast, 'strict liability' implies simply that the defendant is responsible without fault for an accident but may still raise defences to reduce liability. LC [Liability Convention] art. II uses but does not define the term 'absolutely liable'. LC art. VI.1 does allow a State to avoid 'absolute liability' if the plaintiff has been guilty of gross negligence or intentionally incurs harm. Thus, the LC (as well as national laws) often use the term 'absolute liability' to impose a greater degree of liability than 'strict liability' but still less than complete liability.[25]

Cheng explains the distinction between the two terms in a different context as follows:

> In other words, in strict liability, there is a causal link between the person held strictly liable and the damage. 'Absolute liability', however, which shares with 'strict liability' the common characteristic that fault on the part of the person to be held liable is not a condition of such liability, differs from 'strict liability' in that absolute liability will arise whenever the circumstances stipulated for such liability to arise are met, it mattering not by whom the damage is caused or how it is caused. The normal defences are not available. Liability arises absolutely. In contrast with strict liability, there is no requirement of a causal relationship between the person to be held liable and the damage complained of, although the conditions prescribed for absolute liability will normally require a causal relationship between one or more of the circumstances stipulated for such liability to arise and the damage.[26]

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[24] See: PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 117.

[25] See: R Bender, *Space Transport Liability: National and International Aspects* (Kluwer 1995) 135 n14.

[26] B Cheng, 'A Reply to Charges of Having Inter Alia Misused the Term Absolute Liability in Relation to the 1966 Montreal Inter-Carrier Agreement in My Pleas for an Integrated System of Aviation Liability' (1981) 6 Annals of Air and Space Law 3, 9.

Therefore, although the Convention uses the term absolute liability, it seems that the existence of the defence in Article VI.1 suggests that strict liability is applied.

3.1.2 Fault Liability

Article III of the Convention prescribes fault based liability: 'In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.'

Diederiks-Verschoor elaborated on the difference between 'absolute' and 'fault' liability as follows:

> The traditional method to assign liability for an act of tort is through fault, i.e. the liability attaches to the person causing harm, either intentionally or neglectfully. Another approach, though less common, is through absolute liability, often referred to as risk liability. This is the type of liability incurred upon mere proof that the damage exists and that it has been inflicted by a particular person. No proof of intent or negligence is required here, and the liability is incurred irrespective of the perpetrator's compliance with the required standards of care. [27]

Article III is clear on the need to establish fault in order to successfully claim compensation for damage in outer space, however, it does not give any legal indication on what may constitute 'fault'. This lacuna was the subject of vast scholarly work. Such work and the difficulties that arise from the multiple interpretations available to 'fault' will be elaborated in section 3.4 below.

3.1.3 Concluding Remarks

To Conclude, the Liability Convention prescribes different liability standards for damage that is caused on Earth, including the airspace, and outer space. While the Convention includes the term absolute liability, it has been shown that strict liability may be applied. Further, when indicating that fault-based liability applies, the Convention does not include any details on what kind of behaviour or events would amount to fault in the context of damage that is caused in outer space. In this sense, the Convention does not promote legal certainty relating to damage caused by space objects.

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[27] See: IHPh Diederiks-Verschoor, An Introduction to Air Law (8th rev edn; Kluwer Law International 2006). 149; see also B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 326-327.

3.2 Potential Damage Caused by Re-entry of Small Satellites

As mentioned in section 3.1 above, Article II prescribes absolute liability for damage caused by a space object on the surface of the Earth or to aircraft in flight. This section will analyse the risk for damage caused by small satellites on Earth, while section 3.3 will address damage in the air space.

The main purpose of such a straight-forward provision as Article II is to protect innocent victims–third parties–that suffer damage due to the object's re-entry to Earth.[28] Indeed, in such a case it seems like the launching State would be held liable to compensate the victim, with only minimal factual proof needed to invoke Article II.[29] A similar rational is found behind the Rome Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface, 1952.[30]

During re-entry to Earth, space hardware may fully or partly burn up in the atmosphere. In the case of traditional satellites with a mass of several tons, there is a risk of physical impact, which may cause damage to persons or property on Earth. Small satellites, and especially nano-satellites and CubeSats, are likely to completely or almost completely burn upon re-entry, due to their very low mass. Therefore, the probability that damage will be caused by a small satellite due to re-entry in the meaning of Article II of the Liability Convention is reasonably estimated to be very low.[31]

Another re-entry risk, which is unlikely to exist in the case of small satellites, is connected to contamination, due to on board nuclear power sources.[32] This risk was recognised by the United Nations in the context of traditional satellites, and a set of principles was adopted in order to mitigate such risk.[33] The famous case of the re-entry of *Cosmos 954* into Canadian territory[34] illustrated this risk. Although the re-entry, fortunately, did not cause any direct damage to persons on the ground, wide-spread environmental contamination was caused. Accordingly, Canada asked the USSR to provide compensation in connection

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[28] *CoCoSL II*, 102.
[29] This is of course unless the launching State can invoke Article VI which may exonerate it from liability.
[30] Rome Convention on Damage Caused by Foreign Aircraft to Third Parties on the Surface, (1952) 310 *U.N.T.S.* 181; see discussion: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 326.
[31] See risk assessment as part of the reform of the Outer Space Act, 1986 in the UK: UK Space Agency, Reform of the Outer Space Act 1986: Summary of responses and Government response to consultation, (06 Dec. 2013) 7; available at: http://webarchive.nationalarchives.gov.uk/20121212135622/http://www.bis.gov.uk/assets/ukspaceagency/docs-2013/gov-response-osa-consultation.pdf . (Hereinafter: 'UK Reform Explanatory Document').
[32] For 'nuclear damage' see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 323-324; Article XXI of the Convention, in the context of large-scale danger; *CoCoSL II*, 200-201.
[33] UNGA Res. 47/68 Principles Relevant to the Use of Nuclear Power Sources in Outer Space (14 December 1992).
[34] See: *CoCoSL II*, 127-128.

to the Canadian cleaning expenses. Since this was finally resolved via diplomatic channels, with the USSR not admitting liability for the damage and rather agreeing to an *ex gratia* payment, the Liability Convention was not formally invoked, and it is still to be clarified if the Convention would cover such cases of compensation due to indirect damage, i.e. the cleaning expenses.[35] Putting the question of direct versus indirect damage aside, since small satellites currently do not use nuclear power sources it is unlikely that such risk will be relevant to this type of satellites.

In conclusion, the probability of a small satellite causing damage that would invoke Article II, and the absolute liability of the launching State, seems to be extremely low.

3.3 Other Damage on Earth or in the Air Space Involving Small Satellites

In case of a launch failure,[36] damage may be caused as well. This type of scenario seems to be included in the Convention, which refers to this situation as an attempt to launch.[37] When a launch vehicle malfunctions, causing a launch failure, there is a risk that damage on Earth or in the air space may be caused; this makes Article II relevant again.[38]

Industry practice prescribes that the launch service provider is the entity which obtains third party liability insurance to cover the risk connected to the launch.[39] Since small satellites are usually launched as auxiliary payloads it is unlikely that they will be the cause of this potential damage. This is because the launch vehicle itself and the primary payload(s) are much larger in mass and often contain explosive fuels, which may be the main source of damage in case of malfunctions. If damage is caused pursuant to the launching activities, it will be, most likely, covered by the available insurance arrangements. Some insurance policies allow payment of compensation in case the claim

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[35] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 117; F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 200; B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 288. For the definition of 'damage' and discussion relating to indirect damage see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 323; *CoCoSL II*, 105-106, 111-113; V Kayser, *Launching Space Objects: Issues of Liability and Future Prospects* (Springer 2001) 44.

[36] *CoCoSL II*, 113-114.

[37] Article I(b) of the Convention; *CoCoSL II*, 106-107.

[38] This is true provided that the damage was suffered by third parties, as the Convention does not cover damage caused to the nationals of the launching State, or to persons who are not nationals, however, are launch participants, see Article VII of the Convention.

[39] *CoCoSL II*, 144; This may be done pursuant to national regulations making the insurance mandatory, or by self-insurance in cases that the launching activities are governmental; for an overview on practical aspects of space insurance see: P Montpert, 'Space Insurance' in LJ Smith and I Baumann (eds), *Contracting for Space: Contract Practice in the European Space Sector* (Routledge 2011) 283.

was settled by diplomatic channels, provided the insurer accepts such settlement. Hence, it is unlikely that Article II will be invoked in this context, when considering small satellites.

3.4 Risk of Collisions in Outer Space Involving Small Satellites and Fault Liability

3.4.1 Fault in Case of Collisions in Outer Space

Risks connected to collisions between space objects are the most relevant ones as far as small satellites are concerned. Contrary to the unlikelihood of realisation of the risks presented in the above sub-sections, collisions between space objects orbiting in Low Earth Orbit (LEO) seem to be probable, as this is a highly congested orbit.[40] The hundreds of small satellites, which are already positioned in LEO, are enough to raise concerns with regulators,[41] in addition to the planned small satellites 'mega constellations', which will increase the probability of collisions in the future.[42]

The liability regime concerning damage in outer space caused by space objects is set out in Article III of the Convention. This regime assumes a situation in which one space object causes damage to a second space object of another launching State, in outer space including the Moon and other celestial bodies. The prescribed liability standard in such a case is fault liability.[43] Compensation is due when the space object of the party at fault causes[44] damage[45] by colliding[46] with a space object of the injured party.

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[40] J-C Liou, Modeling the Large and Small Orbital Debris Populations for Environment Remediation, 3rd European Workshop on Space Debris Modeling and Environment Remediation CNES HQ, Paris, France, 16-18 June 2014.

[41] *UK Reform Explanatory Document*, 7-8.

[42] See for examples to small satellites 'mega constellations' based companies: N Palkovitz, '*Dealing with the Regulatory Vacuum in LEO: New Insurance Solutions for Small Satellites Constellations*' 419 IISL Proceedings of the 59th Colloquium on the Law of Outer Space (2017).

[43] 'In the event of damage being caused elsewhere than on the surface of the Earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible'; for commentary see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 320-323; the notion of 'fault liability' is not defined in the Convention, creating a difficulty in applying Article III, see this section 3.4 for discussion and possible standards of fault in this context; for the difference between absolute and fault based liability see section 3.1 *supra*.

[44] For causation see: *CoCoSL II* at 126- 127; BA Hurwitz, State Liability for Outer Space Activities in Accordance with the 1972 Convention on International Liability for Damage Caused by Space Objects (1992) 34.

[45] For commentary on the definition of 'damage' see*: supra* note 35.

[46] Article IV of the Convention presents a situation according to which, the collision between two space objects created damage to a third space object belonging to a third-party. As fault liability applies in the latter case, the legal analysis brought below is relevant to Article IV, as far as establishing fault. For commentary

One of the components of Article III, which needs to be further clarified and developed, is the notion of 'fault' as applied to outer space:

Cheng points out the following:

> Article III is ambiguous. On the one hand, it can mean that a launching State is liable only to the extent of its fault. On the other hand, it can also mean that a State becomes liable for the totality of the damage as soon as it has been established that there is fault on its part, and there is a causal connection between this fault and the damage.[47]

Haanappel adds:

> Article III gives no indication as to who carries the burden of proving fault or of disproving it: in this context, the facts of each case will probably be determining, since compensation under the Convention is determined, *inter alia*, according to principles of justice and equity (*ex aequo et bono*).[48]

While scholars agree that 'fault' under Article III is ambiguous, there are different opinions as to what would constitute 'fault'.

According to *Jakhu* 'fault' should be understood in the same way as it is under general international law.[49] When contemplating liability under general international law, *Lyall* and *Larsen* refer to landmark PCIJ and ICJ cases as codified by the UN International Law Commission (ILC) in its work.[50]

Such work includes the 'Draft Articles on Responsibility of States for International Wrongful Acts, 2001'[51] and 'Prevention of Transboundary Harm from Hazardous Activities, 2001'.[52] These legal instruments do not state their applicability to damage in

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on Article IV see: *CoCoSL II*, 138-140; B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 330-331.

[47] B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 328.

[48] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 116.

[49] See: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 256.

[50] F Lyall and PB Larsen, *Space Law: a Treatise* (2nd edn; Routledge 2018) 95.

[51] International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts, *Official Records of the General Assembly*, Fifty-sixth session, Supplement No. 10 (A/56/10), chp.IV.E.1 (2001).

[52] International Law Commission, Prevention of Transboundary Harm from Hazardous Activities, *Official Records of the General Assembly*, Fifty-sixth Session, Supplement No. 10 (A/56/10) (2001). http://legal.un.org/docs/?path=../ilc/texts/instruments/english/draft_articles/9_7_2001.pdf&lang=EF .

outer space and *Lyall* and *Larsen* note that: 'The question remains whether and how these generalities are to be found within space law.'[53]

The ILC Articles on State Responsibility are referred to in chapter 3 of this study, in the context of State responsibility. Responsibility is different from liability according to general international law, and the Outer Space Treaty, which includes provisions on State responsibility in its Article VI, and Liability in Article VII.[54] In general international law, it is possible to establish State responsibility by attribution of an internationally wrongful act to a State under certain conditions.[55] In other words, if the State is responsible for the act that caused damage, the State may be held liable to pay reparations to the injured party.[56]

Even if there is no difficulty applying the ILC Articles on State Responsibility to satellites collisions in outer space, the legal assumption is that there should be an internationally wrongful act by a State, or its organs, in order to successfully invoke this legal instrument and claim reparations:

> The articles deal only with the responsibility for conduct which is internationally wrongful. There may be cases where States incur obligations to compensate for the injurious consequences of conduct which is not prohibited, and may even be expressly permitted, by international law.[57]

As will be illustrated in the next subsection, a collision in outer space may occur without any indication of a wrongful act, and the parties involved are often private entities, not acting on behalf of a State. This makes the ILC Articles on State Responsibility less relevant in case a private small satellite operator is involved in a collision in outer space.

The second ILC instrument mentioned by *Lyall* and *Larsen* is: Prevention of Transboundary Harm from Hazardous Activities, does not include the term 'damage'. Instead, the term 'transboundary harm' is included, which seems irrelevant to satellites collisions in outer space.[58]

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[53] F Lyall and PB Larsen, *Space Law: a Treatise* (2nd edn; Routledge 2018) 96.
[54] Chapter 3, sections 2.2 and 2.3.
[55] See: Chapter 3, section 2.2.
[56] See: International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts, *Official Records of the General Assembly*, Fifty-sixth session, Supplement No. 10 (A/56/10) Part Three, Articles 42-48 (2001).
[57] International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts with Commentaries, *Yearbook of the International Law Commission* (2001) vol. II, Part Two Commentary 4(c), 310.
[58] According to Article 2(c) 'transboundary harm means harm caused in the territory of or in other places under the jurisdiction or control of a State other than the State of origin, whether or not the States concerned share a common border'. It seems unlikely that outer space will qualify as an 'other place' under the jurisdiction or control of a certain State, especially when contemplating satellite collisions which are in orbit.

In conclusion, general international law does not use the notion of 'fault' in order to attribute responsibility or liability to States, as the Liability Convention does.

Therefore, *Smith* and *Kerrest*, are of the opinion that international law commonly refers to violations of legal obligations, which are different from 'fault' in the case of the Liability Convention:

> The notion of fault used in Art. III is not common in international law; international law generally refers to violation of a legal obligation and not to fault. The reference to fault is significant. The judge applying the Convention will have to examine the behavior of the launching State or the person for whom it is responsible. He may rely on relevant sources to evaluate conduct and assess whether this behavior constitutes fault.[59]

Smith and *Kerrest* continue to elaborate on the relevant sources to evaluate the behaviour. They specify codes of conduct adopted by space agencies, or the UN. They argue that as long as the launching State acted in compliance with such codes of conduct 'there will be no room for presumption of fault'.[60]

Therefore, according to *Smith* and *Kerrest* fault can be established when a certain act of a launching State was not in compliance with relevant codes, regardless of the fact that such codes are not internationally-legally binding. This, in their opinion, is because such codes are an evidence of 'correct procedure and behavior to be followed.'[61]

They conclude by repeating the general scholarly view, which pertains to the ambiguity of Article III and the practical difficulties in its application. They also note that the adoption of Space Traffic Management (STM) rules would provide further insight into the notion of fault in outer space.[62]

Indeed, the absence of 'rules of the road' which apply to outer space raises yet another difficulty in establishing fault:

> A fault determination in space is certainly more complicated than that on the roadways, where vehicles are controlled by human beings and are required to follow a set of predetermined traffic rules.[63]

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[59] *CoCoSL II*, 133.
[60] ibid.
[61] ibid.
[62] ibid, 135-136.
[63] K-U Schrogl, 'A New Look on the Concept of the "Launching State"' (2002) 51(3) Zeitschrift für Luft und Weltraumrecht 359, 369. See also: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010), 260; *CoCoSL II*, 223.

A recent STM study carried out by the International Academy of Astronautics (IAA), with the contribution of space law scholars, offers a solution to this exact problem. The study suggests a multi-tier regulatory approach, which includes a new Outer Space Convention (OSC) on top of the current regulatory framework. It would be supplemented by Outer Space Traffic Rules (OSTR) indicating the operator's potential liability and finally, Outer Space Traffic Technical Standards (OSTTS) providing detailed technical standards.[64]

According to the study, Article 10 of the OSC should include provisions on:

> relative liability of States for damages elsewhere, i.e. in outer space (whereby the notions of fault, negligence, diligence, etc. may receive new impetus from a fully elaborated STM regime).[65]

The OSTRs should include specific rules for:

> in-orbit operations (including the allocation of certain orbital slots and rules for 'operational behaviour') − specific rules for certain types of space objects or space activities, for example relating to *small satellites* or satellite constellations in LEO.[66]

While the study does not provide a clear standard of liability for satellite collisions in outer space, it anticipates the need to establish specific rules for the operation of small satellites. This new approach is very different from the approach currently found in the Liability Convention. The author is of the opinion that while the suggested OSC and OSTRs need further elaboration, the general innovative approach taken by the IAA STM study is better suited to the case of small satellites and collisions in outer space.

The IAA study is valuable since it was conducted by a group of legal and scientific distinguished experts. The opinions of the most notable space law scholars are of importance since the provisions of the Liability Convention were never subject to interpretation before the International Court of Justice or any other international tribunal. Collisions in outer space are still rare and therefore the exact meaning of 'fault' remains unknown for now and creates legal uncertainty.[67]

Adding to these difficulties in law, there is difficulty in establishing a clear factual ground in order to determine possible fault, since outer space is not commonly accessible and at

[64] *Space Traffic Management Towards a roadmap for implementation*, IAA Cosmic Study (2017) 16.
[65] ibid, 113.
[66] ibid, 116, emphasis added.
[67] See discussion in the context of the *Iridium-Cosmos* collision *infra*.

times even the parties involved may lack the ability to successfully monitor their space objects.[68]

To conclude, the notion of fault-based liability, in case of collisions, remains ambiguous in the context of the Convention, relating to all space objects. Clarification of the legal standard of fault for damage caused in outer space is relevant to the specific case of small satellites.

In order to understand the theoretical and practical legal aspects in relation to the applicability of the Liability Convention with respect to damage caused by a collision between a traditional space object and a small satellite, the case of the *Iridium-Cosmos* collision will be analysed, as an analogy to the case of small satellites. A second case of a collision between an Ecuadorian small satellite and fragments of a non-functioning Russian space object will be analysed as well as the sole known case study.

3.4.2 The *Iridium-Cosmos* Collision as an Analogy to Establishing 'Fault' in case of a Collision between a 'Traditional' Operational Satellite and a Small Satellite

A collision between a regular operational satellite and a small satellite did not occur to date, however, a collision between a manoeuvrable satellite and a non-manoeuvrable satellite is illustrated in the case of the *Iridium-Cosmos* collision, making this case the most suitable to draw an analogy to the first collision case. Notwithstanding the foregoing, the case of a collision between a small satellite, which is operational and thus not 'dead', yet incapable of manoeuvring in order to avoid the collision, and a regular operational satellite, differs from the case of the *Iridium-Cosmos* collision. The main differences are, firstly, that fault could not be established pursuant to a breach of debris mitigation standards, since the small satellite is not 'dead' and secondly, the small satellite is valuable to its operator, unlike in the case of *Cosmos 2251*.[69]

The collision between *Cosmos 2251* and *Iridium 33* happened on the 10th of February 2009. *Cosmos 2251* was a Russian military telecommunication satellite. It was launched in 1993 from Russian territory on board a Russian launch vehicle. In 1995 the satellite malfunctioned, rendering it out of its operator's control.[70] *Iridium 33* was a

[68] RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 260; *CoCoSL II*, 134.

[69] The Convention has an objective to restore, as far as possible, the situation of the victim to what it was before the damage occurred, in the way of compensation. This standard is in line with the PCIJ's judgment relating to the principal of integral reparations as expressed in the *Chorzow Factory Case (Germany v Poland)* 1928 PCIJ Ser. A.17 at 29; see also: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 336; In case the 'victim' is essentially space debris, reparations would not be effective since the damaged space object was worthless or almost worthless even prior to being damaged by the collision.

[70] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 199.

telecommunication satellite owned by a US private company- the Iridium Corporation. It was launched in 1997 from Baikonur, Kazakhstan, on board a Russian launch vehicle.[71] The collision happened in LEO. Both satellites were damaged and the collision created a cloud of debris.[72] While this collision unquestionably occurred between two space objects in outer space, causing damage, the Liability Convention was not invoked by the launching States.[73]

Von der Dunk analysed the applicability and relevance of the Liability Convention to this collision, concluding that the Convention would doubtfully stand the test if it were invoked.[74] *Jakhu* analysed the legal implications of the collision, referring to Article III of the Convention, putting an emphasis, however, on the problem of space debris, which is not relevant in the case of an operational small satellite.[75] Their comprehensive analysis and conclusions will be applied, by way of analogy, in order to assess the Convention's relevance in the context of small satellites.

Firstly, there is a legal difficulty in establishing fault. Scholars have agreed that the lack of a clear workable definition of 'fault' relating to Article III of the Convention presents a challenge to its future relevance.[76] Considering the above, *von der Dunk* suggests the following regarding the issue of fault under Article III of the Convention:

> In other words: a 'fault' presumes a *choice* for the person at fault, a choice between at least two options of 'conduct', where that person whether by 'intention' or 'negligence' has chosen an option (that is flawed by 'judgment') leading to the harm concerned, where choosing another option would *not* have led to such harm.[77]

Applying this test, calling to examine the operator's *choice* of action in respect of manoeuvring the small satellite to avoid a collision, the fault would be with the other party-operating the controllable satellite. This would mean that in case of a collision between an operational-controllable satellite and a small satellite, the operator of the controllable

[71] The launch facility in Baikonur is leased by Kazakhstan to Russia, and the facility is managed by the Russian Federal Space Agency. See: T Masson-Zwaan, 'Space Law and the Satellite Collision of 10 February 2009' in Space Research Today, COSPAR's Information Bulletin no. 174 (2009) 4, 7.
[72] ibid.
[73] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 200.
[74] ibid, 206.
[75] See: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010).
[76] *CoCoSL II*, 222.
[77] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 203, original emphasis.

satellite would be at fault by default, as far as it could be established under Article III, since only the latter had the choice to manoeuvre its satellite.

In reality, the situation will be more complex due to the parties' awareness of the nearing collision, or the lack thereof. It was reported in the press that *Iridium 33*'s operator, which could have potentially moved the satellite and avoid the collision, lacked precise warning for the upcoming collision.[78] In this sense, the Iridium Corporation was not in the position to exercise its judgment, and to actively choose to avoid the collision. *Jakhu* concludes that the US may be at fault due to its failures to predict the collision and alert Iridium's management and provide instructions to carry out a manoeuvre in order to avoid the collision.[79]

Masson-Zwaan analyses the potential fault of the parties as follows:

> It will be necessary to prove that one of the launching states has not fulfilled its obligations under international law and that this has caused the damage to occur. I will not go into the technicalities of this but suffice it to say that many elements can be brought into the picture to weaken the causal link, including the availability of information, the duty to inform and to consult, and the question whether any outside party (such as an agency monitoring objects) might have been negligent in warning Iridium of the imminent collision. It might also be established that one of the parties has somehow contributed to the damage by not adequately monitoring collision risks, thus reducing the extent of 'fault' by the other party.[80]

Therefore, it is submitted that the fault would simply lie with the party who had awareness of the potential collision and did not take action to avoid it. Following this logic, the party that operates the traditional satellite would not be at fault in case of a collision with a small satellite by default. Regardless of the ability of a certain party to physically avoid the collision by making a manoeuvre, it seems reasonable that if a certain party becomes aware

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[78] See: S Borenstein and S Birch, 'Crash of US, Russian satellites a threat in space' (*The Sydney Morning Herald*, 12 February 2009, updated 13 February 2009); available at: https://www.smh.com.au/technology/crash-of-us-russian-satellites-a-threat-in-space-20090212-857v.html.. See for further analysis: F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 203; RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 257.

[79] RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 259; Jakhu brings information that would support the assumption that the US authorities were capable of monitoring the space objects in question and hence, could have known about the collision risk, see: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 258.

[80] T Masson-Zwaan, 'Space Law and the Satellite Collision of 10 February 2009' in Space Research Today, COSPAR's Information Bulletin no. 174 (2009) 4, 8.

of the potential collision it should take action to avoid it and therefore, in case the satellite cannot be controlled, inform the other party which may be able to control its satellite. Lack of action expressed by not moving the satellite or not informing the other party of the need to move its satellite amounts to negligence and may establish fault.

It could be argued that the party operating the controllable satellite is still under a greater obligation to act in order to avoid the collision with the small satellite. Further, executing a manoeuvre of a satellite is not a risk-free activity, and more importantly, it may reduce the operational life of the satellite due to the unplanned propellant consumption, causing a reduction in revenue when the satellite is on a commercial mission. In that sense it can be argued that small satellites operators disregard the commercial interests of other operators. Would this amount to fault under Article III of the Liability Convention?

Referring to the obligation in Article IX of the Outer Space Treaty to carry out space activities with due regard to the interests of other States parties, *Jakhu* is of the opinion that since Russia did not act to remove *Cosmos 2251* from LEO, it breached its obligation under Article IX. In his view, this breach amounts to fault, making Russia liable for the damage caused to *Iridium 33*.[81]

In the case of an operational small satellite, the duty to remove 'dead' satellites in order to avoid future potential damage can be replaced with the duty not to launch uncontrollable satellites in the first place, since they can cause damage and 'force' other operators to take action to avoid colliding with them, and hence be considered as an activity which does not take the interests of other States in due regard.

The author puts forward that it would be wrong to argue that launching non-manoeuvrable small satellites can be seen as an activity that violates the obligation laid down in Article IX of the Outer Space Treaty. This conclusion derives from a holistic reading of Article IX. The obligation for a due regard-based conduct is set out in the Article side by side with other obligations, namely, for States to act in cooperation and avoid harmful interference with space activities of other States. Small satellites are endorsed by the United Nations' Space Applications Program and recognised as a platform which is used by developing countries, thus, the activity corresponds with interests of other States[82] and in this sense the

[81] RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 256; Jakhu proposes that the norm under Article IX should be observed subject to State practice, which stands for abandonment of dead satellites for the past 50 years. This, to his opinion, does not reflect customary law since State practice may change (i.e. some States do de-orbit their dead satellites) and there is no clear evidence for *opinio juris* expressly stating that States have the right to abandon dead satellites in outer space.

[82] See: Chapter 1 subsection 2.4.8, chapter 2 section 3.2; W Balogh, 'Capacity Building in Space Technology Development: The Role of the United Nations' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 28-46; see generally in the context of developing countries: UNGA Res. 51/122 Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit

activity does not breach the due regard standard. Additionally, different States and operators have different interests. While small satellites can potentially injure commercial interests of certain operators, they fulfil other interests like capacity building, educational and scientific interests, which are no less important under international space law. Further, as there are many multinational collaborative small satellites projects, this activity is in line with Article's IX objectives relating to cooperation.[83]

Finally, fault may be based on the failure of a party to maintain an international standard of conduct, relating to the obligation to avoid harmful contamination of outer space according to Article IX. *Von der Dunk* concludes, and the author agrees, that the nature of this obligation is not sufficiently powerful to establish liability upon its breach in this case.[84]

Another standard in the context of international conduct in outer space could be found in the IADC guidelines aimed to mitigate space debris.[85] These guidelines are not relevant to the present case since the operational small satellite is not space debris but a functional space object.[86]

It is therefore concluded that it would be rather difficult to establish fault pursuant to Article III of the Convention on the part of the party, which is operating a functional yet non-manoeuvrable small satellite, in case of an accidental collision with a functioning manoeuvrable satellite. Nonetheless, the element of physical manoeuvrability should be secondary in establishing fault, since the awareness of any operator of the need to move the satellite is significant, as seen in the case of the *Iridium-Cosmos* collision. Of course, this conclusion would change in case specific STM rules for satellites in orbit would determine that in this situation, one of the parties is clearly at fault.[87]

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and in the Interest of all States, Taking into Particular Account the Needs of Developing Countries (13 December 1996).

[83] See for commentary: S Marchisio, 'Article IX of the Outer Space Treaty' in S Hobe, B Schmit-Tedd and K Schrogl (eds), *Cologne Commentary on Space Law* (vol. I; Carl Heymanns Verlag 2009) 169-182.

[84] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 205, referring to the obligation as follows: 'at best an obligation of effort rather than an obligation of result, of *trying* in good faith rather than being *obligated* to avoid any harmful contamination.' (original emphasis).

[85] Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (2002, as revised in 2007), IADC-02-01, Revision 1 (Hereinafter: 'IADC Guidelines').

[86] ibid at section 3.1: 'Space debris are all man made objects including fragments and elements thereof, in Erath orbit or re-entering the atmosphere, that are non functional'.

[87] See STM analysis in subsection 3.4.1 *supra*.

3.4.3 The 2013 Collision between NEE-01 Pegaso and the Remains of a Russian Rocket: Establishing 'Fault' in Case of a Collision between a Non-operational Space Object and an Operational Small Satellite

Apart from the case of a collision between an operational space object and a small satellite, a collision between an operational small satellite and a non-operational space object may occur. The first Ecuadorian satellite '*NEE-01 Pegaso*' (meaning 'Pegasus'), which was a 1U CubeSat weighing 1.2 Kilograms, was launched on board of a Chinese Long-March launch vehicle on April 25, 2013. As this author previously wrote:

> About one month after it was launched, the satellite and a particle cloud from an old Soviet-era rocket, which had been in space since 1985, collided in LEO. The satellite, which was a national pride and received massive media attention in Ecuador, was reported to be damaged yet operating, however, after the attempts to communicate with the satellite failed, the Ecuadorian space agency- 'EXA' finally declared it lost. No claims under the Liability Convention were presented up to date, and to the best of the author's knowledge, no other international litigious paths were followed. In theory, Ecuador could have brought a claim for the damage caused by the Russian non-functioning space object, as far as such an object may be included in the definition of a 'space object' under the Convention.
>
> In such case where one object is operational though cannot be manoeuvred to avoid the collision, and the other is non-operational and non-manoeuvrable as well, it is hard to determine who is at fault. Is Russia at fault for not safely de-orbiting its dead space object, creating space debris? Firstly, the following has to be considered: during the launch of the space object in 1985 there were no international guidelines aiming to mitigate space debris that would potentially generate fault due to a breach of an internationally recognizised practice or duty. Secondly, even if the dead object would have been launched after the issuance of the IADC Guidelines, it would not be clear whether the failure to de-orbit the dead object would amount to fault due to a breach of an internationally recognized practice or duty, or due to a breach of international customary law.
>
> Would a claim by Ecuador be accepted? The answer is dubious, considering that compensations will be claimed due to a collision with a dead satellite, while the Ecuadorian satellite itself has no mechanism for controlled de-orbiting (since it is non-manoeuvrable), and hence is expected to remain dead in LEO after the

> end of its operational life. How does this situation correspond with principles of justice and equity? [88]

Putting the question of fault determination aside, the Convention allows the victim to obtain reparations from the party at fault. The Ecuadorian Government reportedly invested 700,000 US Dollars in the satellite's launch.[89] Under these circumstances, clearly, the damage that would have been claimed under Article III would have been at a rather small scale, much smaller than possibly envisaged during the drafting process of the Convention.[90]

The non-material damage suffered for the loss of the country's first satellite may be argued to exceed the physical damage caused to the small satellite. It is highly doubted that such a claim for damage in the wider sense would succeed in the context of Article III of the Convention.[91] It may be that in such a case the victim would not be motivated to start the diplomatic and legal procedure dictated by the Convention.[92]

The damage caused to the small satellite was reported to have been covered by the insurer - a local Ecuadorian insurance company.[93]

As this author concluded before:

> [I]n the case of a collision between an operational small satellite and a 'dead' space object, establishing fault on the basis of breach of international standards relating to debris mitigation and de-orbiting, may not be successful under the Convention, since it does not correspond well with principles of justice and equity. It would not seem just and equitable to grant compensations on the grounds of one party's failure when the other party suffers from the same failure, with no possibility for either of the parties to act in order to avoid the damage.
>
> Thus, in case that de-orbiting would be a mandatory practice, both of the parties would be at fault, since one party did not de-orbit its dead satellite, while the other

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[88] N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 58-60.

[89] See: BBC News: Ecuador Pegasus satellite fears over space debris crash (24 May 2013) http://www.bbc.co.uk/news/world-latin-america-22635671; BBC News: Ecuador tries to fix satellite after space debris crash (27 May 2013) http://www.bbc.co.uk/news/world-latin-america-22678919 (both links were accessed Aug. 22, 2016).

[90] See: PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 118.

[91] See discussion: *CoCoSL II*, 174-175.

[92] See: *infra* section 3.6.

[93] 'The insurance Ecuadorian company Seguros Equinoccial 'has compensated the loss of Pegasus completely and in a very short time', points out the release', see: Ecuador Times: Pegasus satellite was declared 'lost' by EXA (05 September 2013) http://www.ecuadortimes.net/2013/09/05/pegasus-satellite-was-declared-lost-by-exa/ (accessed Aug. 22, 2016).

> party will not de-orbit its small satellite in the future, creating space debris. Similarly, in the case that de-orbiting is not a mandatory practice, like in the present, both parties would not be able to avoid the collision, even if they become aware of it, and hence, in that respect, they are both not at fault.
>
> These conclusions illustrate the failure of the Convention to successfully deal with such situations, as Article III is applicable in theory, yet its application does not seem to provide even a slight indication of the legal result in such a case.[94]

In addition to the conclusions above, I put forward that a clear set of STM rules may make the Liability Convention potentially more effective in collision cases involving small satellites, since these rules can shed a light on whether a party who cannot manoeuvre its otherwise functioning space object is at fault in the meaning of Article III of the Convention.[95]

3.5 Private Ownership and the 'Launching State'

In the words of *Haanapple*:

> In the *corpus iuris spatialis*, the Liability Convention is the only international legal instrument that deals with a private law matter, namely liability, although it only covers the liability of States and that of international organizations. This is so, because, at the time of its negotiation in the early 1970s, few outer space activities by private enterprises were foreseen […][96]

Indeed, an additional factor, which may present a difficulty in the application of the Convention, is the involvement of non-governmental entities. The Convention binds States and not private entities.[97] Accordingly, the dispute resolution process has to be carried out by at least two launching States.[98]

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[94] N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed) *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 60-61.

[95] See in general: A. Soucek, 'Space Traffic Management' ICAO / UNOOSA Symposium, Abu Dhabi, 15–17 March 2016. Available at: http://www.icao.int/Meetings/SPACE2016/Presentations/7%20-%20A.%20Soucek%20-%20ESA.pdf; and for STM analysis in this chapter, see pages 13-14 *supra*.

[96] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 114.

[97] With the only special case of 'international organizations' see: Article XXII of the Convention; B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 310-320; PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 116.

[98] With the exception presented in Article VIII of the Convention, which allows a State which is *not* the launching State to take action under the Convention on behalf of the victim, relaxing the general rule of nationality of claims under international law see: B Cheng, *Studies in International Space Law* (Clarendon

Recalling the above case studies, even if Iridium Corporation, the owner of the damaged satellite, would consider seeking compensation in the way of applying the Convention, it would have to convince one of the launching States to take action on its behalf, invoking the Convention.[99] In this specific case, tracing the 'launching State' would have caused the Convention to be irrelevant with respect to a potential claim on behalf of Iridium.[100] In short, while the satellite's owner is a US legal entity, there is no clear consensus to determine that the US would be one of the launching States only on the grounds of the operator's nationality.[101]

Under the definition in Article I of the Convention, a State which 'launches' or 'procures' the launch is indeed a 'launching State', however, as these criteria remain the subject of on-going interpretation,[102] absent of satellite registration[103] with the United Nations by the US,[104] it is not clear whether the US would be considered as the launching State.[105]

Press 2004) 306-308; for discussion about the terminology of 'launching State' and 'State' in the Convention see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 302-306.

[99] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 200.

[100] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 201-202.

[101] Interestingly, during the drafting process it was the US that suggested that the launching State should include the State which 'owns or controls the space object, irrespective of its participation in the launch' see: *CoCoSL II*, 107-108.

[102] UNGA Res. 59/115 Application of the Concept of 'Launching State' (25 January 2005).

[103] While the satellite was not registered with the UN pursuant to the Convention on Registration of Objects Launched into Outer Space, (1975) 1023 *U.N.T.S.* 15 [hereinafter: 'Registration Convention']. The following information, which refers to all 7 *Iridium* satellites which were launched jointly, can be found: 'On 14 September 1997, seven IRIDIUM satellites were placed in Earth orbit by a single Proton carrier rocket from the Baikonur launch site. The satellites will operate as part of the global personal communications system designed to serve regions with insufficient data-transmission infrastructure and for ensuring communications in the event of natural disasters. The satellites are owned and operated by the Motorola company (United States of America).' See: 'Information Furnished in Conformity with the Convention on Registration of Objects Launched Into Outer Space, Note verbale dated 4 March 1998 from the Permanent Mission of the Russian Federation to the United Nations (Vienna) addressed to the Secretary-General', UN Doc. ST/SG/SER.E/332 (19 March 1998) 2; available at:
http://www.unoosa.org/documents/pdf/ser332E.pdf .

[104] Article II of the Registration Convention implies that the registering State is at least one of the launching States and therefore it is argued that such registration provides with the State's *opinio juris* in relation to its self-recognition as a launching State. While such registration was not executed, the US did register *Iridium 33* on its national register- see: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 255 n 684.

[105] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 201-202; Jakhu seems to accept the notion that the US should be considered as a launching State as the State that procured the launch in this context, however stating: 'though the launch agreement seems to have been privately negotiated by the Iridium Corporation'. See: RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 255; See also PPC Haanappel, 'Enforcing the Liability Convention:

It is clear, that Russia and Kazakhstan would be launching States since the satellite was launched from their 'territory' and 'facilities' respectively.[106]Article V(1) of the Convention provides that: 'Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for any damage caused'. This means that Russia would be both the claimant and the respondent.[107] Article VIII 'makes it clear that the Convention only applies to claims by one state against another'[108] the Convention therefore would not be applicable.[109]

This barrier is rather meaningful when considering the launch practices of small satellites. Under the same Article V(1) the launching States are to agree on arrangements to distribute such joint liability. This issue is also expresses in: UNGA Res. 59/115 Application of the Concept of 'Launching State', [110] which reads in paragraph 2:

> Also recommends that States consider the conclusion of agreements in accordance with the Liability Convention with respect to joint launches or cooperation programmes.

Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 115-116, 118 which submits that private procurement of the launch does not necessarily make the State of the private entity's nationality a State that procured the launch; In this respect, the difference between liability in the sense of Article VII of the Outer Space Treaty and the Liability Convention and responsibility in the sense of Article VI of the Outer Space treaty has to be emphasized, the distinction between responsibility and liability originated in the *Chorzow Factory Case (Germany v Poland)* 1928 PCIJ Ser. A.17 at 29, 47; see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 603-604; F von der Dunk, '*Liability versus Responsibility in Space Law: Misconception or Misconstruction?*' IISL Proceedings of the 34th Colloquium on the Law of Outer Space (1992) 363-371; *CoCoSL II*, 123- 125; N Horbach, *Liability Versus Responsibility Under International Law: Defending Strict State Responsibility for Transboundary Damage* (PhD dissertation, University of Leiden, 1996).

[106] The launch facility in Baikonur is leased by Kazakhstan to Russia, and the facility is managed by the Russian Federal Space Agency. See: T Masson-Zwaan, '*Space Law and the Satellite Collision of 10 February 2009*' in Space Research Today, COSPAR's Information Bulletin no. 174 (2009) 4, 7; F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 202; RS Jakhu, 'Iridium-Cosmos Collision and its Implications for Space Operations' in K-U Schrogl (ed), *Yearbook on Space Policy*: *2008/2009* (Springer 2010) 255; during the drafting process a suggestion was presented making the State(s) that the launch is carried-out from its territory or facilities to be liable on a secondary basis, making the State(s) that launches or procures the launch primarily liable for damage, this was rejected and the Convention does not distinguish between the potential liable launching States, see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 329; *CoCoSL II* 108-109, 146-147.

[107] Since it was clearly the launching State of *Cosmos 2251*, making it the launching State of both of the satellites in question.

[108] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 116.

[109] F von der Dunk, '*Too-Close Encounters of the Third Party Kind: Will the Liability Convention Stand the Test of the Cosmos 2251-Iridium 33 Collision?*' IISL Proceedings of the 52nd Colloquium on the Law of Outer Space (2009) 202, Von der Dunk adds that this would be the case even if the US would qualify as one of *Iridium 33's* launching States; *CoCoSL II*, 130.

[110] UNGA Res. 59/115 Application of the Concept of 'Launching State' (25 January 2005).

In practice however, only few agreements were made by launching States.[111] The State of nationality of the owner of the satellite might not necessarily consider itself as the launching State of the satellite. This position is based on the notion that procuring a launch for the small satellite by a private entity does not amount to the situation in which the State had procured the launch.[112] Following that view, a State may not be willing to register the satellite, since it would display recognition on the State's behalf, of being one of the, potentially liable, launching States.[113]

In cases where the small satellite is the first satellite launched by a national of a certain State, administrative difficulties in implementing the provisions of the space treaties may exist, especially where there is no relevant domestic legislation in place. Not all States that launched space objects are parties to the Registration Convention, and therefore may lack the sense of commitment to register the satellite in question.[114]

When the small satellite is owned and operated by a private entity that procured the launch without involving its government in the process, and the satellite was not registered by the same government, the status of the latter as a launching State may be in the legal grey zone until there will be an effort to sort and define the official position of the State towards the satellite and its international obligations, illustrating that: 'Perhaps one of the most difficult issues concerning the "launching state" is determining which countries fall in to the category of States procuring a launch.'[115]

It is clear, much like in the case of *Iridium 33*, that the State(s) from whose territory or facilities the launch was carried out qualifies as a launching State. Currently, the number of States that offer commercial launch services in general and for small satellites in particular, is rather low.[116] This means that there is a considerable chance that one of the launching States of the small satellite will also be the launching State of the second satellite,

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[111] *CoCoSL II*, 146.

[112] In the context of small satellites see: N Palkovitz and T Masson-Zwaan, *Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws*, IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566.

[113] ibid; In contrast, in some cases States are motivated to register space objects even when they were not involved in the launch of the object, in order to establish a legal link to the space object. See for example the case of the registration of 'Sirius 1' by Sweden following its purchase while already in orbit as evidence to State practice relating to registration: *Schrogl* at 371.

[114] Or the resources to do so and understand the legal consequences of registration; Israel is an example of a space-faring nation that launched multiple space objects, and currently is not a party to the Registration Convention, and does not have a national space law creating a national register of space objects.

[115] K-U Schrogl, 'A New Look on the Concept of the "Launching State"' (2002) 51(3) Zeitschrift für Luft und Weltraumrecht 359, 368; see also: *CoCoSL II*, 114.

[116] For a summary on traditional-global launch capabilities see: HP van Fenema, 'Legal Aspects of Launch Services and Space Transportation' in F von der Dunk and F Tronchetti (eds), *Handbook of Space Law* (Elgar 2015) 382, 384-397; and for new upcoming launchers see: chapter 1, subsection 2.5.4.

which was involved in the collision. This will again exclude the option of presenting claims under the Liability Convention.

It may be argued that in the case of small satellites, the launch is procured by the primary payload, and therefore, the State whose national procured the launch of the small satellite will not be a launching State, since the launch would be carried-out even without the small satellite. This argument should not be accepted since this would negatively affect the willingness of States to recognise their status as launching States, by registering the small satellite.[117] In practice, it is not common for the State that executes the launch to register the small satellites it launches, and therefore this would mean that the objectives of the Registration Convention would not be fulfilled to the fullest extent. Chapter 5 of this study will further elaborate on registration of small satellites.

To conclude, current launch practices, State practice relating to registration of small satellites and the fact that States whose national procured the launch of a certain small satellite do not necessarily consider themselves to be the launching States of that satellite, influence the ability to apply the Convention where damage is caused by or to a small satellite. The issue relating to the legal link between the launching State and the private entity which operates the satellite is not unique to small satellites, however, considering that a single launch may accommodate dozens of small satellites, it is clear that many small satellites are being launched and will be launched in the future, while the uncertainty of their attribution to the State which procured their launch will remain. Chapter 6 of this study includes a potential solution to this problem.

3.6 Procedure for Dispute Resolution under the Convention and Alternatives

Additional arrangements that may imply that the Convention is less likely to be invoked in the context of small satellites are found in the procedure suggested by the Convention.[118] Assuming that the Convention is applicable and the parties elect to solve the dispute accordingly, the following procedure is provided: Firstly, the Convention calls for diplomatic negotiations;[119] if these fail to produce a solution a Claims Commission may be formed.[120] The decision of the Commission enjoys a final and binding status, only in case that the parties so agreed.[121] This structure seems most likely to be relevant to disputes at a very significant scale. In the words of *Haanappel*:

[117] For the connection between registration and liability see *supra* note 104.
[118] For commentary see: B Cheng, *Studies in International Space Law* (Clarendon Press 2004) 334-354.
[119] Articles IX and XIV of the Convention.
[120] Article XIV of the Convention.
[121] Article XIX(2) of the Convention; during the negotiations on the Convention's provisions, the US was in favour of a binding force, in contrast to the USSR see: PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005)

> Whatever the shortcomings of the Liability Convention 1972 may be, it seems worthwhile to retain it as an umbrella Convention whereby the contracting States of the world guarantee to indemnify major damage done on earth or its surrounding environment by major outer space disasters, and it may be unwise to tinker with the Convention by attempting to amend it. Certainly, a lot of liability forms lie outside the scope of the Convention […][122]

When damage is limited and at least one of the parties is a private-commercial entity, other procedures may be more fitting than engaging in diplomatic negotiations between States, such as establishing a special *ad hoc* body which will render a decision which may, or may not, be binding. In fact, contrary to most dispute resolution procedures under international law,[123] the Convention in Article XI(1), clarifies that the parties may invoke the Convention with no need for 'prior exhaustion of any *local remedies* which may be available to a claimant State or to natural or judicial persons it represents.'[124] The Convention is therefore not exclusive to disputes relating to damage caused by space object(s),[125] and private entities are generally free to solve such disputes according to the applicable law and forum, which they have elected.

An additional possibility is to follow the Optional Rules for Arbitration of Disputes Relating to Outer Space Activities as adopted by the Permanent Court of Arbitration, which allow the involvement of private entities.[126]

The two abovementioned alternatives provide rules and mechanisms for the settlement of the dispute, while the Convention merely provides a procedure related to settling disputes in connection to its own application.[127] Indeed the 'umbrella' which the Convention creates

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117; Several States have made declarations accepting the binding force of the Claims Commission see PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 119.

[122] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 118; Smith and Kerrest note in the context of Article III: 'This too is a reminder of the Convention's aim of introducing a victim-oriented liability scheme for third parties who suffer damage as a result of space activities, whereas those under-taking space activities are seen as having accepted the risks involved in such activities.'. *CoCoSL II*, 134.

[123] F Lyall and PB Larsen, *Space Law: a Treatise* (Routledge 2009) 111.

[124] Article XI(2) of the Convention provides that the parties will avoid making the same claim for the same damage in parallel proceedings.

[125] *CoCoSL II*, 168.

[126] The Rules are available for download at the following link: https://pca-cpa.org/wp-content/uploads/sites/175/2016/01/Permanent-Court-of-Arbitration-Optional-Rules-for-Arbitration-of-Disputes-Relating-to-Outer-Space-Activities.pdf .

[127] *CoCoSL II*, 170.

to shelter the parties is rather limited in the sense that issues relating to applicable law remain outside of its scope.[128]

The above observations lead to the conclusion that the procedure included in the Convention might not be suitable for cases where damage was caused to or by a small satellite as far as the scale of the damage is low, and especially when the operator is a private entity.

3.7 Intermediary Conclusions

This third section has identified and analysed three main legal difficulties with respect to the application of the Liability Convention in the context of small satellites.

The first difficulty is the legal uncertainty around the notion of fault in Article III of the Convention. Since the main risk relating to small satellites activities is collisions in outer space, Article III is very relevant in case such a collision resulted in damage. As seen in section 3.4, the uncertainty related to fault liability in this context is so great, that it is unclear what kind of conducts will result in fault by a certain party. This has been illustrated by examining satellites collision cases, one that involved a small satellite as well as a case of collusion between two traditional satellites, which offered an analogy to the case of non-manoeuvrable small satellites.

The second legal difficulty in applying the Liability Convention is derived from the nexus between the Convention and the launching State, as was analysed in section 3.5. In many cases, small satellites operators are non-governmental entities, and as such are dependent of one of their satellite's launching States to pursue a legal proceeding against another State, in order to recover their damage as a private, and often commercial entity.

The third difficulty lies in the cumbersome procedure of establishing a Claims Commission according to the dispute settlement provisions of the Convention as analysed in section 3.6. This type of procedure is unfitting to cases where the damage is of a limited scale, as relevant to small satellites operations. It does not fit to protect commercial interests and seems non-binding in its nature unless the parties agree otherwise.

Therefore, it is concluded that the Liability Convention does not offer a clear, certain and legally practical framework in case compensations are due as a result of a collision event involving a small satellite, and especially in the case of privately owned small satellites. In that sense the author submits that the Convention is legally ineffective and has a very low probability of being invoked in the situations described in this third section.

[128] *CoCoSL II*, 170, 174-175.

The following question is: *does this previous conclusion merit special treatment for small satellites as far as liability is concerned?*

Before answering this question in the final conclusions of this chapter 4, the next section will present third party liability and property insurance as a practical financial solution for the small satellites industry, to recover potential damages in an alternative way to the Convention as explained below.

4. Third Party Liability Insurance and Other Insurance Policies for Small Satellites

4.1 Introduction to Space Insurance

Experts from the satellite insurance market offered the following definitions for space insurance:

> 'Space insurance' is defined as a specialized niche market in which fall all insurance contracts designed for protecting against the financial consequences of events occurring between the lift-off of the satellite and its end of life. This definition excludes insurance against the risk of damage on the launch pad or the risk of damage occurring while the satellite is being transported from its factory to the launch site. The liability incurred by a party while its satellite is launched or already orbiting is part of the space insurance domain.[129]

And more specifically in the context of small satellites:

> Space insurance is a type of insurance specifically dedicated to space activities including launch and on-orbit operations. These insurances shall take into account the space activities' specificities. As of today, such insurance (mainly property damage insurance) is the third biggest cost of a commercial launch. With respect to small satellites' exposure, due to their technical nature, the limited scope of activity involved, and the volatility of the risk, not all insurers are willing to underwrite such space risks. Nonetheless, about 35 insurance companies acting worldwide offer such dedicated space insurance.

[129] P Montpert, 'Space insurance' in LJ Smith and I Baumann (eds), *Contracting for Space: Contract Practice in the European Space Sector* (Routledge 2011) 283.

> As there is no legal definition of small satellites, the crucial question would be to know whether these satellites should be treated differently from more standard satellites.[130]

Indeed, the question that *Gaubert* poses is at the core of the present study, namely: should small satellites be treated differently than traditional satellites, also when it comes to satellite insurance?

In the author's experience, when examining practice, the answer is positive.[131] In order to understand better what is insurance in the scope of this section, the different types of satellite insurance will be explained below, starting with the most important one in terms of liability and the Liability Convention- third party legal liability insurance. Later, other insurance policy types- property damage insurance, will be shortly introduced, as they are often used as financial tools in a commercial context, and therefore, these, unlike third party legal liability insurance, are not mandatory for operators by national space legislation.

4.2 Space Insurance Relevant to Small Satellites

4.2.1 Third Party Legal Liability (TPLL) Insurance

As I have explained earlier:

> Third party liability insurance is generally very common on Earth, and the intention behind this concept of liability is the protection of innocent third parties (meaning parties which are not directly involved in the damaging event or activity) and allowing the compensation of such parties in case damage was caused to them by a certain activity.[132]

The international liability regime prescribed by Article VII of the Outer Space Treaty and the Liability Convention is analysed in section 3 of this chapter, and therefore, without the need to repeat the specificities of this regime, it is stated that the stipulations of Article VII and the Liability Convention are regarded as the reason to insure space objects against damage which they may cause to third parties.[133]

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[130] C Gaubert 'Do Small Satellites Need Insurance?' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 369-370.

[131] See the discussion in the author's previous work: N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47 under the section: Third Party Liability Insurance for Small Satellites Activities.

[132] N Palkovitz 'New Insurance Products for the Launch of Small Satellites' *Proceedings of the 4S Symposium* (2016) Malta.

[133] See for further explanation: T Masson-Zwaan, *'Liability and Insurance for Suborbital Flights'*, Proceedings of the 5th IAASS Conference 'A Safer Space for a Safer World', Versailles, France 17–19 October 2011, under section 4.1 (ESA SP-699, January 2012); available at: https://core.ac.uk/download/pdf/15606188.pdf .

The space treaties do not include any provisions about insurance, which means that the launching States of a particular space object are liable for damage it may cause regardless of whether TPLL insurance is available or not. States have enacted national space laws including mandatory TPLL insurance obligations.[134] Such obligations are included in order to make sure that private operators will be able to indemnify their State of nationality in case the State is found liable to compensate another State for damage caused by the operator's space object:

> According to the international rules, the launching state may be liable in case of damage caused to third parties due to the small satellite activity at the origin of the damage, even though the activity is carried out by a private entity. However, these international rules do not tie the liability regime they set forth to any insurance obligation.
>
> Therefore, the obligation to insure, if any, is set up by relevant national legislation. Only a few dedicated national space legislations contain insurance obligations in respect of satellites. In most cases (if not all of them), such insurance or financial guarantee concerns third-party liability and not property damage insurance.[135]

Small satellites operators who are obliged to procure TPLL insurance by applicable domestic law, or operators who voluntarily wish to manage the risk of having to compensate third parties in case their small satellite causes damage, have to negotiate the procurement of a suitable insurance policy.

> The procurement of such an insurance policy means that the operator would have to pay a certain premium in order to secure the coverage of the damage, which is usually limited in a specific amount. A high amount of coverage will usually mean a high premium as well, and vice versa.[136]

Since the space treaties do not limit the liability of the launching States to damage caused by the relevant space objects, in principle, the exposure to liability is unlimited.[137] Although this is the situation, States do prescribe a minimal amount to be insured by the

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[134] For instance: the UK, Austria and the Netherlands see in the context of small satellites: N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47 under the section: Third Party Liability Insurance for Small Satellites Activities.

[135] C Gaubert 'Do Small Satellites Need Insurance?' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 370.

[136] N Palkovitz, 'New Insurance Products for the Launch of Small Satellites' *Proceedings of the 4S Symposium* (2016) Malta.

[137] The Convention does not include limitation of liability *CoCoSL II*, 113.

operator. This means that in case the damage is higher than the sum insured by the operator, the State will have to pay the remaining sum to the victim State. [138]

In the context of launch services providers it was already noted that:

> In order to protect themselves in light of the limited information available to them, these States may set insurance requirements that are unreasonably high and burdensome on the launch service provider.[139]

In the case of small satellite operators, the burden is even heavier due to the lack of proportionality between the minimal amount to be insured and the cost of the space operation. The risk for damage is reasonably assumed to be lower[140] as compared to other traditional space activities; however, in some cases the same insurance requirements are applicable to regulated space activities in general.[141] Finally, in some cases the small satellite operator will lack the needed monetary resources to procure such insurance, since some of the missions are not commercial but rather educational or scientific, and hence the need to adjust the insured amount according to the lower risks. The government of The Netherlands has already accepted lower amounts for the mandatory TPLL insurance of small satellites.[142]

The author further observes that this type of insurance policy functions as a compliance tool. The policy itself contains provisions, which are in line with the Liability Convention, while national space laws are being introduced by States so the latter will be compliant with its international obligations, namely the provisions of the Outer Space Treaty and the Liability Convention. Hence, an operator who procures a TPLL policy is compliant with the provisions of its national space law or policy,[143] and enhances the State's compliance with the space treaties, since Article VI of the Outer Space Treaty stipulates the duty of the States parties to ensure that domestic private space activities are in line with the provisions of the Outer Space Treaty.[144] This means that by imposing TPLL insurance obligations on operators the State ensures that it will have the financial means to compensate potential third party victims.

4.2.2 Types of Property Damage Insurance Relevant to Small Satellites:

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[138] See examples in: Schematic Overview of National Regulatory Frameworks for Space Activities, UN Doc. A/AC.105/C.2/2013/CRP.7 (09.04.2013), available at: http://www.oosa.unvienna.org/pdf/limited/c2/AC105_C2_2013_CRP07E.pdf (accessed Aug. 22, 2016).

[139] K-U Schrogl, 'A New Look on the Concept of the "Launching State"' (2002) 51(3) Zeitschrift für Luft und Weltraumrecht 359, 369 n 19.

[140] Especially in the context of Article II of the Convention, see risk analysis: *supra* at 6-8.

[141] N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47 under the section: Third Party Liability Insurance for Small Satellites Activities.

[142] ibid.

[143] In case these are in place.

[144] See chapter 2 on State responsibility for further analysis of this duty under Article VI.

Unlike TPLL insurance, the following types of insurance policies do not enhance compliance with legal instruments. Instead, they serve a commercial function, insuring the satellite itself against physical damage, or against cases where it cannot perform its mission once in orbit. In that sense they can be regarded as financial tools, which the operator may elect to obtain. Below are three main types of space insurance policies aimed to secure a financial interest:

> *Pre-launch insurance*: This type of insurance coverage may commence by covering the shipment of the satellite from the owner's or manufacturer's facilities to the launch services broker, and/or launch site. It may include coverage against possible damage that can be caused to the satellite during shipment, integration on the launch vehicle and other processes and activities, up to the launch event.
>
> *Launch failure insurance*: Launch activities are still considered to be risky, in the sense that the launch vehicle may be unsuccessfully ignited or launched, causing the loss of the payload(s) on board. Insuring a small satellite against such an unfortunate occurrence will allow the owner to recover its value in case of a failure. Therefore, subject to the policy terms, the owner may be reimbursed with sums, which will allow her or him to re-build a new satellite and procure another piggy-back launch, without the need to resort to a new financing source for the project.
>
> *Insuring the small satellite mission*: it is possible to insure a satellite in terms of capability to carry out its mission. An example would be reception of data from the satellite. This type of insurance is very relevant to commercial missions, however, may not be suitable for educational missions utilizing small satellites.[145]

To conclude, although the above mentioned insurance types are not required by law, operators may use them in order to mitigate financial risks holistically.

4.3 Space Insurance for Small Satellites- Example for Industry Practice

Space insurance, such as the policies that are mentioned in section 4.2 above, were available to cover risks relating to traditional satellites decades ago. Small satellites, however, are different from traditional satellites, in ways that have implications for their operator's and launching States' liability.[146]

This situation led to inaccessibility of the insurance market to small satellites operators. Additionally, insurers knew traditional established players in the satellite market but were unfamiliar with the 'new space' players who were a different crowd. Since small satellites

[145] N Palkovitz 'New Insurance Products for the Launch of Small Satellites' *Proceedings of the 4S Symposium*, (2016) Malta.
[146] See *supra* section 2.

started as an educational non-commercial platform, it seemed that there was no 'market' for insuring these satellites.

Only in recent years, insurance policies for small satellites were actually placed, after a long process, which led to the insurers to be familiar with the satellites and the risks they potentially pose. Existing typical policy-terms were adjusted to provide an optimal market solution for small satellite operators. The author initiated the described process and negotiations on behalf of ISIS- Innovative Solutions In Space B.V. (ISIS) and ISL-Innovative Space Logistics B.V. (ISL), both Dutch companies belonging to the ISIS Group which manufactures small satellites and arranges for their launch.[147]

In 2013 ISIS and ISL together with Willis InSpace (Willis) a large space insurance broker, placed a TPLL insurance policy to cover three Dutch CubeSats, being pioneers in the small satellite insurance market. 'Triton-1' belonging to ISIS, 'Delfi n3Xt' of The Technical University of Delft and 'FUNcube-1' of AMSAT-NL were insured against third party liability risks up to 20M Euros.[148] In space insurance market terms, this amount is considered to be unusually low, making the premium affordable for the small satellites operators.

The insurance was procured to satisfy a requirement made by the Dutch government via the Ministry of Economic Affairs, as a condition to the government's approval to launch the Dutch small satellites. At that time, the Dutch Space Act, which makes TPLL insurance mandatory for Dutch satellite operators, was in force, however, it did not apply to small satellites activities in The Netherlands prior to an administrative decree, which made the Act applicable to Dutch small satellites activities.[149]

As the small satellites market continued to develop, so did the available insurance for these satellites. With the realisation that operators aim to launch more than one small satellite in order to gain better coverage of Earth when executing communication and observation missions, ISIS, ISL and Willis developed a 'declaration based' TPLL insurance policy, the first in the world which is adapted for small satellites. The policy was first placed during 2015, and as the author explained:

> This type of declaration based policy means that a number of satellites are insured under the same policy terms, with the ability to add or omit satellites under it. This is a perfect insurance solution for small satellite swarms and constellations.[150]

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[147] See the ISIS Group website: http://www.isispace.nl/.

[148] N Palkovitz and T Masson-Zwaan, '*Small but on the Radar: The Regulatory Evolution of Small Satellites in The Netherlands*', IISL Proceedings of the 58th Colloquium on the Law of Outer Space (2016) 601, see under *'Ad Hoc Adjustments'*.

[149] N Palkovitz and T Masson-Zwaan, '*Small but on the Radar: The Regulatory Evolution of Small Satellites in The Netherlands*', IISL Proceedings of the 58th Colloquium on the Law of Outer Space (2016) 601.

[150] N Palkovitz 'New Insurance Products for the Launch of Small Satellites' *Proceedings of the 4S Symposium* (2016) Malta.

The practical advantage of this insurance arrangement is the fact that the operator will have to negotiate the policy terms once, with the flexibility of adding new satellites and removing older satellites, which finished their mission. This model makes the insurance coverage more affordable to the operator as well, which in the small satellites industry is considered to be a key advantage.

Similar advancements were made with respect to property damage insurance types. As small satellites technology and applications become more complex, the demand to insure the satellites themselves became greater, together with the need to insure their innovative capabilities. Accordingly, the author was involved in placing the policies which are mentioned above in sub-section 4.2.2 for small satellites, as was never done before for such small CubeSats.

As the author previously concluded:

> It is expected that with this trend there will be more demand for insuring small satellites, which will make the space insurance market more accessible for small satellite operators.[151]

The combination of third party liability insurance and property insurance allow private entities to gain some control over the legal and financial proceedings in case they cause or suffer damage, since they interact with other commercial entities- the insurers, and not only with the launching States concerned.

5. Conclusions

The three cases discussed in this chapter, namely, the re-entry of *Cosmos 954*, *Iridium 33-Cosmos 2551* collision and the *Pegaso*-debris collision, illustrate that even when damage is caused by space objects, the launching States would probably choose not to invoke the Liability Convention in order to bring a claim for compensation. Even if the Convention could be invoked, its application might not result in a clear binding decision setting the liability of one party to the other party, rendering the Convention ineffective.

In this respect, apart from concluding that the Liability Convention probably has little relevance for the case of small satellites, as it is not likely to be invoked in this context, it is further concluded that the technological revolution hailed by small satellites may mark the need for the legal field to react accordingly. In the words of *Haanappel*: 'the Liability

[151] ibid.

Convention is a child of its time'[152] and clearly, the drafters of the Convention were facing a very different reality of space activities, during the Cold War era.

One of the sources of the legal uncertainty around the Liability Convention is the notion of fault in satellite collision cases. Setting internationally binding STM rules will eliminate some of the legal uncertainty in connection with collisions in outer space, especially in the case of non-manoeuvrable small satellites.[153] These rules would make the Liability Convention effective in determining the fault of the parties, making the Convention more likely to be invoked. Further, the application of such rules may result in more insurance products becoming available, since the risk assessment would be based on these rules, making insurance more affordable for small satellite operators.

Therefore, it is possible to overcome this legal difficulty with supplementary external international traffic rules, with no need to amend the Convention. While the Convention will not be amended and stay generally applicable to all space objects, the space traffic rules will be specific to small satellites in LEO, as suggested by the recent IAA study,[154] and thus, may create a specific fault-based liability regime for such.

Another obstacle, which would be harder to overcome, is related to the need to turn to the launching State in case damage was caused to a privately-owned satellite. As *Masson-Zwaan* concludes:

> Despite all this, it must not be forgotten that, in the end, political circumstances and considerations might well prevent a government from presenting a claim to another government to obtain compensation for damage it, or one of its private entities, has suffered.[155]

Having to totally depend on the ever-changing political climate of certain States is suboptimal when considering commercial interest of satellite operators. Yet, there is a need to adjust to a reality in which private entities are the majority of satellite operators. This problem calls for examination of specific solutions, which will alter the 'launching State-to-launching State' legal interface. It would be commercially beneficial and practical to allow non-governmental entities to actively participate in space- legal proceedings related to liability, under the umbrella of international law.

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[152] PPC Haanappel, 'Enforcing the Liability Convention: Ensuring the Binding Force of the Award of the Claims Commission' in M Benko and K-U Schrogl (eds), *Space Law: Current Problems and Perspectives for Future Regulation* (eleven international publishing 2005) 113.
[153] See discussion *supra* at 13-15.
[154] See *supra* note 64.
[155] T Masson-Zwaan, 'Space Law and the Satellite Collision of 10 February 2009' (2009) *Space Research Today*, COSPAR's Information Bulletin no. 174 at 9.

Currently, the *lex specialis* does not recognise the difference between types of activities in outer space. Perhaps the time has come to consider a distinction between space activities as far as liability is concerned, at the international regulatory level. Chapter 6 includes a suggestion to such a regime, specific to small satellites. In case this path will be chosen, it is submitted that the potential risk attached to the activity, as well as its benefits should be considered. Certainly, a physical distinction relating to satellite-dimensions may be effective for the shorter-run; nonetheless, considering the activity's characteristics instead may create a solution that will be relevant in the future.

For now, taking insurance in order to mitigate the risks in the context of legal uncertainty should be seen as a sound solution. As illustrated in the case of the *Pegaso*-debris collision, small satellite operators have a good reason to maintain both third party liability and property insurance, since this seems to be the most probable channel for them to receive compensation in case of a collision with another space object.

After considering and analysing international State responsibility and liability for small satellites activities, the next chapter will be dedicated to the third pillar which connects the first two - registration of small satellites, according to Article VIII of the Outer Space Treaty and the Registration Convention.

Chapter 5: Registration of Small Satellites

1. Introduction

The registration of small satellites is burdensome on their operators and potential States of registry for several of reasons: first, registration is carried out by States rather than private entities, thus, operators must rely on a State to complete this procedure; secondly, at times there is a difficulty to identify the State which should function as the State of registry; third, small satellites are developed, launched, and end their missions very quickly when compared to traditional satellites and thus, States are reluctant to register them since their mission may end before the State has completed the registration process; and lastly, not all States developed appropriate registration practices, which may present a problem to the private operator trying to get its small satellite registered.

Moreover, the legal framework and specific provisions of the Outer Space Treaty[1] and the Registration Convention,[2] concerning the registration process, are somewhat open to different interpretations.[3] These two points were eloquently captured by *Marchisio*, referring to the Outer Space Treaty, as follows:

> The need to reinterpret the Treaty is emphasized mainly where the traditional interpretation could increase the private sector requirements, as in the case of the principles of non-appropriation of space natural resources, the responsibility for damage caused by space objects or *the obligation to register small satellites*.[4]

[1] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967) 610 *U.N.T.S.* 205 (1967). (Hereinafter: 'Outer Space Treaty').
[2] Convention on Registration of Objects Launched into Outer Space, (1975) 1023 *U.N.T.S.* 15 (hereinafter: 'Registration Convention').
[3] S Hobe, B Schmidt-Tedd and K-U Schrogl (eds), *Cologne Commentary on Space Law vol. II Rescue Agreement, Liability Convention, Registration Convention, Moon Agreement* (Carl Heymanns Verlag 2013). (Hereinafter: 'CoCoSL vol. II') 260.
[4] 10th United Nations Workshop on Space Law 'Contribution of Space Law and Policy to Space Governance and Space Security in the 21th Century' 5-8 September 2016 Vienna, Opening Panel: Welcome Addresses and Keynote Speeches Space Law and Governance by Sergio Marchisio, available at: http://www.unoosa.org/pdf/SLW2016/Opening/2. Marchisio MARCHISIO 10th United Nations Workshop on Space Law.pdf.

This chapter will examine and analyse the difficulties in registering small satellites. Section 2 shall examine the international legal framework including obligations relating to the registration of space objects. This will be done by referring to the international legal instruments in their chronological order, and referring to their implementing legal tools and documents.

Section 3 shall explore specific challenges connected to the registration of small satellites. This section refers to the satellites' characteristics, their launch service providers and State practice.

Section 4 shall present two case studies, each of which illustrates the lack of coherent State practice by examining small satellites' missions and their registration or lack thereof. The research will produce academic findings, while it is based on industry and State practices, as these are reflected in UN official documents and other forms of publicly available information.

Finally, section 5 concludes the findings of this chapter concerning the registration of small satellites.

2. Registration of Space Objects- The International Legal Framework

2.1 Overview

The legal framework concerning registration will be analysed in this section 2. Section 2.2 shall begin by examining how the obligation to register space objects has developed chronologically.

The first legal concept of space objects' registration is found in UNGA Resolution 1721B (XVI) of 20 December 1961, that is, at the very inception of the space age.[5] Article VIII of the Outer Space Treaty includes that concept in terms of a legally binding obligation on State Parties. The Registration Convention elaborates the obligations, procedures and legal arrangements connected to registration of space objects. Further, UNGA Resolution 62/101 of 17 December 2007[6] emphasises and refers to provisions of the Registration Convention in a more contemporary perspective, with the aim of enhancing the registration of space

[5] UNGA Res. 1721B (XVI) International Co-Operation in the Peaceful Uses of Outer Space (20 December 1961).
[6] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007).

objects. Finally, UNGA Resolution 68/74 of 11 December 2013 elaborates on the need to implement international registration obligations in national space laws.

In all cases, registration is linked to the concept of 'jurisdiction and control' and with that it presents the nexus between the space object and its State of registry.[7] Such State has the right and obligation to exercise its jurisdiction and control over that object and personal thereof, even while in outer space.[8]

Section 2.3 shall refer to documents and other instruments, which were developed by the UN in order to implement the obligations set out in the international legal framework mentioned in section 2.2.

Section 2.4 shall conclude the examination and analysis of this section.

2.2 The Obligation to Register Space Objects

2.2.1 UNGA Resolutions Prior to the Space Treaties

As mentioned in section 2.1 above, the first indication of the need to register space objects is found in UNGA Resolution 1721B (XVI) of 20 December 1961:

> *The General Assembly,*
> *Believing* that the United Nations should provide a focal point for international co-operation in the peaceful exploration and use of outer space,
> 1. *Calls upon* States launching objects into orbit or beyond to furnish information promptly to the Committee on the Peaceful Uses of Outer Space, through the Secretary-General, for the registration of launchings;
> 2. *Requests* the Secretary-General to maintain a public registry of the information furnished in accordance with paragraph 1 above;
> 3. *Requests* the Committee on the Peaceful Uses of Outer Space, in co-operation with the Secretary-General and making full use of the functions and resources of the Secretariat;
> (a) To maintain close contact with governmental and non-governmental organizations concerned with outer space matters;

[7] See for analysis, subsection 2.2.2 *infra*.
[8] In the words of Article VIII of the Outer Space Treaty: 'A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.'

> (b) To provide for the exchange of such information relating to outer space activities as Governments may supply on a voluntary basis, supplementing but not duplicating existing technical and scientific exchanges;
> (c) To assist in the study of measures for the promotion of international co-operation in outer space activities; [9]

The text of the Resolution makes clear that the main rationale for registering space objects is to promote exchange of information and international cooperation, hence, registration was primarily a confidence building measure. States that did not ratify the Registration Convention rely on this Resolution as a legal basis to furnish information regarding their space objects.[10]

Two years later, Resolution 1962 (XVIII) of 13 December 1963, introduced a more developed concept of registration, in its Principal 7:

> The State on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and any personnel thereon, while in outer space. Ownership of objects launched into outer space, and of their component parts, is not affected by their passage through outer space or by their return to the earth. Such objects or component parts found beyond the limits of the State of registry shall be returned to that State, which shall furnish identifying data upon request prior to return.[11]

The text introduces the link between registration of space objects and the concept of States' jurisdiction and control over such objects. It also clarifies that ownership rights in space objects are not affected by their voyage to space and back to Earth. Finally, it stipulates that said ownership extends to the right to claim the return of the objects in case they are found outside the territory of their State of registry.

These provisions are further developed in the Outer Space Treaty and Registration Convention, which made these concepts legally binding.

2.2.2 Article VIII of the Outer Space Treaty

[9] UNGA Res. 1721B (XVI) International Co-Operation in the Peaceful Uses of Outer Space (20 December 1961).
[10] See section 3.2 *infra*.
[11] UNGA Res. 1962 (XVIII) Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (13 December 1963).

The Outer Space Treaty has elevated the obligation to register space objects to a legally binding status. Article VIII of the Treaty includes such obligation:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Clearly, this text bears resemblance with the text of principle 7 of Resolution 1962 (XVIII), quoted above.[12]

In the context of the Outer Space Treaty, Article VIII comes right after Articles VI and VII, which provide for State responsibility and liability in connection to space activities and space objects.

The concept of 'jurisdiction and control' is at the core of Article VIII and more generally the obligation to register space objects. It relates to Article VI since it is 'the baseline for ensuring the fulfilment of State Parties' international responsibilities.'[13]

The concept of State 'jurisdiction' appears in Article 2(7) of the *UN Charter*:

> Nothing contained in the present Charter shall authorize the United Nations to intervene in matters which are essentially within the domestic jurisdiction of any state or shall require the Members to submit such matters to settlement under the present Charter; but this principle shall not prejudice the application of enforcement measures under Chapter Vll.[14]

The principle of State jurisdiction was also the subject of international case law, in *PCIJ* and *ICJ* judgments, such as the *Lotus Case,*[15] *Nottebohm Case,*[16] and *Barcelona Traction*

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[12] For analysis of the similarities and drafting history see S Hobe, B Schmidt-Tedd and K-U Schrogl (eds), *Cologne Commentary on Space Law vol. I Outer Space Treaty* (Carl Heymanns Verlag 2009). (Hereinafter: 'CoCoSL vol. I')148-150.

[13] *CoCoSL vol. I*, 157 para 49, and 158.

[14] United Nations, *Charter of the United Nations*, 24 October 1945, 1 UNTS XVI, available at: http://www.un.org/en/charter-united-nations/ .

[15] *Lotus Case (France v Turkey)* (1927) P.C.I.J., Ser. A, No. 10.

[16] *Nottebohm Case (Liechtenstein v Guatemala)*, I.C.J. Reports (1955) 4. For analysis in the context of this study see: chapter 3 subsection 2.1.1.

Case,[17] which all reaffirm the principle's *customary* status. Thus, State jurisdiction is a fundamental concept in public international law.[18]

Cheng classifies three different types of State jurisdiction in public international law.[19] The first, *territorial jurisdiction,* is the State's power to apply and enforce its laws by virtue of its territorial sovereignty, and under its governmental authority.[20] The second type of jurisdiction is *personal jurisdiction,* where a State has the power to apply and enforce its laws on individuals and other legal entities who are the States' nationals.[21] The third type, *quasi-territorial jurisdiction,* has elements of both *territorial* and *personal jurisdiction*. *Quasi-territorial jurisdiction* is the State's power to apply and enforce its laws on vessels, aircraft and space objects in an *exterritorial* manner. Jurisdiction is established in these cases by registering the object, or by virtue of the object's nationality.[22] In this sense, the State has the ability to apply and enforce its laws over space objects, which are under its jurisdiction, even if these objects are in outer space.

'Control' is understood as a more practical element relating to jurisdiction. It may imply the State's ability to direct, stop, modify or correct the mission of its space object.[23] Control is linked to jurisdiction and refers to the situation where a State controls the space objects under its jurisdiction.[24]

According to Article VIII the State of registry 'shall *retain* jurisdiction and control' over the space object. This means that there is a *fundamental assumption that the State of registry already has jurisdiction and control over the space object prior to its launch*. It is therefore clarified that such legal status does not change even if the objects is no longer subject to the State's *territorial* jurisdiction, since it is in outer space. Article VIII goes further and clarifies that the same legal assumption is applicable regarding ownership: 'Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space […].'

2.2.3 The Registration Convention

[17] Case Concerning the *Barcelona Traction Light Power Company, Limited (Belgium v Spain)*, I.C.J. Reports (1970) 4. For analysis in the context of this study see: chapter 3 subsection 2.1.1.
[18] B Cheng, *Studies in International Space Law* (Clarendon Press 1997) 72.
[19] The main elements of this classification are available in a table form, ibid, 76-78.
[20] ibid.
[21] ibid, at 73.
[22] ibid, at 73, 86.
[23] G Lafferranderie, 'Jurisdicton and Control of Space Objects and the Case of International Intergovernmental Organizations (ESA)' (2005) Zeitschrift für Luft- und Weltraumrecht 228.
[24] *CoCoSL vol. I*, 157.

The Registration Convention, which entered into force on 15 September 1976, has been ratified by 67 States to date.[25] It is a legal instrument fully dedicated to the registration of space objects. Article VIII of the Outer Space Treaty was further elaborated into a short Convention, which contains information on the obligation to register space objects.[26]

The Convention includes definitions in its Article I:

> (a) The term 'launching State' means: (i) A State which launches or procures the launching of a space object; (ii) A State from whose territory or facility a space object is launched;
>
> (b) The term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof;
>
> (c) The term 'State of registry' means a launching State on whose registry a space object is carried in accordance with article II.'[27]

The term 'launching State' is analysed in the context of small satellites in section 3.5 of chapter 4. The term 'space object' is analysed in relation to small satellites in subsection 2.3.3 of chapter 2. These two definitions are identical to the ones in the Liability Convention.[28]

The definition of the term 'State of registry' is formulated by the Registration Convention for the first time. Article II of the Registration Convention further clarifies the connection between the launching State and the State of registry, specifying in paragraph 1 that the State of registry is one of the launching States of a certain space object. It specifies in paragraph 2 that where there is more than one launching State, the launching States 'shall jointly determine which one of them shall register the object […]'. It then refers to Article VIII of the Outer Space Treaty and repeats the notion that the State of registry retains jurisdiction and control over the space object.[29]

Article II(2) further specifies that its provisions are: '[…] without prejudice to appropriate agreements concluded or to be concluded among the *launching States* on *jurisdiction and control* over the space object and over any personnel thereof.'

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[25] Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2018, UN Doc. A/AC.105/C.2/2018/CRP.3 at 10 (2018); available at:
http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2018_CRP03E.pdf .

[26] For negotiation and drafting history see: *CoCoSL vol. II*, 244.

[27] These definitions in (a) and (b) are identical to the ones in the: Convention on International Liability for Damage Caused by Space Objects, (1972) 961 *U.N.T.S.* 187. (Hereinafter: 'Liability Convention').

[28] *CoCoSL vol. II*, 244.

[29] For extended commentary see: *CoCoSL vol. II*, 251-257.

This clarification strengthens the connection between the provisions of Article VIII of the Outer Space Treaty and Article II of the Registration Convention. When reading the two together, the main legal assumption seems to be that *at least one of the launching States had jurisdiction and control over the space object*, which it shall *retain* even when the object is in outer space, *unless it concluded agreements with the object's other launching States* which indicate that *another launching State will have jurisdiction and control over the object while it is in outer space*.

Sections 3 and 4 below will analyse and explain why the pre-launch assumption of jurisdiction and control, combined with the reference to the launching State cause legal uncertainty and non-consistent State practice with respect to registration of small satellites.[30]

In relation to registration procedures, paragraph 1 provides that States shall maintain a registry, meaning on a national level,[31] and that 'Each launching State shall inform the Secretary General of the United Nations of the establishment of such a registry.' Paragraph 3 adds that: 'The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned.' This means that national space registers can take many different forms.[32]

Article III states that 'The Secretary-General of the United Nations shall maintain a Register in which the information furnished in accordance with article IV shall be recorded.' It further elaborates that 'There shall be full and open access to the information in this Register.' Currently, this Register is publicly accessible online at the UN OOSA website under the name 'Online Index of Objects Launched into Outer Space'.[33]

Article IV(1) specifies what kind of information States should furnish to the Secretary-General of the United Nations:

> (a) name of launching State or States;
>
> (b) an appropriate designator of the space object or its registration number;
>
> (c) date and territory or location of launch;
>
> (d) basic orbital parameters, including:
>
> (i) nodal period;

[30] For comprehensive analysis of the term 'launching State' see also chapter 4, section 3.5.
[31] *CoCoSL vol. II*, 251.
[32] *CoCoSL vol. II*, 260; For the notification process relating to national registers see subsection 2.4.3 *infra*; for registration practices in the context of small satellites see sections 3 and 4 *infra*.
[33] UN OOSA's Website http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=; see subsection 2.3.2 *infra* for more information about the index.

(ii) inclination;

(iii) apogee;

(iv) perigee;

(e) general function of the space object.

This information is considered basic and general.[34] The information should be furnished 'as soon as practicable'. Since this is the only indication of the instructed timeframe to register space objects, and since the wording is vague, States have developed different practices in relation to registration timeframes.[35]

There are also different practices to providing information on the general function of the space object. While most States describe the function in two words, for example, 'Telecommunication Satellite', others furnish more information about the object's mission, mass and specify which instruments are onboard.[36]

Paragraph 3 of Article IV adds that:

> Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit.

Meaning, that while there is no de-registration procedure, States should notify the Secretary-General about space objects which are no longer in orbit.[37]

Although the Convention is the most comprehensive legal instrument dealing with the registration of space objects, elaborating on the obligation to register and the associated procedures, it fails to include any enforcing measures in its provisions. This means that States may lack concrete incentives to comply with registration procedures. Such cases, leading to lack of small satellite's registration will be analysed in sections 3 and 4 below.

2.2.4 UNGA Resolution 62/101, Enhancing Registration Practices in Light of the Treaties

[34] *CoCoSL vol. II*, 301.
[35] See further section 3.3 and 4 *infra*; *CoCoSL vol. II*, 301.
[36] See for example the practice of the Czech Republic, *CoCoSL vol. II*, 302-303.
[37] *CoCoSL vol. II*, 303-304.

Resolution 62/101 'Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects'[38] was the outcome of a UN COPUOS Working Group[39] under agenda item 'Practices of States and international organizations in registering space objects.'[40] The agenda item and working group came to be after different efforts, such as working papers submitted to UN COPUOS by States, indicating that there is a need to improve registration practices. One of the main points raised in this context was that with the privatisation of space activities, not all States involved in the launching activities were adequately covered by the term 'launching State' and so, could not register space objects falling under their jurisdiction.[41] This problem is very relevant to small satellites operations.[42]

The Resolution addresses a situation where the launch service provider could potentially register a certain satellite, however, it is clear that the owner of such satellite, represented by the State of its nationality, is more suited to register and exercise its jurisdiction and control, also after the satellite has been launched. This is again very relevant to small satellites launched in the piggy-back practice.[43]

The most relevant provisions of the Resolution in this context are:

> 3 (b) The State from whose territory or facility a space object has been launched should, in the absence of prior agreement, contact States or international intergovernmental organizations that could qualify as 'launching States' to jointly determine which State or entity should register the space object;
>
> (c) In cases of joint launches of space objects, each space object should be registered separately and, without prejudice to the rights and obligations of States, space objects should be included, in accordance with international law, including the relevant United Nations treaties on outer space, in the appropriate registry of the A/RES/62/101 4 State responsible for the operation of the space object under article VI of the Outer Space Treaty;

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[38] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007).

[39] Report of the Legal Subcommittee on its forty-sixth session, held in Vienna from 26 March to 5 April 2007, UN Doc. A/AC.105/891, Report of the Chairman of the Working Group on the Practice of States and International Organizations in Registering Space Objects, (2 May 2007) 30-35; available at: http://www.unoosa.org/pdf/reports/ac105/AC105_891E.pdf .

[40] K-U Schrogl and N Hedman, 'The U.N. General Assembly Resolution 62/101 of 17 December 2007 on "Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects"' (2008) 34 Journal of Space Law 141-162.

[41] See S Hobe, B Schmidt-Tedd and K-U Schrogl (eds.), *Cologne Commentary on Space Law vol. III* (Carl Heymanns Verlag 2015). (Hereinafter: 'CoCoSL vol. III') 410.

[42] See section 3.2 *infra* and for in depth analysis of the problem of privately owned small satellites and the 'launching States' chapter 4, section 3.5.

[43] See section 3.4 *infra* and for the piggy-back launch practice, chapter 1 subsection 2.5.2.

> (d) States should encourage launch service providers under their jurisdiction to advise the owner and/or operator of the space object to address the appropriate States on the registration of that space object;[44]

In addition, the Resolution aims to enhance registration of space objects in general. In recommendation number 1 it calls upon States to ratify the Registration Convention or use Resolution 1721B (XVI) to register their space objects.[45] The second recommendation's purpose is to harmonise the information States submit when registering their space objects. It also encourages States to provide updates on the status of their registered objects when these re-enter Earth or become 'no longer functional'.[46] The above quoted third recommendation is designed to achieve the most complete registration.[47] The fourth recommendation specifies best practices in case of 'change in supervision' meaning when a space object is being sold to a new owner from a different jurisdiction.[48] The fifth and last recommendation stimulates States and intergovernmental organisations to report to the UN about any developments regarding their registration practices.[49]

This Resolution is important as it highlights some practical matters relating to current registration practices, for instance, with respect to launch service providers, which are very relevant to small satellites.[50]

Nevertheless, its provisions do not have a legally-binding status, and the Resolution itself stipulates that:

> nothing in the conclusions of the Working Group or in the present resolution constitutes an authoritative interpretation of or a proposed amendment to the Registration Convention.[51]

Meaning that the provisions of the Resolution should be seen as recommendations for best practices and in any case, a secondary instrument under international law.

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[44] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007) 3(b)-(d).
[45] ibid, at 1; for summary and commentary see T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 181; for extended commentary see *CoCoSL vol. III*.
[46] ibid, at 2; ibid.
[47] ibid, at 3; ibid.
[48] ibid, at 4; ibid at 182.
[49] ibid, at 5; ibid.
[50] See section 3.4, *infra*.
[51] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007) see preamble.

2.2.5 UNGA Resolution 68/74, Implementing International Registration Obligations in National Space Laws

Resolution 68/74 'Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space' was adopted on 11 December 2013.[52] It lists recommendations for common building blocks of national space legislation, as drafted by experts of the Working Group under COPUOS agenda item 'General exchange of information on national legislation relevant for the peaceful exploration and use of outer space'.[53]

Recommendation 6 lists the important elements, which national space laws should include, in the context of registration of space objects:

> A national registry of objects launched into outer space should be maintained by an appropriate national authority; operators or owners of space objects for which the State is considered to be the launching State or the State responsible for national activities in outer space under the United Nations treaties on outer space should be requested to submit information to the authority to enable the State on whose registry such objects are carried to submit the relevant information to the Secretary-General of the United Nations in accordance with applicable international instruments, including the Convention on Registration of Objects Launched into Outer Space, 4 and in consideration of General Assembly resolutions 1721 B (XVI) of 20 December 1961 and 62/101 of 17 December 2007; the State may also request information on any change in the main characteristics of space objects, in particular when they have become non-functional.[54]

The Resolution refers to the legal instruments, which are analysed in this section above, and merely specifies that provisions in national space laws should take the latter into account.[55] The aim was to promote harmonisation in national space laws in the context of national registries, as they implement international registration obligations specified by the instruments analysed in subsections 2.2.1-2.2.4 above.[56]

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[52] UNGA Res. 68/74 Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space (11 December 2013).
[53] See: Report of the Legal Subcommittee on its forty-sixth session, UN Doc. A/AC./105/891 (26 March- 5 April 2007), 2 May 2007, para 136. For commentary and drafting history see: *CoCoSL vol. III*, 538-546.
[54] UNGA Res. 68/74 Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space (11 December 2013).
[55] For commentary see: *CoCoSL vol. III*, 500-502, 524-530.
[56] ibid, 502.

2.2.6 Intermediate Conclusions

The concept of registration of space objects has evolved over time, and it seems that it keeps evolving. Nonetheless, the legal instruments, which provide the obligation to register space objects, are rather basic, short and procedural in nature.

Other than specifying that upon registration of space objects, the State of registry retains its jurisdiction and control over such objects,[57] there is no indication of the legal outcome in case an object is not registered by any State.

There is also no clear specific timeframe for States to complete the registration procedure, which leads to very-delayed registration practices, and to reluctance to register small satellites with short mission times.[58] Once again, there are no legally binding measures designed to enhance timely registration practices.

While Resolution 62/101 attempts to improve adherence to registration obligations, it has a very limited power to do so, as a secondary source of international law. It is not legally-binding primary source of international law, as treaties are.[59]

The next section will shed light on the practicalities of performing registration of space objects.

2.3 The UN Register of Space Objects

2.3.1 Context

Section 2.2 introduced and analysed the legal obligation to register space objects as well as their different legal binding forces and enforcement. This section will specify in what ways this obligation is carried out. It refers to the practical tools, which were developed by UN OOSA to facilitate the registration of space objects. In this respect, the Online Index of Objects Launched into Outer Space will be firstly introduced, followed by the Model Registration Form, which was drafted by UN OOSA, and finally, the Index of Notifications on the Establishment of National Registries.

2.3.2 Online Index of Objects Launched into Outer Space

With the adoption of Resolution 1721B (XVI),[60] the UN began to systematically gather the information furnished by States with respect to their space objects. This was done starting

[57] See Article VIII of the Outer Space Treaty and Article II of the Registration Convention which have binding legal force.
[58] See sections 3 and 4 *infra* for examples.
[59] United Nations, *Statute of the International Court of Justice*, Art. 38 (18 April 1946).
[60] See section 2.2.1 *supra*.

from 1961 and the UN created a special designation for documents, which contain the furnished information. The information was disseminated through the Secretary-General.[61]

With the technological advancement over the years, UN OOSA created an online tool named: 'Online Index of Objects Launched into Outer Space'.[62] The Index contains the information furnished by States regarding their space objects, pursuant to Article III of the Registration Convention and Resolution 1721B (XVI).

In addition to the official information, which is provided in the context of registration, more information is visible, within square brackets and in green text. Satellites, which appear within brackets and listed in green, are not registered with the UN.[63] This information is extracted from different bodies and the media.[64] Therefore, the unofficial information, which appears in the Index, does not carry any legal status. There are currently 55 States and two international organisations, which provided information about their space objects.[65] The combination of official and unofficial information gives a holistic picture of the current status of space objects, as there are over 8,000 objects currently listed in the Index.[66]

Since it is available online, the Index is accessible to the general public. It is searchable, making it is easy to find information regarding space objects. For instance, it is possible to search certain satellites by their State of registry, launch vehicle or the satellite's name. While the information is basic, this online tool truly promotes transparency and confidence building objectives in the context of space activities.

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[61] *CoCoSL vol. II*, 299.

[62] UN OOSA's website- Online Index of Objects Launched into Outer Space: http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id= .

[63] See examples in sections 3.4 and 4 *infra.*

[64] *CoCoSL vol. II*, 299.

[65] UN OOSA's website- Notifications from States & Organizations: http://www.unoosa.org/oosa/en/spaceobjectregister/submissions/states-organisations.html .
The listed States and organizations are: Algeria, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bolivia, Brazil, Canada, Chile, China, Czech Republic (includes information from Czechoslovakia), Democratic People's Republic of Korea, Denmark, Egypt, European Space Agency (ESA), European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Finland, France, Germany, Greece, Hungary, India, Indonesia, Israel, Italy, Japan, Kazakhstan, Lithuania, Luxembourg, Malaysia, Mexico, Mongolia, The Netherlands, Nigeria, Norway, Pakistan, Papua New Guinea, Peru, Philippines, Poland, Republic of Korea, Russian Federation (includes information from the Union of Soviet Socialist Republics), Saudi Arabia, Slovakia, South Africa, Spain, Sweden, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, and Venezuela.

[66] UN OOSA's websites- Online Index of Objects Launched into Outer Space: http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id= .

2.3.3 Model Registration Form

Pursuant to Resolution 62/101,[67] UN OOSA prepared a model form for registering space objects. The aim of providing a model form was to assist States in their registration submissions, as well as harmonise registration practices.[68] In this sense, the form is merely a standardised document, which facilitates registration, and reflects the existing obligation to register pace objects. The form is publicly available online at the UN OOSA website.[69] Nevertheless, only States and international organisations[70] may officially submit the information, to effectively register space objects pursuant to the Registration Convention or Resolution 1721B (XVI).[71]

UN OOSA explains:

The form is comprised of four separate parts and reflects information customarily provided by States and organizations when registering a space object as well additional information as recommended in resolution 62/101. The four parts are:

- Part A for information provided in conformity with the Registration Convention or General Assembly resolution 1721 B (XVI);
- Part B for additional information for use in the United Nations Register of Objects Launched into Outer Space, as recommended in General Assembly resolution 62/101;
- Part C for information relating to the change of supervision of a space object, as recommended in General Assembly resolution 62/101; and
- Part D for additional voluntary information for use in the United Nations Register of Objects Launched into Outer Space.[72]

The form also has an Annex, section A of this Annex contains instructions and section B contains definitions. It is submitted by States via their permanent missions to the UN.[73]

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[67] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007), 5.
[68] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007) recommendation number 2 at page 3. For commentary see: *CoCoSL vol. III*, 458-459.
[69] UN OOSA's website- Registration Information Submission Form: http://www.unoosa.org/oosa/en/spaceobjectregister/resources/index.html; see for commentary: *CoCoSL vol. III*, 458.
[70] Who made a declaration of acceptance of the rights and obligations pursuant to Article VII of the Registration Convention.
[71] See subsections 2.2.1 and 2.2.3 *supra*.
[72] UN OOSA's website- Registration Information Submission Form: http://www.unoosa.org/oosa/en/spaceobjectregister/resources/index.html.
[73] T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 184.

2.3.4 Index of Notifications on the Establishment of National Registries

The first paragraph of Article II of the Registration Convention obliges States to establish a national registry of space objects and to inform the UN accordingly.[74] Resolution 62/101 requests UN OOSA to display notifications on the establishment of such national registries on UN OOSA's website.[75]

Accordingly, UN OOSA created the Index of Notifications by Member States and Organisations on the Establishment of National Registries of Objects Launched into Outer Space.[76]

The Index includes entries from 33 States to date.[77] Some of these States have national space laws, which include provisions on the establishment of a national registry.[78] In these cases, registration is often a condition to receiving a license to launch or operate space objects.[79] This means that operators are under a legally binding obligation to submit registration information to their State of nationality and the State then proceeds to register the space object in its national register and in most cases with the UN as well.[80]

2.4 Conclusions

Section 2.2 showed the different legal instruments which can serve as a basis for registering space objects, and which supplement treaty provisions on the topic. Section 2.3 introduced the practical tools, which are used to register space objects with the UN.

The chronological examination of the legal instruments shows that at the inception of the concept of registration, the main rationale was promoting an information sharing mechanism between States. This was regarded as a confidence building measure, which was politically necessary, pre and during the cold war era.

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[74] See also section 2.2.3 *supra*.
[75] For commentary see *CoCoSL vol. I*, 165-166.
[76] UN OOSA's website- Index of Notifications by Member States and Organizations on the Establishment of National Registries of Objects Launched into Outer Space: http://www.unoosa.org/oosa/en/spaceobjectregister/national-registries/index.html .
[77] Updated for July 2018. The two last entries were by Indonesia and Finland, both during 2017.
[78] See for examples and different implementation of national registries in national laws: *CoCoSL vol. I*, 165.
[79] *CoCoSL vol. I*, 165.
[80] For different State practice in this regard see the case of The Netherlands, which registers space objects in a national register but not with the UN: T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 190.

With time, it seems like the latter rationale was overcome by the practical purpose of arranging a legal mechanism, which allows States to exercise their quasi-territorial jurisdiction over their space objects.

The concept of State jurisdiction and control is at the core of the obligation to register space objects. The word 'retain' is used in the treaties in this context. This implies that the State of nationality has jurisdiction and control over the object, which it then retains even if the object is in space, that is, if the object is registered.

The problem is that Article II of the Registration Convention limits the State of registry to one of the object's launching States. In the past, the State of nationality, which is responsible for the object pursuant to Article VI of the Outer Space Treaty, the launching State in Article VII of the treaty, and the State of Registry in Article VIII of the treaty, were all the same State.

With the shift from governmental to commercial space activities, and towards collaboration in space activities, this arrangement was fragmented. This is since more commercial entities are involved in the launch of space objects, and these entities have different national States. In many cases the State that has jurisdiction and control over the space object pursuant to nationality, is *not* one of the launching States[81] and therefore, even if it has jurisdiction and control which it should *retain* upon registration, it is not qualified to be the State of registry. As will be shown in section 3, this fragmentation is a cause for legal uncertainty and confusion as to registration obligations, especially in the case of small satellites.[82]

This legal uncertainty, joint with other factors, which will be elaborated in the next section,[83] may cause States to be reluctant to register space objects.

Further, all the instruments mentioned in section 2 do not refer to the legal situation of an *unregistered* space object. This lacuna is problematic, since it is not clear what are the legal consequences of non-registration.

The fact that there is also no specific timeframe for States to execute registration makes the obligation to register seem even weaker, although, it is legally binding upon all member States of the Outer Space Treaty and Registration Convention.

[81] See chapter 4, section 3.5 for an extensive analysis of 'launching State'.
[82] See section 3.2 *infra*.
[83] See sections 3.3 and 3.4 *infra*.

Soft law instruments such as Resolutions 62/101[84] and 68/74[85] are an expression to the need to enhance registration practices, but also to the reality that such enhancement efforts carry only a non-legally binding status under international law.

The next section will present and analyse State practice in registration of space objects, revealing a complex legal picture. It will also briefly discuss efforts to enhance registration practices.

3. Registration of Small Satellites- Practices, Challenges and Enhancement Efforts

3.1 Overview

Not all space objects launched into outer space are registered according to the instruments mentioned in Section 2 above. Non-registration of space objects may originate for different reasons, as analysed below,[86] but the common issue that is raised in this context is lack of any legal measures to enforce registration. While this is a problem, which is relevant to all sorts of satellites, the innovative way in which small satellites' missions are being carried out presents an extra challenge to registration practices.

This section shall address the variations in State practice concerning registration, challenges to registration of small satellites and the recent efforts to enhance registration practices.

First, section 3.2 will present the main problems relating to registration of space objects, namely, lack of registration and lack of consistent State practice relating to registration. This examination will continue to address these problems specifically with respect to small satellites. It will further show how the UN has responded to such problems by encouraging States and private entities to enhance registration practices.

Following that, section 3.3 will focus on a specific legal challenge related to registration of small satellites. The short timeframe of their presence in outer space vis-à-vis the flexible time frame the Registration Convention prescribes to States in their obligation to register space objects results in a lack of registration in some cases.

[84] See subsection 2.2.4 *supra*.
[85] See subsection 2.2.5 *supra*.
[86] See sections 3.2-3.4 *infra*.

Section 3.4 will analyse the role of launch service providers in the registration of space objects launched by them. This will be done while focusing on small satellites.

Finally, conclusions will be drawn in section 3.5.

3.2 Non-Adherence to Obligations, Lack of Consistent State Practice and Enhancement Efforts in the Context of Small Satellites' Registration

The International Law Association[87] (ILA) has published registration statistics in the past. When summarising a study held by UN COPUOS[88] the following was noted:

> Before the 1975 Registration Convention, and under UNGA Resolution 1721B (XVI), 129 objects were launched into outer space in 1972, all of which were registered (0 % unregistered objects). In 1990, 165 objects were launched into outer space of which 160 were registered (9 % unregistered objects). In 2002, 92 objects were launched into outer space of which 73 were registered (20 % unregistered objects). In 2004, 72 objects were launched into outer space of which only 50 were registered (30.5 % unregistered objects). Indeed we are going downhill in this regard.[89]

Since this statistical data was extracted between the years 1957-2004, before the current age of small satellite launches, it seems like non-adherence to registration obligations is a general problem.

While 107 States have ratified the Outer Space Treaty, only 67 States have ratified the Registration Convention.[90] This is one reason why not all space objects are registered pursuant to the Registration Convention. Some States, which are not parties to the Convention, register their space objects pursuant to UNGA Resolution 1721B (XVI).[91]

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[87] ILA's website: http://www.ila-hq.org/index.php .

[88] UN Committee on the Peaceful Uses of Outer Space (Legal Sub Committee, 44th Session, April 2005), 'Registration Statistics for 1957- 2004'; Note by the Secretariat UN Doc.A/AC.105/C.2/2005/CRP.10 (14 April 2005).

[89] M Williams 'Legal Aspects of the Privitazation and Commercialization of Space Activities Remote Sensing and National Space Legislation', ILA Space Law Committee, International Law Association Toronto Conference (2006) Space Law, second report 2006 at 2-3, available at: https://ila.vettoreweb.com/Storage/Download.aspx?DbStorageId=1043&StorageFileGuid=578798c1-0572-41a7-ab75-b64e102739cd .

[90] Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2018, UN Doc. A/AC.105/C.2/2018/CRP.3 (2018) 10; available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2018_CRP03E.pdf .

[91] See subsection 2.2.1 *supra*; *CoCoSL vol. II*, 294-297.

State practice is inconsistent when it comes to registration of space objects. In case the objects are registered, the information that is provided and the timeframe in which registration is carried out can vary drastically.[92] In other cases, objects are not registered at all.[93]

Masson-Zwaan summarises the legal situation as follows:

> Unfortunately, not all states provide the information they are required to under the Convention and sometimes, differing information is submitted by different parties. The vagueness of the information to be furnished does not help. It is also confusing that states register objects under different legal instruments – sometimes under the Registration Convention, sometimes under resolution 1721B (XVI), and sometimes on the basis of Article XI Outer Space Treaty. It also happens that several states register the same object, or, worse, that no state does. This is caused by the fact that several states can qualify as launching state, and thus have a legal basis to register. If they do not agree among themselves which of them will register the object, confusion may arise.[94]

Marboe further explains the origin of the problems mentioned by *Masson-Zwaan*, in the context of small satellites' registration:

> However, in the context of small satellites it is possible that no State considers itself as the launching State for the purpose of registration. As a consequence, several small satellites had not been registered. The main reason for this undesired result is the uncertainty of the meaning of 'to procure the launch of a space object.' As many small satellites projects are developed and operated by private entities, it may be questionable whether in fact, a State 'procured' the launch.[95]

The difficulties in interpreting the term 'launching State' are extensively analysed in chapter 4 of this study.[96] As briefly explained in section 2.4 above, there is fragmentation between the 'appropriate State' or State of nationality, the launching State and the State of registry. This is since according to Article II of the Registration Convention, the State of registry must be one of the launching States of the space object in question.[97] As *Marboe* writes, there is fragmentation or incompatibility between the State which would be the

[92] See subsection 3.3 and section 4 *infra* for examples.
[93] See section 4 *infra* for examples.
[94] T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 180.
[95] I Marboe, 'Small is Beautiful? Legal Challenges of Small Satellites' in PM Sterns and LI Tennen (eds), *Public Law, Private Law, Metalaw and Public Policy in Space* (Springer 2016) 1, 10.
[96] See chapter 4, section 3.5.
[97] See section 2.2 *supra*.

logical State of registry, since it has jurisdiction and control over it, which it should retain, and the launching State, which is involved only in the launch process. This creates a situation where it is unclear which State is the State of registry. The problem is usually raised where the State of nationality of the small satellite is not directly involved in its commercial launch, and therefore, since it is not a launching State, it cannot register it as the State of registry.

The author was directly involved in such a situation where The Netherlands, which was *responsible* for small satellites activities of its nationals pursuant to Article VI of the Outer Space Treaty, did not consider itself as a *liable- launching State* of these satellites. The Netherlands holds this view since the satellites were developed and built by private Dutch entities, and were launched by foreign launch service providers on contractual-commercial terms. In the absence of any involvement of the Dutch government in the process, the Netherlands did not agree with the view that it 'procured the launch' and therefore, decided not to register the satellites pursuant to the Registration Convention, although the Netherlands is a member of the Registration Convention.[98] As will be shown in section 3.4 and section 4 below, launch service providers and their States of nationality, who are qualified as launching States since they launch space objects from their territory and facilities, do not take registration obligations for foreign satellites, even if no other State does. This results in unregistered small satellites, like in the case of the Dutch satellites.[99]

In an attempt to enhance registration practices of small satellites, by raising awareness for the registration process among both operators and States, UN COPUOS and the ITU issued a special hand-out. The hand-out is titled 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites'. It was presented to COPUOS delegates at the Fifty-fourth session of the Legal Subcommittee, in April 2015.[100] The content of this document is analysed in chapter 2 of this study.[101]

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[98] See in more detail: N Palkovitz and T Masson-Zwaan, 'Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566; N Palkovitz, 'Small Satellites: Innovative Activities, Traditional Laws, and the Industry Perspective' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 47, 63; and T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe, *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 189-192.

[99] See in UN OOSA's Online Index of Objects Launched into Outer Space: http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=#?c=%7B%22filters%22:%5B%7B%22fieldName%22:%22en%23object.launch.stateOrganization_s%22,%22value%22:%22The%20Netherlands%22%7D%5D,%22sortings%22:%5B%7B%22fieldName%22:%22object.launch.dateOfLaunch_s1%22,%22dir%22:%22desc%22%7D%5D,%22match%22:%22%22,%22termMatch%22:%22netherlands%22%7D .

[100] UN OOSA and ITU, 'Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites' UN Doc. A/AC.105/C.2/2015/CRP.17 (13 April 2015), available at: http://www.unoosa.org/pdf/limited/c2/AC105_C2_2015_CRP17E.pdf .

[101] See chapter 2 section 3.2.

Furthermore, COPUOS is currently gathering information from States about their small satellites' registration practices, with a 'Questionnaire on the application of international law to small satellite activities'. Question number 5 in the Questionnaire is dedicated to an international exchange of information regarding State practice in registering small satellites.[102]

To conclude this subsection, small satellites' registration is challenging to carry out from the State perspective, which reflects in the difficulties private operators face in this context. The need to involve the 'launching State' remains one of the biggest obstacles, since at times there is no substantive legal link between such State and the private operator. This subsection already hinted that there are additional challenges that are specific to small satellites' registration. These are analysed in the next two sections.

3.3 Lack of Small Satellites' Registration due to Short Orbital Life

Article IV of the Registration Convention calls upon member States to register their space objects 'as soon as practicable'.[103] This means that the Registration Convention does not set a clear timeframe in which States have to fulfil their registration obligations. In this context, *Schmidt-Tedd* notes that: 'The lack of clear reference points in this regard leads to different approaches by States […].'[104]

When contemplating the practical meaning of this obligation, *Schmidt-Tedd*, *Hedman* and *Hurtz* found that States furnish the relevant registration information to the UN within 2 to 3 months after launch on average.[105] The authors also found that on a few occasions, States have furnished registration information to the UN even before the space object was launched and, on the other hand, some States provide information long after the object was launched.[106] Hence, there is no clear State practice in this regard.

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[102] The Questionnaire is analysed in more detail in chapter 2, section 3.2; Question 5 referring to registration was drafted as follows: '5.1 Does your country have a practice of registering small satellites? If so, does your country have a practice of updating the status of small satellites? Is there any legislation or regulation in your country that requires non-governmental entities to submit to the government information for the purpose of registration, including updating of the status of small satellites they operate?' UNOOSA, 'Draft Questionnaire on the Application of International Law to Small Satellite Activities' UN Doc. A/AC.105/C.2/2017/CRP.11 (27 March 2017), available at: http://www.unoosa.org/res/oosadoc/data/documents/2017/aac_105c_22017crp/aac_105c_22017crp_11_0_html/AC105_C2_2017_CRP11E.pdf.

[103] See subsection 2.2.3 *supra*.

[104] *CoCoSL vol. II*, 303 para 225.

[105] *CoCoSL vol. III*, 471 para 192.

[106] *CoCoSL vol. III*, 471 paras 192, 193.

When considering the legal uncertainty relating to registration of small satellites as mentioned in section 3.2, and the fact that some small satellites have a very short mission lifetime in orbit, States may decide to simply not register small satellites which are under their jurisdiction.[107] The combination of very short mission duration and lack of a concrete time frame to perform registration leads to non-registration practices.

Along these lines, *Jakhu* makes the following observation, referring to small satellites:

> One of the main reasons for this growing reluctance towards international registration is that such registration is required to be carried out as soon as possible, after a satellite has been launched and registered on a national registry. There is, however, no specific time limitation for international registration. States tend to delay or decide not to send the required information to the U. N. Secretary General, particularly regarding those satellites that have been launched by foreign launch vehicles and those that might not remain in orbit for a long time.[108]

Jakhu further foresees that the expected growth in small, and very small, satellites' launches, with very short orbital life, would amount to less adherence to States' registration obligations.[109]

When presenting 'An Introduction to the Questionnaire on Small Satellites of the Legal Subcommittee', UN OOSA expressed the same abovementioned problem:

> Under the Registration Convention, states must register space objects regardless of their size. However, registration to the UN is done in a 'timely manner', hence the status of the small satellites are not changed or sometimes never registered due to their relatively short life time.[110]

To conclude, one specific reason, which leads to non-registration of small satellites, is the fact that in some cases, their mission time is so short, that States simply do not bother to start the registration process with the UN.

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[107] For analysis of 'jurisdiction and control' see subsection 2.2.2 *supra*.

[108] RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 55 (2014).

[109] RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 57; RS Jakhu et al, 'Critical Issues Related to Registration of Space Objects and Transparency of Space Activities' (2018) 406 Acta Astronautica 143; see section 2.4 'Challenge of the registration of small satellites', available at: https://planet4589.org/space/papers/JJM2018/JJM_published.pdf .

[110] Y Okumura, An Introduction to the Questionnaire on Small Satellites of the Legal Subcommittee, United Nations/ South Africa Symposium on Basic Space Technology, at slide 17- 'Registration' (13 December 2017); available at: http://www.unoosa.org/documents/pdf/psa/activities/2017/SouthAfrica/slides/Presentation52.pdf .

3.4 Small Satellites' Registration and Launch Service Providers' Practices

Currently, small satellites are usually launched into outer space using the 'piggy-back' launch practice.[111] While this practice is viewed in the industry as a well-established and cost-effective way to launch small satellites, it creates legal uncertainties with respect to registration.

As analysed in chapters 3[112] and 4[113] and mentioned above in the current chapter[114] this launch practice may detach the States which are responsible for the satellite mission from being considered as the liable 'launching States' as well. Since Article II of the Registration Convention prescribes that the State of registry is one of the launching States,[115] the lack of compatibility between the launching State and the State, which can practically exercise its jurisdiction and control over the satellite mission- meaning the State of registry, results in non-registration in some cases.[116]

Although the national State of the launch service provider is also a launching State, since it carries out the launch from its facilities and territory,[117] these States have no interest in registering foreign payload, such as small satellites. This is since registration implies jurisdiction and control over the object, while the involvement of the launch service provider usually ends right after the satellite was launched.[118] It does not operate the satellites and therefore it would make more sense that the national State of the operator, who is internationally responsible for the satellite mission, would exercise its jurisdiction and control.[119]

In practice, some launch services providers and launch services brokers contractually oblige the small satellites owner, who is a secondary payload customer, to arrange for registration with its national State.[120] Since registration is usually carried out after a successful launch,[121] satellite owners may need to provide a declaration, which confirms

[111] Chapter 1, for terminology- subsection 2.1.10 and for detailed explanation- subsection 2.5.2.
[112] Chapter 3, section 3.2 relating to State responsibility.
[113] Chapter 4, section 3.5 relating to liability.
[114] See section 3.2 *supra*.
[115] See section 2 *supra*.
[116] As shown in this section *infra*.
[117] Pursuant to the definition in Article I(c) of the Liability Convention, and Article I(a) of the Registration Convention.
[118] From the author's experience, most launch service contracts are considered to be fulfilled once the small satellite has been launched.
[119] See subsection 2.2.2 *supra* for 'jurisdiction and control'.
[120] The author observes that this practice may vary and be concluded with changing levels of contractual obligations.
[121] *CoCoSL vol. III*, 470-471.

that the satellite will be registered in the future.[122] The request for such declarations is a welcome effort to enhance registration, which is also mentioned in UNGA Resolution 62/101 as a recommended practice,[123] however, reality may present complex scenarios to registration's fulfilment:

> Notwithstanding, in practice the well known issues remain if a launch service customer does not carry out the Registration despite a contrary agreement with the launch service provider, respectively if the State responsible behind the launch service customer continues to stay inactive.[124]

Indeed, in some cases, the satellite owner, which is contractually obliged to register the satellite via its State of nationality,[125] may not succeed in doing so.[126]

One obvious reason for non-registration is that the State of nationality did not ratify the Convention, and thus, lacks the obligation to register pursuant to Article II of that Convention.[127] This is the case since each sovereign State has discretion to ratify or to avoid ratifying treaties. Additionally, lack of registration does not result in any immediate sanctions or enforcement measures and thus States may be less motivated to follow registration obligations. It may also be the case that the State of nationality had never launched a space object beforehand, and therefore lacks any registration practices.[128]

Another situation is that the national State decides not to register the small satellite because of its interpretation of its international obligations, as reflected in domestic law. In the context of registering Dutch small satellites, *Masson-Zwaan* explains that:

> In the case of the Netherlands this also happened, as the launch provider asked the client for such a declaration. This placed the Netherlands Government in front of a dilemma; on the one hand it could not register the small satellite because it does not fall within the scope of the law (no launch, guidance or

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[122] N Palkovitz and T Masson-Zwaan, 'Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws', IISL Proceedings of the 55th Colloquium on the Law of Outer Space (2013) 566.
[123] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007), 3(d): 'States should encourage launch service providers under their jurisdiction to advise the owner and/or operator of the space object to address the appropriate States on the registration of that space object.'
[124] *CoCoSL vol. III*, 471 para 194.
[125] Or at least to provide a declaration which states that the satellite will be registered in the future.
[126] For the problem of enforceability and non-compliance in this context, see: *CoCoSL vol. II*, 322.
[127] Israel as an example with respect to the *Duchifat* CubeSat- see *infra*.
[128] For instance, *NEE 01 PEGASUS* which was the first Ecuadorian satellite (and CubeSat) launched to outer space, was not registered with the UN. See in UN OOSA Online Index: http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=#?c=%7B%22filters%22:%5B%7B%22fieldName%22:%22en%23object.launch.stateOrganization_s%22,%22value%22:%22Ecuador%22%7D%5D,%22sortings%22:%5B%7B%22fieldName%22:%22object.launch.dateOfLaunch_s1%22,%22dir%22:%22desc%22%7D%5D,%22match%22:%22%22,%22termMatch%22:%22ecuador%22%7D .

operation), while on the other hand it has a policy to encourage innovation and not giving the declaration might hamper the business of the Dutch company.[129]

These situations may be solved by bilateral agreements between States, which determine which State should register the satellite, ensuring that one State will indeed register.[130] In practice, States are reluctant to conclude such agreements.[131] It is also not practical for the State of the launch service provider to conclude what can amount to several dozens of agreements per launch.[132] Especially since small satellites customers are usually secondary launch customers[133] and there were cases in which more than 100 small satellites were launched at the same time.[134]

Some States, like Russia, notify the UN of foreign small satellites, which were launched by it in the piggy-back practice.[135] However, this does not amount to registration, or

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[129] T Masson-Zwaan, 'Registration of Small Satellites and the Case of the Netherlands' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 174, 192.
[130] ibid, 192-193.
[131] See *infra* in the context of the QB50 project section 4.1.
[132] See *infra* note 135 for the magnitude of small satellites which are launched as secondary payload in a single launch.
[133] See chapter 1 terminology, subsection 2.1.11.
[134] S Mathewson, 'India Launches Record-Breaking 104 Satellites on Single Rocket' Space.com (15 February 2017) available: https://www.space.com/35709-india-rocket-launches-record-104-satellites.html; This launch had 104 satellites in total, out of which 101 were small satellites. The author was involved in this launch as the legal adviser of ISL- Innovative Space Logistics B.V. which is a Dutch launch service broker. As such, the author was responsible for the legal documents relating to the launch of these 101 small satellites.
[135] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 12 August 2014 from the Permanent Mission of the Russian Federation to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/728, Annex II at 4. (20 October 2015), available at:
https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=ST/SG/SER.E/728 .
The following text was used to describe the launches Russia carried out for foreign entities. Small satellites are explicitly mentioned, however this is done separately from the satellites Russia registered, and does not constitute international registration of these mentioned satellites:
'In June 2014, the Russian Federation launched the following space objects on behalf of foreign clients: On 19 June 2014, a cluster of 12 small satellites (including the TabletSat-Aurora satellite of the Russian Federation) and five containers with 21 nanosatellites was launched by a converted RS-20B intercontinental ballistic missile from the Dombarovsky launch site. The 12 small satellites were the TabletSat-Aurora (Russian Federation); Earth remote sensing satellite KazEOSat-1 (Kazakhstan); Earth remote sensing satellite Deimos-2 (Spain); Earth remote sensing satellites Hodoyoshi-3 and Hodoyoshi-4 (Japan); technology demonstration satellite SaudiSat-4 (Saudi Arabia); the AprizeSat-9 and AprizeSat-10 satellites for a system to identify maritime vessels (United States of America); the Brite-Toronto and Brite-Montreal satellites for astronomical observations (Canada); technology demonstration satellite UniSat 6 (Italy); and Earth remote sensing satellite BugSat 1 (Argentina). The 21 nanosatellites were: technology demonstration satellite PolyITAN-1 (Ukraine); student telecommunications satellite Duchifat (Israel); technology demonstration satellites SPQR-1 and SPQR-2 and educational satellite PACE (Belgium); scientific satellite research NanosatC-Br1 (Brazil); technology demonstration satellite POPSAT-HIP1 (Singapore); scientific research satellite DTUSat-2 (Denmark); Earth remote sensing satellites Flock 1c-1, Flock 1c-2, Flock 1c-3, Flock 1c-4, Flock 1c-5, Flock 1c-6, Flock 1c-7, Flock 1c-8, Flock 1c-9, Flock 1c-10 and Flock 1c-11 and the Perseus M1 and Perseus M2 telecommunications satellites for technology development (United States).'

provides for any other legal outcome.[136] There are cases where such a notification is issued, however, no State registers the satellite, as to which see for instance the case of *Duchifat*, the first Israeli CubeSat, which was mentioned by Russia as the State of the launch service provider,[137] but, was registered neither by Russia nor by Israel[138]:

International Designator	National Designator	Name of Space Object	State/Organization	Date of Launch	GSO Location	UN Registered	Registration Document	Other Documents	Status	Date of Decay or Change	Function of Space Object	Secretariat`s Remarks	External website
[2014-033M]		[DUCHIFAT]	[(for Israel)]	[2014-06-19]		No		ST/SG/SER.E/728	[in orbit]		------	Not registered with the United Nations. Mentioned by the Russian Federation in ST/SG/SER.E/728.	

While the same situation happened in the past with bigger satellites,[139] it seems that the situation is much more severe with the current intensive small satellites launch rate.[140]

To conclude, even though Resolution 62/101 encourages launch service providers to ask their customers- the satellites' owners, to address their national States and arrange registration, in some cases, registration is still not done.

This is an interesting case since it can be argued that the Resolution provides for States' *opinio juris*, supporting the enhancement of registration, while State practice does not correlate well with such vision. As such, it is difficult to agree that Resolution 62/101 is the basis for emerging binding customary law, at least, until States show concrete efforts to enforce registration. This can be done with a domestic binding mechanism, which will be entrusted to ensure that launch service providers obtain all the needed documents for the registration of the satellites they launch.

Therefore, the author believes that the problem originates in State practice, and not in launch service providers or their brokers, since they are not the ones internationally obliged to register these satellites.

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[136] UN OOSA explain on their website: 'Information in square brackets ([and]) and highlighted in green has been obtained from other sources and has not been communicated officially to the United Nations. Reference to external websites does not imply endorsement by the United Nations Office for Outer Space Affairs (UNOOSA) of their contents. The views expressed are those of the authors and do not necessarily reflect the policies or views of UNOOSA. The hyperlinks are provided solely for informational purposes.' See: UN OOSA's website- Online Index of Objects Launched into Outer Space: http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id .

[137] *Supra* n 135.

[138] UN OOSA's website- Online Index of Objects Launched into Outer Space, search word 'Duchifat': http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id .

[139] *Iridium* satellites as an example, see: RS Jakhu and JN Pelton, *Small Satellites and Their Regulation* (Springer 2014) 56.

[140] See *supra* n 135. The list of small and nano satellites is very long and many of the mentioned satellites were not registered. See also *CoCoSL vol. III*, 470, paras 189-190.

3.5 Concluding the Challenges

Section 3.2 showed that not all space objects are registered; this applies both to traditional satellites and small satellites. Subsections 3.3 and 3.4 illustrated that there are also specific challenges that add complexity to the registration of small satellites. Short orbital life and practices relating to piggy-back launch of private small satellites missions seem to create a challenge in fulfilling treaty law and practical registration procedures.

So far, registration enhancement efforts by the UN carried only non-binding legal status. Resolution 62/101 which was adopted in 17 December 2007, calling States to ratify the Registration Convention resulted, in 16 ratifications by States over a decade, meaning between 1 January 2008 and 1 January 2018.[141] This demonstrates the very limited ability to enhance State practice, or adherence to binding law, by non-binding legal instruments.[142]

The complexity of the legal regime, the fact that small satellites are a relatively new space activity, which is primarily based on the private sector, joint with somewhat weak and vague registration obligations, which are not enforceable, lead to unregistered small satellites.

In the next section, these issues will be examined with respect to two case studies. These will show that when considering innovative small satellites' missions, registration may become even more challenging to carry out, due to certain mission characteristics.

4. Registration of Small Satellites - Case Studies

[141] This figure was calculated as the total number of ratifications in 2008- 51 subtracted from the current total number of ratifications- 67. These figures are taken from the following UN official documents: Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2008 UN Doc. ST/SPACE/11/Rev.2/Add.I (2008); available at: http://www.unoosa.org/pdf/publications/ST_SPACE_11_Rev2_Add1E.pdf; and Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2018, UN Doc. A/AC.105/C.2/2018/CRP.3 at 10 (2018); available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2018_CRP03E.pdf.

[142] To compare, the Registration Convention currently enjoys 67 ratifications while the Outer Space Treaty was ratified by 107 States- see: Committee on the Peaceful Uses of Outer Space- Legal Subcommittee, Status of International Agreements relating to Activities in Outer Space as at 1 January 2018, UN Doc. A/AC.105/C.2/2018/CRP.3 at 10 (2018); available at: http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2018_CRP03E.pdf .

4.1 Overview

In order to illustrate the challenges of registering small satellites the following subsections will present and analyse two case studies.

Section 4.2 will be dedicated to practices relating to registration of small satellites, which are a part of a multinational constellation. The *QB50* constellation is presented in chapter 3 of this study in the context of State responsibility.[143] It offers a unique case study for small satellites registration practices as well, and thus, will be analysed in that respect herein. This time, the analysis will be compared with another example, namely, satellite registration of the *BRITE* satellites' constellation.

Analysing these two examples and comparing the results will lead to findings with respect to registration practices for small satellites constellations, especially, when the satellites originate from different jurisdictions.

The second case study presented in section 4.3 relates to small and very small satellites, which are contained and released while in space, from a larger small satellite. The examples of *KickSat* and *UNISAT 5* show how small satellites can be used in an innovative manner, which creates challenges in applying the obligations to register space objects in practice. This case study is truly unique to small satellites and was not legally analysed yet by scholars.

The conclusions from these two case studies will be presented in section 4.4.

4.2 The *QB50* and *BRITE* Multinational Constellations: Contradicting Registration Practices

4.2.1 The QB50 Constellation

This section analyses the registration practices of small satellites that are a part of multinational constellations.

The first constellation is the *QB50* mission, which included small satellites from about 40 different States.[144] The mission's objectives as well as additional information are available

[143] See chapter 3, section 3.2.
[144] For the full participation list see the QB50 project's website: https://www.qb50.eu/index.php/community; https://www.qb50.eu/index.php/precursor-amateur-radio-operator.

in chapter 3.[145] For the purpose of analysis in the current section, it is important to know that while each satellite may come from a different jurisdiction or at least institute, the satellites, which are CubeSats, are standard and include instruments which are specific for this mission.[146] Further, the project is led by a Belgian entity, and received EU funding as an FP7 project.[147]

The Belgian authorities, which assumed responsibility for the project, had to decide in what way registration of all satellites should be carried out. They first decided that:

> Supervision of the activities is under the responsibility of Belgium, while other states whose institutes participate in the mission may consider themselves as launching states.[148]

While some States assumed their role as launching States for satellites owned by their nationals, others did not,[149] and therefore, the Belgian government decided to register all the participating CubeSats as Belgian, regardless of their State of origin:

> This is the reason why the Belgian government adopted a flexible approach with regard to registration of the CubeSats: by default, all CubeSats flying with the mission will be registered by Belgium, except if another state (notably the state of the institute of origin of the CubeSat) would officially declare its commitment to register it. In such a case the 'appropriate state' would differ from the 'state of registry'.[150]

This is a fascinating example of State practice. While in some cases States are reluctant to register space objects under their own jurisdiction,[151] Belgium registered many space objects that carry different nationalities.

This implies a wider view of the constellation-project as a whole, rather than considering each CubeSat as a stand-alone space object. Of course, this is a pragmatic approach, since this concept is nowhere to be found in international space law.

When dealing with registration, Article II of the Registration Convention clarifies that only one State may register the space object in case there are more than one launching State. It also calls upon these States to conclude an agreement to determine who serves as the State

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[145] See chapter 3, section 3.2.
[146] 'QB50 mission objectives' on the project's website: https://www.qb50.eu/index.php/project-description-obj.
[147] Von Karman Institute for Fluid Dynamics's website: https://www.vki.ac.be/ .
[148] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 200.
[149] ibid, 201.
[150] ibid, 200.
[151] See for examples section 3 *supra*.

of registry.[152] UN Resolution 62/101 also repeats the recommendation to conclude agreements in that respect.[153]

The Belgian government chose not to pursue the option to conclude bilateral or multilateral agreements with other participating States, relating to registration of their national's CubeSats. *Jean-Francois Mayence* of the Belgian Science Policy Office (BELSPO) reported that as of the time the project was already advanced, only one State had approached the Belgian government with respect to its involvement in the project. That led to an informal exchange of information.[154] This shows the need to take a pragmatic approach and not strictly depend on the law, which does not always provide practical solutions. In his words:

> Agreements between States might provide the best solution on paper, but they do not always fit the requirements and the tight schedule of space projects.[155]

The participating entities in the *QB50* project had to sign an 'Agreement on the Facilitation of the QB50 Project' which included provisions on adherence to international space law.[156]

To conclude, the case of the *QB50* constellation shows a very wide and practical interpretation of registration obligations in the Belgian State practice. On the one hand, assuming registration obligations for small satellites that may not have been registered otherwise is a generally welcomed practice. On the other hand, it shows the poor legal construction, which relates to jurisdiction and control, registration, and the launching-liable State.

While Belgium registered all the satellites it clearly disclaimed any liability for them as their 'launching State'. Since Article II of the Registration Convention stipulates that only a launching State may register space objects, there is a question regarding the validity of such disclaimer or the registration in general.

Moreover, it is perfectly clear that Belgium did not have jurisdiction and control over the foreign small satellites prior to their launch, and thus, it could have never 'retained' such

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[152] See subsection 2.2.3 *supra*.
[153] UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects, 3(b) (17 December 2007). See for analysis subsection 2.2.4 *supra*.
[154] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 201.
[155] ibid, 209.
[156] The author was the initial drafter of this agreement, which is not publicly available, however, referenced to in States official documents, for instance: Responses to the questionnaire on the application of international law to small-satellite activities, UN Doc. A/AC.105/C.2/2018/CRP.10 (6 April 2018) at page 3, available at: http://www.unoosa.org/res/oosadoc/data/documents/2018/aac_105c_22018crp/aac_105c_22018crp_10_0_html/AC105_C2_2018_CRP10E.pdf .

jurisdiction and control with registration. It also did not have *de facto* jurisdiction and control post launch activities, since the small satellites were operated by foreign entities in foreign territory.

This case raises the question of the legal value such registration carries, but also whether in such a case it would have been better not to affect registration of all foreign small satellites by one State.

4.2.2 The BRITE Constellation

The second example for a multinational small satellite constellation is the *BRITE* project. Unlike *QB50*, which demonstrated large scale cooperation and was supported by institutional funding, *BRITE* presents scientific collaboration on a smaller scale.

The *BRITE* constellation consists of only five nano-satellites from Austria, Canada and Poland. The first participating satellites have been orbiting Earth since 2013.[157] The constellation's mission objective is to 'observe the brightness variations of massive luminous stars'.[158]

Although each participating nano-satellite was named *BRITE*, each with a different addition in its name, they were not registered by one State as part of the constellation, but rather, separately by the State of nationality of each respective satellite.

The two Austrian nano-satellites were registered in Austria as two standalone satellites.[159] *BRITE-A TUGSAT-1* and *BRITE-U UNIBRITE* were both launched in 2013 and were timely registered by Austria about three months after their launch.[160]

[157] BRITE's website: http://www.brite-constellation.at/. See also Chapter 1 subsection 2.4.5.
[158] O Koudelka, 'Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 7, 16.
[159] Responses to the questionnaire on the application of international law to small-satellite activities, UN Doc. A/AC.105/C.2/2018/CRP.10 (6 April 2018) 5, available at: http://www.unoosa.org/res/oosadoc/data/documents/2018/aac_105c_22018crp/aac_105c_22018crp_10_0_html/AC105_C2_2018_CRP10E.pdf.
[160] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 13 May 2013 from the Permanent Mission of Austria to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/676 (17 May 2013), available at: http://www.unoosa.org/oosa/osoindex/data/documents/at/st/stsgser.e676.html .

The two Polish satellites are *BRITE-PL-1 'Lem'* which was launched in 2013 and registered by Poland in 2014[161] and *BRITE-PL-2 'Heweliusz'* which was launched in 2014 and registered by Poland in 2016.[162]

The Canadian satellite, *BRITE-CA1*, was launched in 2014 and registered by Canada three years later in 2017.[163]

This shows that although all the satellites were registered, each State chose a different time frame to perform registration, ranging from three months to three years after launch.

With respect to the option of concluding international agreements in the context of this collaborative project, the Austrian government explained:

> The first two Austrian satellites BRITE-Austria and UniBRITE are part of the BRITE constellation together with one Canadian and two Polish satellites. No binding international agreement exists regulating the mission and the cooperation between the participating institutions. Rather, the non-binding Bylaws of the BRITE Executive Science Team, which is composed of scientists from Austria, Poland, Canada, Germany and France, determine the publication strategy, the decision-making process regarding the selection of stars for observation by the constellation as well as the use and publication of data obtained from the observations.[164]

This situation is similar to the *QB50* example with respect to States being reluctant to conclude bilateral or multilateral agreements in order to determine legal matters, such as registration of the participating small satellites. On the other hand, since Austria, Canada and Poland each registered their nano-satellites, perhaps there was no need to conclude any agreements relating to registration.

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[161] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 17 December 2013 from the Permanent Mission of Poland to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/695 (13 January 2014), available at: http://www.unoosa.org/oosa/osoindex/data/documents/pl/st/stsgser.e695.html .

[162] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 28 June 2016 from the Permanent Mission of Poland to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/773 (2 August 2016), available at: http://www.unoosa.org/oosa/osoindex/data/documents/pl/st/stsgser.e773.html .

[163] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note Verbale dated 24 January 2017 from the Permanent Mission of Canada to the United Nations (Vienna) addressed to the Secretary-General (22 February 2017), available at: http://www.unoosa.org/oosa/osoindex/data/documents/ca/st/stsgser.e788.html .

[164] Responses to the questionnaire on the application of international law to small-satellite activities, UN Doc. A/AC.105/C.2/2018/CRP.10 (6 April 2018) 3, available at: http://www.unoosa.org/res/oosadoc/data/documents/2018/aac_105c_22018crp/aac_105c_22018crp_10_0_html/AC105_C2_2018_CRP10E.pdf .

To conclude, the registration of the *BRITE* satellites by each of their States of origin seems contrary to State practice in the case of the *QB50* constellation. This raises the question whether there is any legal outcome to the fact that small satellites are launched as part of a constellation.

4.2.3 Intermediate Conclusions

The two examples of *QB50* and *BRITE* illustrate that there is no consensus as to the legal outcome of launching small satellites as part of a constellation, at least as far as registration is concerned. In the first case, one State became the State of registry for all satellites, and in the second case, each State registered its own satellites without even mentioning the fact that the satellites are part of a constellation.

BRITE is a fairly small constellation, and *QB50*, which was one of the first to reach a number of almost 50 small satellites, can be considered as a medium-size constellation in the future. Commercial companies such as *SpaceX*[165] and *OneWeb*[166] are already building much bigger small satellites-based constellations.[167] Although these will not be multinational, it remains to be seen how their States of registry will execute the registration of many hundreds and thousands of satellites per constellation.

4.3 *KickSat* and *UNISAT 5*, Multiple Small and Very Small Satellites Contained in a 'Bigger Small Satellite': Challenging Registration Obligations

4.3.1 The KickSat Mission

Some small satellites are launched into outer space containing very small objects[168] inside them. One example is the *KickSat* satellite, which was launched in 2014, and funded using a web-based crowd-funding platform.[169] The satellite, which is a CubeSat of a nano-satellite class, holds a large number of very small chips called 'Sprites', which were released from the satellite once in orbit. These Sprites are 'free flying' in space.[170]

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[165] SpaceX's website: https://www.spacex.com/ .
[166] OneWeb's website: http://www.oneweb.world/ .
[167] See an overview of these and additional planned constellations in chapter 1, section 2.6.2.
[168] See chapter 1 for the terminology: 'very small satellites', subsection 2.1.3.
[169] Kicksat at Kickstarter's website: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space. For legal aspects of crowd-funding the launch of small satellites see: N Palkovitz, '*Space Entrepreneurship and Space Law- Future Challenges and Potential Solutions*' IISL Proceedings of the 56th Colloquium on the Law of Outer Space (2014) 61.
[170] As visually illustrated at Kickstarter: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space .

According to the mission's description:

> Sprites are the size of a couple of postage stamps but have solar cells, a radio transceiver, and a microcontroller (tiny computer) with memory and sensors - many of the capabilities a bigger spacecraft would have, just scaled down.[171]

In light of this description, it seems that both the satellite itself and all the Sprites it carries may be considered as 'space objects' according to Article I(b) of the Registration Convention.[172] The mission's initiator compares the Sprites to other spacecraft, which are space objects. Additionally, even if it would not be accepted that the Sprites are space objects on their own, they may all be regarded as 'component parts' of *KickSat*, which is a space object, rendering the Sprites as space objects as well.[173]

This mission has technology demonstration objectives, and with respect to its duration, it is provided that:

> Because we will only launch KickSat into a low-altitude orbit, we can guarantee that all of the Sprites will re-enter the Earth's atmosphere within a few days or weeks, leaving no trace of space debris. KickSat itself will last somewhat longer, but should burn up in the atmosphere within a few months.[174]

Therefore, the CubeSat was designed to orbit Earth for a few months, while the Sprites stay in space only for a few days or weeks.

This case illustrates the State's difficulty to comply with registration obligations when dealing with very small satellites. First, should *KickSat* and all the Sprites be registered? Are they all space objects? And if so, is there a need to register each object separately? Or perhaps carry out one registration document that specifies the number of Sprites? All these questions should be answered also taking into account the extremely short lifetime of these objects in space.[175]

While technically, each Sprite may fall under the definition of 'space object', it seems unlikely that States would register them separately, especially since by the time registration is processed, they may no longer be in space.

A search at the Online Index of Space Objects Launched into Outer Space shows that, in this case, neither *KickSat* nor the Sprites were registered. The initiator is an American

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[171] Kicksat at Kickstarter: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space.

[172] See the discussion regarding small satellites as 'space objects' chapter 2, subsection 2.3.3.

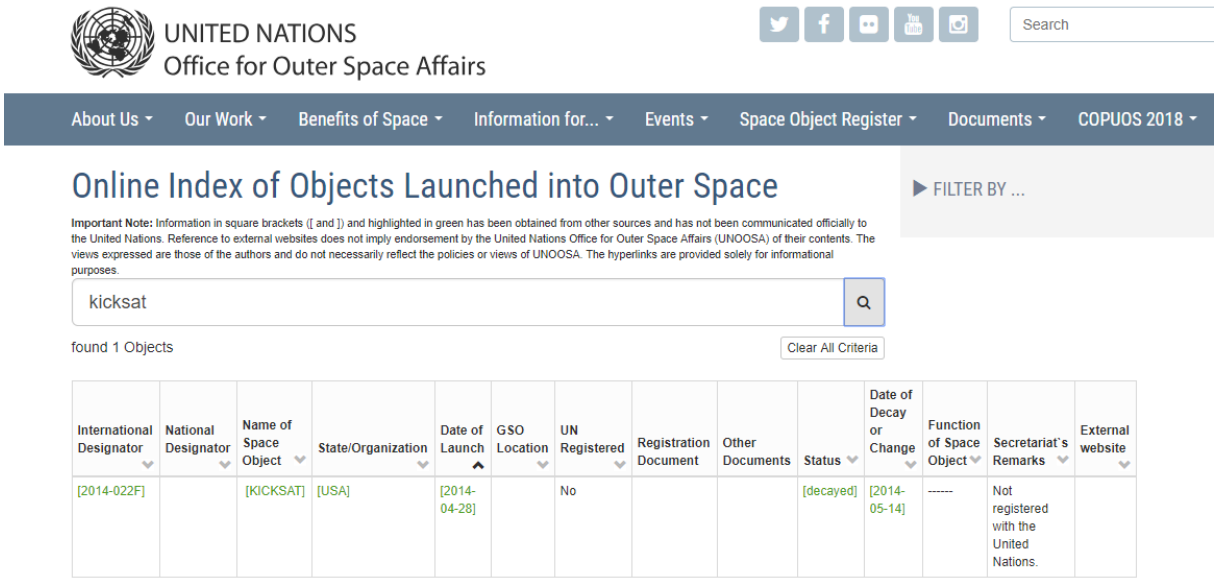
[173] Since according to Article I (b) of the Registration Convention the definition of a space object is: 'The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.'

[174] Kicksat at Kickstarter: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space.

[175] See section 3.3 *supra* from the problem of registering satellites with very short orbital life.

national, and the launch was carried out by *SpaceX*, a U.S. launch service provider, from U.S. territory.[176] This means that the satellite should have been under U.S. jurisdiction and registered by the U.S., as the sole launching State. While the U.S. is a party to the Registration Convention, and often registers small satellites, no registration was carried out in this case.

This can be demonstrated by the following caption:[177]



To conclude, the case of *KickSat* raises the question of what is a space object, and illustrates the need to have a better definition of this term, for the sake of legal certainty. Generally, size should not matter when it comes to space objects under international space law. However, when considering extremely small space objects in very large numbers, it is unclear whether States should act to fulfil their registration obligations in the same manner they should for traditional space objects.

4.3.2 The UNISAT 5 Mission

A second example, which may show an even more complex legal outcome is the *UNISAT 5* mission, launched on 21 of November 2013[178]:

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[176] Kicksat at Kickstarter: https://www.kickstarter.com/projects/zacinaction/kicksat-your-personal-spacecraft-in-space/posts/814035 .

[177] See in Online Index of Space Objects Launched into Outer Space, search word 'Kicksat': http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=.

[178] Gauss' website- 'UNISAT 5 Mission': https://www.gaussteam.com/satellites/gauss-latest-satellites/unisat-5/.

> UNISAT 5 is an educational civilian satellite carrying some onboard experiments. It is also a platform for the release of smaller satellites in orbit, the first in the history of micro-satellites. Its weight at launch is 28 kg. […] UNISAT 5 carried onboard the following sub-satellites: 4 cubesats (10 cm cubes): ICUBE-1 (Pakistan), Humsat-D (Spain), Dove-4 (USA) & PUCP-Sat 1 (Peru); 5 femtosats also known as 'Pocket Cubes' (5 cm cubes and mass between 0.1 and 1 kg): Eagle 1 and Eagle 2 (USA), QBScout-1 (USA), PUCP (Peru) and WREN (Germany). UNISAT 5 satellite's estimated decay date is 1 December 2034.[179]

Without elaborating on the mission of each small satellite mentioned,[180] it is clear that the overall mission is multinational. In this case, the satellites contained in the micro-satellite were bigger compared with the case of *KickSat* and the Sprites. What would be the registration practice in such a case?

UNISAT 5 is owned by an Italian company named *Gauss*, it was launched (containing the smaller satellites) in 2013 from Russia, using a Russian launch service provider, and was registered by Italy.[181] Although contained inside that satellite, the smaller CubeSats, which were not Italian, were not registered by Italy.

Dove-4, which belongs to the American company *Planet* was registered by the U.S.[182]

On the contrary, *Humsat-D*, belonging to Spanish nationals, was mentioned in the Italian registration information for *UNISAT 5* as one of the satellites contained in it, however, the CubeSat itself was not registered by Spain, Italy, or any other State.[183]

These different registration practices become evident from the information in the Index of Space Objects Launched into Outer Space:

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[179] Satellite's 'general function' description as provided by Italy to UN OOSA upon registration: Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 7 November 2014 from the Permanent Mission of Italy to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/734 (19 December 2014) 3, available at: http://www.unoosa.org/documents/pdf/ser734E.pdf .

[180] The information is available at Gauss' website: https://www.gaussteam.com/satellites/gauss-latest-satellites/unisat-5/ .

[181] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 7 November 2014 from the Permanent Mission of Italy to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/734 (19 December 2014), available at: http://www.unoosa.org/documents/pdf/ser734E.pdf .

[182] Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space, Note verbale dated 23 December 2014 from the Permanent Mission of the United States of America to the United Nations (Vienna) addressed to the Secretary-General, UN Doc. ST/SG/SER.E/736 (15 January 2015), available at: http://www.unoosa.org/documents/pdf/ser736E.pdf .

[183] As clearly shown in the Index, UN OOSA's website- Online Index of Objects Launched into Outer Space search words, 'UNISAT 5' or 'Humsat-D': http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id .

2013-066F		UNISAT 5	Italy	2013-11-21		Yes	ST/SG/SER.E/734	ST/SG/SER.E/709	in orbit		UNISAT 5 is an educational civilian satellite carrying some onboard experiments. It is also a platform for the release of smaller satellites in orbit, the first in the history of micro-satellites. Its weight at launch is 28 kg. Details and points-of-contacts are available at www.gaussteam.com. UNISAT 5 carried onboard the following sub-satellites: 4 cubesats (10 cm cubes): ICUBE-1 (Pakistan), Humsat-D (Spain), Dove-4 (USA) & PUCP-Sat 1 (Peru); 5 femtosats also known as "Pocket Cubes" (5 cm cubes and mass between 0.1 and 1 kg): Eagle 1 and Eagle 2 (USA), QBScout-1 (USA), PUCP (Peru) and WREN (Germany). UNISAT 5 satellite's estimated decay date is 1 December 2034.	Mentioned by the Russian Federation in ST/SG/SER.E/709.
2013-066U		Dove 4	USA	2013-11-21		Yes	ST/SG/SER.E/736	ST/SG/SER.E/734	in orbit		Spacecraft engaged in practical applications and uses of space technology such as weather or communications	Mentioned by Italy in ST/SG/SER.E/734.
[2013-066T]		[HUMSAT D]	[(for Spain)]	[2013-11-21]		No		ST/SG/SER.E/734	[in orbit]		------	Not registered with the United Nations. Mentioned by Italy in ST/SG/SER.E/734.

To conclude, the case of *UNISAT 5* illustrates that several small satellites enclosed and deployed by a bigger-small satellite are seen by States as individual space objects. This conclusion derives from the fact that some of the small satellites were registered by their State of origin, and some were not registered by any State. This also shows the different State practice in the registration of small satellites.

4.3.3 Intermediate Conclusions

In conclusion, the two examples of KickSat and UNISAT 5 show that it is impossible to extract clear State practice when evaluating the registration of small and very small satellites by States. The size of the objects as well as their short mission life and the involvement of many different entities in some cases, seem to be complicating factors to executing registration by States. The legal uncertainty regarding registration of very small satellites, or satellites which are enclosed in a bigger-small satellite result in unregistered space objects.

The lack of coherent and consistent State practice in relation to registration of small satellites makes is difficult to reach clear conclusions with respect to potential customary norms that may emerge. Further, since small satellites and very small satellites are a

relatively new form of space activities, the author is of the opinion that it is simply too early to argue that customary law was established in this context.

4.4 Concluding the Case Studies

The case studies illustrate the mixed State practice relating to registration of small satellites. The law is more difficult to apply when international collaboration is carried out, and as shown, States are not eager to conclude agreements relating to such collaboration. This results in contradicting practices, which make it impossible to detect any emerging customary norms in this respect.

As far as constellations are concerned, in one case the satellites were seen as part of one constellation with regard to registration. In the second case, each satellite was registered separately with no mention of it belonging to a constellation.

Although this lack of coherency may seem confusing and does not lead to one clear State practice and *opinio juris*, at least, registration was carried out in both cases.

The second case study shows a worse outcome, where some small satellites are registered and some, simply, are not. Small satellites containing a large number of smaller satellites is a scenario the space treaties cannot deal with. The definition of 'space object' is put to the test of reality, which negatively affects adherence to registration obligations.

The author therefore points out the difficulty to apply the general treaty obligations to specific cases where small satellites and very small satellites push innovation to its final frontier.

5. Conclusions

The authors of the third volume of the Cologne Commentary on Space Law acknowledge small satellite registration as 'one of the current issues regarding registration practices'.[184]

Further, in their conclusions, *Jakhu, Jasani and McDowell* suggest measures to enhance registration practices, they include the following specific recommendation regarding small satellites:

[184] *CoCoSL vol. III*, 470.

> requiring the registration of all objects, except for fragmentation debris, and requiring that it be noted whether the objects were inert or actively operating; this removes any ambiguity about whether small satellites or packages attached to rocket stages should be registered […].[185]

The author is of the opinion that 'requiring' registration will not solve the current issues with respect to small satellites (un)registration practices. States, even those who are parties to the Registration Convention, do not always register small satellites under their jurisdiction.

The problem stems from the legal uncertainty found in treaty obligations. There is a need to define the term 'space object' in a way, which will not leave open questions relating to very small satellites. Further, there is a need to promote the common understanding of the legal relations between the State that has jurisdiction and control *de facto*, the responsible State, the launching State and the State of registry.

Moreover, since the relations between Articles VI, VII and VIII of the Outer Space Treaty, combined with the provisions of the Liability Convention and the Registration Convention are unclear or unworkable, there is a need to investigate the legal outcome of peculiar registration practices by States. The registration of small satellites in the *QB50* project and the Dutch State practice towards non-international registration of Dutch small satellites are just two examples in this respect.

Considering that Article VI of the Outer Space Treaty stipulates clear and automatic attribution of any kind of space activity to the State of nationality, and since State responsibility is linked to jurisdiction, the author puts forward that in any case, the 'appropriate' responsible State shall retain its jurisdiction and control over national entities performing space activities and their space objects.

Registration, in its meaning in Article II of the Registration Convention assumes that launching States exercise their jurisdiction and control over objects which they launch under commercial-contractual terms. This assumption includes the notion that the launching States stay involved in satellite operations. This assumption is simply *wrong* in many cases of small satellites operations.

In that respect, the author submits that one must ask: what is the *legal outcome* of non-registration? The author argues that apart from merely not adhering to treaty obligations, in case the State of registry is a party to the Registration Convention, *there is no difference between a registered privately-owned small satellite and an unregistered one*.

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[185] RS Jakhu et al, 'Critical Issues Related to Registration of Space Objects and Transparency of Space Activities' (2018) 406 *Acta Astronautica* 417, available at: https://planet4589.org/space/papers/JJM2018/JJM_published.pdf .

Registration is primarily a legal tool to retain State *jurisdiction and control* over space objects. The appropriate-responsible State automatically has *jurisdiction* over the small satellite, because of the nationality link in Article VI of the Outer Space Treaty, which provides that the State must *authorise and supervise* the space activity. This means that *the State of nationality already has jurisdiction and control* over the small satellite, which it *retains* even when the satellite is in outer space. For that, there is no need to involve any other States that may be the satellite's *launching State*.

Moreover, the real entity, which has actual control over the satellite's operation, is not the State in case the owner is a commercial operator. The State may regulate domestic measures under which it can seize property and control over operations of its incorporated nationals. In order to do the latter, there is no need to rely on the Registration Convention, or any other piece of international space law that provides a duty to register space objects. It simply flows from the State's power to *authorise and supervise* satellite operations as provided for in Article VI of the Outer Space Treaty.

Given the inconsistency in State practice, the lack of adherence to registration obligations and the problematic legal structure which binds the ambiguous *'launching State'* to the *'State of registry'*, the author concludes that while adherence to international law is a general positive goal, *in the case of privately owned small satellites there is absolutely no benefit in enhancing registration practices*.

Since performing registration of space objects is also a confidence building measure it could be argued that it is still important to register space objects with the UN. The author argues that the information furnished by States pursuant to the Registration Convention is very basic, and our times dictate that a simple search in the internet results in more detailed information regarding non-governmental small satellites projects. In that respect, registration as a confidence building measure becomes less and less relevant, especially in a commercial setting, since the mission's information and many other details are available online by a simple search. To support this argument, the author points out that even UN OOSA includes unofficial information about space objects, which did not originate in State registration, in its Online Index of Objects Launched into Outer Space.

Therefore, in the next concluding chapter, the author suggests alternative ways to keep promoting transparency in this kind of space activity through legal practices which are based on State responsibility, rather than registration in its meaning in the Registration Convention. These suggestions as well as the overall conclusions of this study are presented in the concluding chapter of this study.

Chapter 6: Conclusions and Recommendations

1. Introduction

This study examined whether the revolution in industrial and technological domains of space exploration merits a regulatory revolution as well, or at least, specific regulation which may accommodate the case of small satellites operations better than the existing international regulations. More specifically, should small satellites be treated differently than other space objects under international law?

This concluding chapter aims to answer this question, while presenting the findings of this study, making recommendations and justifying them by drawing legal analogies from other branches of international law.

The main conclusion is that *there is a need to treat non-governmental small satellites operations differently than other satellite operations as far as the distribution of treaty obligations relating to State responsibility, liability and registration goes*.

This means that the substantive rights and obligations provided by the space treaties do not have to change in this respect, however, there is a need to change the legal structure that the concept of the 'launching State' creates.

Instead of dividing State responsibility, liability and registration or 'jurisdiction and control' amongst potentially different States, it is suggested to create a new legal structure which gathers all of the above and centralises these legal concepts into one State, which has the strongest *nationality link* to the small satellite operator.

In this sense, it is suggested to primarily rely on *State responsibility* in order to effectively regulate non-governmental small satellites operations, and to legally and conceptually detach the launching activity from ongoing satellite operations in outer space. The author submits that the practical way to achieve this result is by reaching a common understanding between States, on a soft law basis, rather than amending the space treaties.

Section 2 of this chapter shall summarise the findings of this study as elaborated in the previous chapters, while highlighting the most important findings, which are in the core of this study and its conclusions.

Section 3 shall draw an analogy to the case of small satellites from other branches of law, namely, air law and the regulation of small aircraft operators on a supra-national level.

The above leads to the recommendations in section 4. Thereafter, section 5 will encapsulate those recommendations into a proposed Optional Protocol to the Outer Space Treaty. The objective is to promote legal certainty by supplementing treaty provisions on State responsibility, liability and registration in a manner, which will accommodate non-governmental small satellites operations better.

Finally, section 6 shall discuss the future of space law as a legal system in the context of NewSpace activities, going beyond the case of non-governmental small satellites operations.

2. Concluding the Findings of the Study

2.1 Small Satellites Missions and International Space Law

This study found that small satellites are treated under international space law as any other space objects - at least conceptually - since the subject was never formally disputed. There are some legal uncertainties, which relate to the size of very small satellites and to whether there is a legal relevance to the fact that some of them are launched in large numbers as part of constellations.[1] In any case, it is clear that, small satellites are space objects in the meaning of the space treaties.[2]

A different question is whether the operations of 'unguided'[3] or 'non-manoeuvrable' small satellites is a space activity in the meaning of Article VI of the Outer Space Treaty. While there is no legal sense in excluding small satellites operations as a regulated space activity, this matter was a cause for uncertainties in the past.[4]

It is concluded that small satellites, both as space objects and their operation as space activities, are subject to international space law in principle. There are cases where legal lacunae and discrepancies arise. These cases are related to questions of State responsibility, the validity of the concept of the 'launching State' and which entity has actual 'jurisdiction and control' over a non-governmental small satellite mission. These matters will be elaborated in the following sections.

[1] See: chapter 1 subsection 2.6.2; chapter 3 section 3.2; and chapter 5 section.
[2] See: chapter 2 subsection 2.3.3.
[3] See: chapter 3 subsection 2.1.3 and section 3.3.
[4] ibid.

The international space community became aware of small satellites activities in the past years, and most recent developments show that small satellites constellations are identified as a challenge to the long-term sustainability of LEO.[5] While there are no binding legal instruments, which would apply to States in this respect, there are initiatives in international organisations that promote soft law norms and raise awareness to the need to consider the space environment when launching many thousands of small satellites.[6]

2.2 Non-Governmental Small Satellites Missions and the Liable Launching State(s)

The most important finding in this study is that the concept of the 'launching State' and generally, the provisions of the Liability Convention, are not well suited to deal with liability, which may arise from non-governmental small satellite missions.

The treaties include a very traditional assumption, namely, that launch service providers through their national State, are deeply involved with the payloads they launch to outer space. This is so because of the definition of launching States as: '(i) A State which launches or procures the launching of a space object; (ii) A State from whose territory or facility a space object is launched.'[7] *This assumption often becomes invalid when contemplating commercial small satellite missions*.

Many small satellites are launched by foreign launch service providers, whether the latter are governmentally owned or commercial entities. Even though legally, the national State of the launch provider is considered to be a launching State, and a potential State of registry,[8] this study shows that such States do not assume registration obligations, even

[5] See for instance: S Erwin, 'At small satellite conference, frustration about lagging efforts to deal with space junk' (*Space News*, 5 November 2018), available at: https://spacenews.com/at-small-satellite-conference-frustration-about-lagging-efforts-to-deal-with-space-junk/ .

[6] See: chapter 2 section 3.

[7] Article I(c) of the Convention on International Liability for Damage Caused by Space Objects, (1972) 961 *U.N.T.S.* 187 (hereinafter: 'Liability Convention').

[8] Since Article II of the Convention on Registration of Objects Launched into Outer Space, (1975) 1023 *U.N.T.S.* 15 (hereinafter: 'Registration Convention') stipulates:
'(1) When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary General of the United Nations of the establishment of such a registry.
(2) Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article, bearing in mind the provisions of article VIII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and without prejudice to appropriate agreements concluded or to be concluded among the launching States on jurisdiction and control over the space object and over any personnel thereof.[…]'.

when no other launching State would register the satellite. Since only a launching State can affect registration, this implies reluctance to assume liability for foreign secondary payload.

This situation leads to unregistered small satellites, and worse, to questions regarding the liability of all launching States that are involved in the launch. State practice shows that launch service providers provide information to the UN on the small satellites, which they launch as secondary payloads, but this information lacks any legal outcome, and certainly does not affect registration and assumption of liability.[9]

Other State practice shows that the legal concept of the 'State which procures the launching of a space object' is also a cause for legal uncertainty and confusion. What kind of actions should a State take to demonstrate that it procured the launch of a commercial small satellite, owned by a commercial entity?

In cases where private entities that are incorporated in State X independently procure a commercial launch service for their satellites, with a foreign entity, State X does not have any involvement whatsoever in launch arrangements. This means that the State that is responsible for the small satellite mission is not represented at all in one of the categories that define the liable 'launching State'. This artificial legal fragmentation between State responsibility and liability barely holds in the realm of space treaty law since the English language can accommodate the differences. However, some of the other authentic treaty languages cannot.[10]

The vagueness of the term 'procures the launch' and the lack of a definition in the treaties allows room for different interpretations. And indeed, The Netherlands made a clear expression of its *opinio juris* in this matter, stating that lack of any involvement in arranging for a launch of Dutch small satellites cannot result in the legal assumption of launch procurement.[11] It also coherently demonstrates a State practice where it does not assume international liability or UN registration obligations for purely commercial satellite missions.

On the other hand, this study found opposite State practice as well, and even more apparent when registration obligations are on the line, in the case of the Belgian Government's involvement in the QB50 project.[12]

The one concept, which seems non-controversial, is State responsibility for commercial small satellites missions. The satellite's owner or *operator's nationality* is still the most

[9] See: chapter 5 subsection 4.3.2.
[10] See: chapter 3 section 2.3.
[11] Note verbale dated 29 July 2003 from the Permanent Mission of the Netherlands to the United Nations (Vienna) addressed to the Secretary-General UNGA Doc. A/AC.105/806. See chapter 3, section 2.3 and chapter 4 section 3.5.
[12] See chapter 5 section 4.2.

accurate and important attribution or link between a commercial small satellite, its commercial owner and operator and their State of nationality which assumes the obligations under *Article VI* of the Outer Space Treaty.[13]

Another pressing problem is that 'liability' has different meaning in the context of the launching State in international space law, under general international law, and in the commercial realm. The Liability Convention is designed to only bring claims for the compensation of catastrophic damage out into the daylight. This is not surprising, since it cannot be expected that States will undergo vast diplomatic efforts to resolve minor commercial disputes between commercial small satellite operators. International law, simply, is not suited and should not be suited for this kind of situations, which have very little to do with the States.

The strength of the Liability Convention is in its promise to third party victims who suffered damage caused by a space object and look for compensations. This strength is found in Article II of the Convention, which deals with a situation where a space object causes damage to third parties on the ground or to aircraft in flight. The severity of the moral outcome in these situations calls for absolute liability, or at least, strict liability.[14] These situations are irrelevant to small satellites missions.[15]

Article III of the Convention, which speaks of damage in outer space, applies to small satellite operations. In the cases, which may fall under this provision, even an innocent third party is a space-faring entity, which is aware of space being an ultra-hazardous environment. For this reason, the Convention dictates fault liability in case of damage caused to space objects in outer space.

As mentioned in this study, fault liability in this context remains unclear. None of the space treaties, or any other source of international space law defines what amounts to committing fault in outer space. Scholars have presented different interpretations in this respect.[16]

This uncertain legal environment, which always assumes claims by and between the launching States, is unsuitable to regulate the conduct of commercial entities. When contemplating small and very small satellites in particular, the most probable foreseen damage is at smaller scales when compared to traditional satellites with large dimensions and mass. The scale of the likely damage emphasises the incompatibility of the regulatory environment the Liability Convention creates in the context of small satellites operations. No launching State will bother to present a claim against another launching State, at a

[13] The operator's nationality is set according to the domestic corporate law which applies to the operator.
[14] See: chapter 4 section 3.1.
[15] See: chapter 4 section 3.2.
[16] See: chapter 4 section 3.4.

special claims commission or the ICJ, for small scale damage, which was caused to a commercial entity.[17]

For these considerations, and the fact that the Liability Convention does not stipulate exclusive remedies, the author submits that such potential disputes are better solved in domestic legal proceedings. Domestic legal systems have a better grasp of what would amount to fault under their national applicable laws.

In this sense it would be preferable to encourage non-governmental entities to pursue claims against other non-governmental entities, that is, without being dependent on any launching States. If State involvement is required to solve the dispute, the Liability Convention can be invoked as a secondary measure.[18] The Convention clearly allows such way of dispute resolution, since it does not stipulate exclusive procedures of dispute resolution relating to damage caused by space objects.[19]

With the expected emergence of Space Traffic Management (STM) rules, it may be easier to define fault liability for damage caused in outer space, since these may specify satellite priority rights in orbit and other 'rules of the road'. Recent leading studies in this field have suggested specific rules for small satellites operations, and a radical change in international space treaty law in general.[20] This mentioned approach, which sees small satellites as a distinct category of space objects, also supports the conclusions of the current study.

2.3 Jurisdiction and Control Over Non-Governmental Small Satellites Missions

The State, which is most likely to have jurisdiction and control over a non-governmental small satellite mission, is the State of *nationality* of the satellite operator, since such State is responsible for the satellite operation and has the duty to authorise and supervise it according to Article VI of the Outer Space Treaty. The satellite's operator, which is usually the owner as well, is bound by the *domestic laws* of such a State, as an incorporated entity or on a personal basis.

Therefore, it makes little sense to link the State, which should retain its jurisdiction and control over the satellite, to the State or States that were involved in its launch. In other words, it would be more logical to link the State of registry which retains jurisdiction and control to the appropriate State which is responsible to license, meaning, authorise and

[17] And indeed, to date, no such claims were presented, not even in the *Iridium-Cosmos* collision which involved a functioning traditional satellite, see chapter 4 section 3.4.2.
[18] See: chapter 4 section 3.6
[19] Liability Convention, Article XI (2).
[20] See: chapter 4 subsection 3.4.1

supervise, the satellite mission. Articles VI and VIII of the Outer Space Treaty should be linked in that respect, as they may point out the State which can exercise jurisdiction over the small satellite operation *in practice*.[21]

Unfortunately, the existing treaty provisions, namely Article II of the Registration Convention, expressly link jurisdiction and control with the launch of the satellite.[22] As explained in section 2.2 regarding the concept of the 'launching State', basic assumptions relating to the actual involvement of the potential launching States in non-governmental small satellites operations are often wrong.[23]

Such assumptions also create a distorted legal concept regarding which State is entitled and obliged to exercise jurisdiction and control over non-governmental small satellites operations.

This study showed that while it is clearly stated in the treaties that the State of registry should be one of the launching States, in practice, some States chose to register small satellites while acknowledging that they are responsible for the operation of the satellites but disclaiming being their liable launching State.[24]

It is unclear what is the legal outcome when a satellite is registered by a State that takes responsibility for its operation but is not its launching State.[25] It is also unclear what is the legal outcome of a situation where a small satellite is not registered by any State.[26]

More specifically, what is the *legal meaning of a domestically licensed commercial small satellite activity, where the satellite is not registered by any State?* Does the responsible State that authorised the space operation *retain its jurisdiction and control even without registration*? If the answer is positive, it is concluded that registration of small satellites carries no legal value. If the answer is negative, it means that national space laws are inadequate to regulate space activities, which completely stands in contradiction with Article VI of the Outer Space Treaty.

It is therefore concluded that *the concept of the 'launching State', although fundamental, cannot adequately regulate non-governmental small satellite operations in a logical and realistic manner*.

[21] See: chapter 5 section 5.
[22] Since it stipulates that the State of registry has to be one of the launching States.
[23] See: chapter 5 section 5.
[24] See: chapter 5 section 4.2.
[25] See: chapter 5 section 5.
[26] ibid.

Accordingly, this study recommends using State responsibility and specifically Article VI of the Outer Space Treaty as the legal basis for international regulation of small satellites missions, as elaborated below.

2.4 Non-Governmental Small Satellites Missions and State Responsibility

It is concluded that State responsibility is the most effective legal concept to internationally regulate non-governmental small satellite missions. This study showed the different interpretations of Article VI of the Outer Space Treaty, which includes a special State responsibility regime for 'national activities in outer space'.[27]

Based on the legal analysis of key international space law and general international law instruments, custom and ICJ cases it was concluded that the *operator's nationality* is the most effective way to attribute space activities to a certain State, in the context of small satellites.[28]

The author submits that while some concepts in Article VI remain vague, establishing the nationality of a small satellite's owner or operator, according to *domestic law*[29] should fairly easily indicate which State is the 'appropriate' *responsible State* for that satellite, in the meaning of Article VI.

It is further submitted that *there is great disadvantage in detaching nationality and State responsibility from liability and registration requirements*. In other words, the current disconnection between international responsibility and liability for non-governmental small satellites operations creates an unsound legal environment.

First, according to general international law, State responsibility may lead to liability in cases damage is caused pursuant to certain activities.[30]

Second, as mentioned above, some of the authentic languages of the Outer Space Treaty do not distinguish responsibility from liability as English does.[31]

Third, while responsibility can be distinguished from liability in a theoretical manner,[32] it is unclear what are the legal outcomes in case damage was caused by a space object in

[27] See: chapter 3 sections 2 and 3.
[28] See: chapter 3 section 2.
[29] Meaning according to domestic corporate law when the satellite owner or operator is an incorporated entity.
[30] See: International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts with Commentaries, *Yearbook of the International Law Commission*, vol. II, Part Two (2001) 92 para 8.
[31] See: chapter 3 section 2.3.
[32] ibid.

outer space. In case State X is only *responsible* for a commercial small satellite operation, and State Y is its *liable* launching State[33] and the satellite caused damage in outer space, would only State Y be required to compensate for such damage? What is then the relevance of State responsibility in such a case?

It is argued that there is sense in making the State that authorised and supervised the damaging operation the one which is responsible and liable to compensate for the damage. This is both a moral-theoretical argument and a legal-practical one. A situation where States are free to authorise space activities, which expose other States to liability, simply seems illogical. For this reason, the author puts forward that the State, which is responsible for the operation of the non-governmental small satellite, should be recognised as potentially liable for damage it may cause, jointly with the satellite's launching States.

As mentioned above, it can be challenging to identify a satellite's launching State, and in case there are several launching States, agreements should be made between these States on distribution of liability. This study found that currently, States do not engage in such agreements when it comes to non-governmental small satellites operations.[34] In other words, it would be easier for the party that suffered damage to claim compensation from the *national State of the operator*, rather than investigating on its own who are all the potential launching States of the damaging satellite. The nationality of a corporation is very basic information, which is publicly available. Even if the satellite was registered properly with the UN, there is no requirement to specify who are the launching States of a certain satellite. This means that such information is not publicly available even if all the parties involved observe their treaty obligations.

Similar arguments apply to registration obligations. The national-responsible State has jurisdiction and control over the satellite operation, otherwise it cannot fulfil its authorisation and supervision obligations in Article VI. Since the State of registry *retains*[35] jurisdiction and control, it makes sense that such State would be the State of the operator's nationality, meaning, the responsible State and State of registry should ideally be the same State, which retains jurisdiction and control over the small satellite.[36]

To take the arguments one step further, the conclusion is that *the operator's nationality, which determines which State is responsible for its space activities, should serve as the legal nexus between international space law and non-governmental small satellites missions*.

[33] For the sake of simplicity, it is assumed that only State Y qualified as the launching State although there would potentially be more than one launching States in many cases.
[34] See: chapter 5 section 4.2.
[35] In the meaning of Article VIII of the Outer Space Treaty and the Registration Convention.
[36] See: chapter 5 section 5.

This means that States will have to ensure that their national legislation can effectively regulate non-governmental small satellites missions. As shown in chapter 3, both The Netherlands and Belgium had to amend or expand their domestic space laws in order to include small satellite operations as a regulated activity.[37]

The following third section includes an analogy to the adjustment of regulatory powers between the supra-national and national level in the case of small aircraft operators. The manner in which it is suggested to reaffirm the role of national States with respect to non-governmental small satellites operations will be elaborated in sections 4 and 5 below.

3. The *De Minimis* Principle and Analogies Supporting Special Regulation of Small Satellites Activities

The use of the *de minimis* doctrine in other branches of law illustrates that there is justification to regulate certain small-scale activities in a special manner. This section will present analogies such as the de-regulation of small aircraft operators, small-scale state aid and light drones to show legal practices aimed to simplify regulation of such small-scale activities.

The idea behind the *de minimis* doctrine is to simplify the existing regulation of a certain activity, setting a certain threshold, under which, the existing regulation will not apply to the small-scale activity, or apply in a simplified manner.

The concept of giving more power to national States in order to regulate smaller or less complex objects and activities is not new. The relaxed supra-national regulation of small aircraft is a good analogy to the case of small satellites.

The recent EU Regulation 2018/1139 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, states that:

> It would not be appropriate to subject all aircraft to common rules.[38]

It further provides in its Article 11 that:

> In order to take into account the interests and views of their aeronautical industry and aircraft operators, Member States should be allowed to exempt from this Regulation the design, production, maintenance and operation

[37] See: chapter 3 sections 3.2 and 3.3.
[38] See: Preamble point (4) Regulation (EU) 2018/1139 of the European parliament and council 4 July 2018, available at:
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1139&from=EN.

> activities which are performed in respect of certain small aircraft, other than unmanned aircraft […].[39]

All EU member States are primarily subject to the Chicago Convention on Civil Aviation.[40] The EU Regulation does not derogate from any obligations that are included in international law, but it leaves certain regulatory matters to the member States when it comes to small aircraft, in order to facilitate their operation.

One example to the relaxed regulation of small aircraft is found in Article 74:

> The fees and charges levied by the Agency should be set in a transparent, fair, non-discriminatory and uniform manner. They should not jeopardise the competitiveness of the Union's industry concerned. Furthermore, they should be established on a basis which takes due account of the ability of the legal or natural persons concerned to pay, *in particular regarding small and medium-sized enterprises*.[41]

This provision recognises the need to avoid over-burdening small aircraft operators with fees and charges, expressing the idea that institutional discretion is needed when regulating different aircraft operators. The rationale is to allow small aircraft operators to pursue their business as part of the industry in a way, which is feasible to these operators.

The *de minimis* tool is used with regards to state aid regulation as well, in different industries. For example, EU Regulation 1407/2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid[42] encapsulates the idea that small amounts of aid are unlikely to distort the competition in a certain market, and sets criteria on aid which is considered *de minimis* and thus is allowed and has different reporting duties compared to other cases of state aid.

Article 3(2) sets the maximal aid amount that is considered as *de minimis* aid:

> The total amount of de minimis aid granted per Member State to a single undertaking shall not exceed EUR 200 000 over any period of three fiscal years.

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[39] Regulation (EU) 2018/1139 of the European parliament and council 4 July 2018, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1139&from=EN.
[40] Convention on International Civil Aviation, (1944) 15 *U.N.T.S.* 295.
[41] Regulation (EU) 2018/1139 of the European parliament and council 4 July 2018, emphasis added, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1139&from=EN.
[42] Regulation (EU) 1407/2013 of 18 December 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid, available at: http://ec.europa.eu/competition/state_aid/legislation/de_minimis_regulation_en.pdf .

> The total amount of de minimis aid granted per Member State to a single undertaking performing road freight transport for hire or reward shall not exceed EUR 100 000 over any period of three fiscal years. This de minimis aid shall not be used for the acquisition of road freight transport vehicles.

And Article 3(1) clarifies that:

> Aid measures shall be deemed not to meet all the criteria in Article 107(1) of the Treaty, and shall therefore be exempt from the notification requirement in Article 108(3) of the Treaty, if they fulfil the conditions laid down in this Regulation.

While this regulation is general, the EU has regulated *de minimis* aid for specific sectors as well, for instance, agriculture. EU regulation 1408/2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid in the agriculture sector[43] sets a different *de minimis* aid amount.

While Article 3(1) of the regulation is similar to Article 3(1) in the general regulation mentioned above, Article 3(2) stipulates that:

> The total amount of de minimis aid granted per Member State to a single undertaking shall not exceed EUR 15 000 over any period of 3 fiscal years.

These examples show the need to treat specific sectors differently when it comes to competition regulation. Small amounts of state aid will not be scrutinised as large amounts in general, and the exact amount that is considered to be de minimis may change according to specific markets.

The concept of *de minimis* is not unique to EU regulations. For instance, Canada uses the *de minimis* principle to regulate the operation of drones of different categories. According to Section 3(1) to the Interim Order No. 9 Respecting the Use of Model Aircraft of the Aeronautics Act, an individual flying a drone that weighs less than 250 grams, for recreational purposes, does not need to obtain a permit or to follow a set of safety measures.[44]

[43] Regulation (EU) 1408/2013 of 18 December 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid in the agriculture sector, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1408&from=en .

[44] Canada Gazette, Part I, Volume 152, Number 24: Government Notices, Interim Order No. 9 Respecting the Use of Model Aircraft (31 May 2018), available at: http://www.gazette.gc.ca/rp-pr/p1/2018/2018-06-16/html/notice-avis-eng.html#ne6 .

This means that the Canadian authorities consider the potential damage caused by a drone with such light weight as *de minimis.* The operation of drones weighing more than 250 grams and less than 35 kilograms are subject to the Interim Order and safety measures.[45]

The regulatory practice of *de minimis* is in line with the suggested approach in this study, since small satellites operators should be subject to a simplified regime relating to authorisation in the meaning of State responsibility, international liability and registration. All as suggested in the recommendations section and Optional Protocol below.

4. Recommendations

Following the findings of this study, it is recommended to create a clearer and simpler legal regime, which supplements the classic treaty provisions on State responsibility, liability and matters related to jurisdiction and control in a more modern, efficient and holistic manner. This should be done to increase legal certainty with respect to the different concepts in the space treaties while considering non-governmental small satellites activities.

The author will present a specific concept in the form of an Optional Protocol to the Outer Space Treaty, aimed towards States parties to the treaty, in section 5 below. Such Protocol, will encapsulate the general recommendations in this section, in particular terms.

The form of a Protocol was chosen since the author believes this is the most suited legal instrument to supplement the basic provisions of the Outer Space Treaty in the narrow context of non-governmental small satellites operation.

A direct amendment to the treaty is not realistic for political and procedural reasons, and further, it makes no sense to amend the very general and time-proof treaty text for a specific space activity. Instead, the Protocol, which is addressed to the States parties to the treaty, will supplement its basic provisions, and offer a chance to adapt and modernise such provisions to increase common understanding between subscribing States regarding the operation of non-governmental small satellites in outer space. It is also a practice in international law to draft protocols in order to allow implementation of a general treaty-regime in more specific fields and terms.[46]

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[45] Transport Canada- Rules for recreational drone users: https://www.tc.gc.ca/en/services/aviation/documents/rules-recreational-drones.pdf.

[46] As explained by the UN with respect to the Optional Protocol to the Convention on the Elimination of All Forms of Discrimination against Women *U.N.T.S.*, vol. 2131, p. 83: 'Very often, human rights treaties are followed by "Optional Protocols" which may either provide for procedures with regard to the treaty or address a substantive area related to the treaty. Optional Protocols to human rights treaties are treaties in their own

Other types of legal instruments, which may promote the implementation of this study's conclusions, are soft law instruments. An international Code of Conduct on the operation of non-governmental small satellites can serve as a legal non-binding alternative to the Protocol. It is difficult to assess the potential success of such a Code. The IADC Space Debris Mitigation Guidelines[47] are a good example to a case where a topic that is not included in the space treaties is supplemented by a soft law instrument, in a successful manner.[48] Since the conclusions of this study directly relate to the space treaties, the author maintains that the Protocol is a more appropriate legal tool in the case of small satellites. Nevertheless, the author appreciates that soft law may be suitable to modernise and supplement international space law, as scholars agree that soft law instruments are suitable for the development of international space law.[49]

Another form of non-binding legal instrument that was considered is a UN General Assembly Resolution text, much like the previous resolutions regarding the concept of the launching state, and registration of space objects.[50] The author appreciates the value of discussions at UN COPUOS which may lead to such a resolution, however, argues that with the advancement of the industry there is an urgent need to create more legal certainty on an international level, regarding non-governmental small satellites operations. The procedure and timeframe, which may lead to a resolution, and its non-binding status, are two great shortcomings in the context of this study.

Therefore, the recommendations of this study, which are elaborated below, are organised as a suggested Optional Protocol to the Outer Space Treaty, attached in section 5 below.

The core recommendation is to supplement the regime in the space treaties with respect to State responsibility, liability and registration in the sense of 'jurisdiction and control', in

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right, and are open to signature, accession or ratification by countries who are party to the main treaty.' http://www.un.org/womenwatch/daw/cedaw/protocol/whatis.htm .
The practice of optional protocols is common to other fields of international law, for example: Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Space Assets (Berlin, 9 March 2012); and the Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998).

[47] Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (2002, as revised in 2007), IADC-02-01, Revision 1.

[48] I Marboe, 'The Importance of Guidelines and Codes of Conduct for Liability of States and Private Actors' in I Marboe (ed), *Soft Law in Outer Space: The function of Non-binding Norms in International Space Law* (Brill Nijhoff 2012) 119-144.

[49] K-U Schrogl, 'The Launching State and the Registration Practice Resolutions as 'Kick Off' for a New Phase in Space (Soft) Law Development' in I Marboe (ed), *Soft Law in Outer Space: The function of Non-binding Norms in International Space Law* (Brill Nijhoff 2012) 195-204. In the context of small satellites see: W Balogh 'The Role of Binding and Non-binding Norms in the Implementation of Small Satellites Programmes' in I Marboe (ed), *Soft Law in Outer Space: The function of Non-binding Norms in International Space Law* (Brill Nijhoff 2012) 325-342.

[50] UNGA Res. 59/115 Application of the Concept of 'Launching State' (25 January 2005); UNGA Res. 62/101 Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering space Objects (17 December 2007).

the context of non-governmental small satellites operations. All with the aim of increasing legal certainty and international understanding which will benefit both States and industry.

Each space activity in this context should be identified as a national activity of a certain State. The criteria of establishing nationality are domestic corporate or personal law. The idea is to identify which entity controls the satellite operation and find to which laws the entity is subject. The national laws according to which the entity legally exists should be the same nationality of the space activity and small satellite.

That *national State should be named responsible* for the non-governmental small satellite operation. The same State will also *assume the obligations* in Article VIII of the Outer Space Treaty relating to *jurisdiction and control in case the small satellite in question was not registered by any State*. In this way, *when a small satellite is not registered it will be clear that its responsible State has retained its jurisdiction and control, even if registration was not properly done*. This solution will help to eliminate some of the legal uncertainties in case of non-registration. It will also accommodate the planned small satellite swarms and constellations better, in case States struggle to register these many satellites.

It is also recommended to encourage States to domestically regulate the operations of non-governmental small satellites under their responsibility and jurisdiction. This recommendation is in line with the UN recommendations regarding national legislation relating to space activities in general.[51] When regulating such activities States will ensure that private entities have sufficient funds in order to provide compensations in case they cause damage in outer space, or alternatively, ensure that proper insurance arrangements are made to cover such scenarios.

Further, it is recommended that States will encourage private small satellites operators under their jurisdiction to resolve commercial liability related disputes, in competent domestic tribunals which are experienced in similar commercial disputes, when both parties to such a dispute are non-governmental small satellites operators. This recommendation is in line with Article VII of the Outer Space Treaty and Article XI of the Liability Convention, which allow parties to settle their disputes in domestic proceedings, since these treaties do not stipulate an exclusive dispute resolution procedure.

In addition, it is recommended to emphasise the role of the responsible national State in promoting the long-term sustainability of outer space, since it is the one that has the legal power to authorise the launch and operation of any small satellites' constellations. Currently, the space treaties do not address the need to keep outer space sustainable, and minimise the creation of space debris. This gives a golden opportunity to use the Protocol

[51] See: chapter 5 subsection 2.2.5.

as a tool, which 'imports' very general understandings among the international community, into a legally binding instrument.

Finally, it is recommended to bring the results of this study to the awareness of the international space community, by its publication and by promoting a discussion on its findings and recommendations in international forums, such as UN COPUOS.

Since the recommendations are encapsulated in the proposed Optional Protocol, and since UN COPUOS Legal Subcommittee is currently discussing the applicability of international space law to small satellites operations, the author hopes that this study and its end result, the Protocol, may be helpful to States which are currently participating in the discussions at COPUOS.

5. Optional Protocol

The Non-governmental Small Satellites Optional Protocol to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies

The Parties to this Protocol,

Being Parties to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter referred to as the Outer Space Treaty),

Conscious of the need to adapt the Outer Space Treaty to meet the particular demand for and the utility of small satellites, in particular when operated by non-governmental entities,

In pursuit of the ultimate objectives of the Outer Space Treaty as stated in its Article I,

Being guided by Articles VI, VII and VIII of the Outer Space Treaty, and

In pursuit of reaching common international understanding with respect to the operation of non-governmental small satellites in outer space, and promoting legal certainty in this respect,

Have agreed as follows:

1. Definitions

   The following definitions shall apply to this Protocol:

   (a) Small satellite- means, a satellite which qualifies as a small satellite according to scientific and industry standards, and in any case, does not exceed 1,000 kilograms by mass.
   (b) Non-governmental small satellite- means, a small satellite as defined in Article 1(a), which is made and operated by a non-governmental entity which is pursuing non-governmental activities in outer space.
   (c) Responsible State- shall have the meaning as defined in Article 3(a) of this Protocol.
   (d) Parties- means the States which are parties to this Protocol.
   (e) Outer Space Treaty- means the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 1967.
   (f) Liability Convention- means, the Convention on International Liability for Damage Caused by Space Objects, 1972.
   (g) Launching State- means, (i) A State which launches or procures the launching of a small satellite; (ii) A State from whose territory or facility a small satellite is launched.

2. Scope

   This Protocol shall apply solely to the operation of non-governmental small satellites in outer space.

3. State Responsibility

   (a) The State in which, and according to whose domestic laws, an entity is engaging in the operation of non-governmental small satellites, is internationally responsible for such operation in outer space (the 'Responsible State'). The Responsible State shall assume the rights and obligations provided for in Article VI of the Outer Space Treaty.

(b) The Responsible State shall authorize and continually supervise non-governmental small satellites operations in outer space, whether by enacting appropriate domestic laws, or otherwise.

4. State Liability

(a) The Responsible State shall bind the operator and/or owner of the small satellite in a legal arrangement relating to liability potentially arising from the non-governmental small satellites operation in outer space. It shall do so by enacting appropriate domestic laws, or otherwise.

(b) With respect to potential liability claims originating from third parties, meaning, any entities or individuals which are not the nationals of the Responsible State or the launching States, the Responsible State shall assume international liability pursuant to Article VII of the Outer Space Treaty, jointly with any other launching State or States.

(c) Observing Article VII of the Outer Space Treaty and Article XI of the Liability Convention, the Parties shall encourage non-governmental small satellite operators to resolve liability related disputes of a commercial nature, with other non-governmental small satellites operators, by domestic proceedings of their choice which do not require the involvement of any Responsible and/or launching States.

5. Registration

(a) Where possible, the registration of the non-governmental small satellite with the UN shall be done according to Article VIII OST, by one of the launching States of the satellite or by the Responsible State for its operations under Article VI OST, in case the satellite is not registered by any of its launching States.

(b) In case registration was not carried out by any of the mentioned States in this Article, it shall be assumed that the Responsible State has retained its jurisdiction and control over the operation of the non-governmental small satellite.

6. Long-term Sustainability of Outer Space

When authorizing small satellite activities, and especially in the case of large swarms and constellations, the Responsible State shall take into account any developments in international law, referring to the long-term sustainability of outer space in general and space debris mitigation and remediation in particular.

7. Signature, ratification, acceptance, approval or accession

   (a) This Protocol shall be open for signature in _____ on _____ by States participating in the diplomatic Conference for the adoption of the draft Protocol to the Outer Space Treaty. After _____ this Protocol shall be open to all States for signature at _____ until it enters into force in accordance with Article 9.

   (b) This Protocol shall be subject to ratification, acceptance or approval by States which have signed it.

   (c) Any State which does not sign this Protocol may accede to it at any time.

   (d) Ratification, acceptance, approval or accession is effected by the deposit of a formal instrument to that effect with the Depositary.

   (e) A State may not become a Party to this Protocol unless it is or becomes also a Party to the Outer Space Treaty.

8. Amendments and Reviews

   (a) Any State Party to the Protocol may propose amendments to this Protocol. Amendments shall enter into force for each State Party to the Protocol accepting the amendments upon their acceptance by a majority of the States Parties to the Protocol and thereafter for each remaining State Party to the Protocol on the date of acceptance by it.

   (b) Ten years after the entry into force of this Protocol, the question of the review of this Protocol shall be included in the provisional agenda of the United Nations General Assembly in order to consider, in the light of past application of the Protocol, whether it requires revision. However, at any time after the Protocol has been in force for five years, and at the request of one third of the States Parties to the Protocol, and with the concurrence of the majority of the States Parties, a conference of the States Parties shall be convened to review this Protocol.

9. Entry into Force

   This Protocol shall enter into force upon the deposit of instruments of ratification by five Governments.

10. Depositary

(a) Instruments of ratification, acceptance, approval or accession shall be deposited with _____, which is hereby designated the Depositary.

(b) The Depositary shall:

(i) inform all States Parties of:

(1) each new signature or deposit of an instrument of ratification, acceptance, approval or accession, together with the date thereof;

(2) the date of entry into force of this Protocol;

(3) each declaration made in accordance with this Protocol, together with the date thereof;

(4) the withdrawal or amendment of any declaration, together with the date thereof; and

(5) the notification of any denunciation of this Protocol together with the date thereof and the date on which it takes effect;

(ii) transmit certified true copies of this Protocol to all States Parties;

(iii) perform such other functions customary for depositaries.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Protocol.

DONE in ____, at _____, this _____ day of _____.

6. Beyond Small Satellites, States, Corporations and our World

> Space law is an essential element of international cooperation and security. It is time for states to regain control on it and for the academic community to come up with pragmatic solutions.[52]

This chapter has begun with the realisation, based on this study, that there is a justification to treat non-governmental small satellites activities differently under international space law. Through the comparison with small aircraft regulation, it was pointed out that there is precedence in treating such operators differently. Likewise, this study recommends to supplement some of the UN space treaties' obligations in a way which leaves no doubt as to the regulatory powers and responsibility of States whose nationals are engaged in small satellites operations. State responsibility should be regarded as the nexus between the non-governmental activity and the State. This may also encourage States to regulate these activities on a national level, where regulation is not yet in place.

The author hopes that the international space community will become aware of the matters analysed in this study and will consider the recommendations and suggested Optional Protocol as a possible solution to effectively regulate the upcoming commercial small satellites missions. Even if this study only pushes stakeholders to consider any kind of legal instruments in order to fill some of the lacunae in the space treaties, this would be a welcome progress.

'Space law' often seems detached from other legal systems. Relying solely on space law as *lex specialis* with respect to non-governmental and commercial NewSpace activities creates an uncertain and unworkable legal environment, because of the lack of jurisprudence and customary law.

The space treaties cannot comprehensively accommodate commercial space activities on their own, as they were never drafted for such a purpose. The use of vague terms and many lacunae is one of the reasons for the legal uncertainty surrounding 'commercial space law'.

The study concludes that there is an urgent need to integrate space law, other branches of public international law and commercial domestic regulation in order to create a legal system, which could provide all stakeholders involved with sufficient legal certainty for pioneering activities outside of our world.

The author believes that the need to regulate novel space activities will become more and more relevant as time passes and human capabilities in outer space become more complex.

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[52] JF Mayence, 'QB50: Legal Aspects of a Multinational Small Satellites Initiative' in I Marboe (ed), *Small Satellites: Regulatory Challenges and Chances* (Brill Nijhoff 2016) 195, 210.

The author also believes that non-governmental entities are key players in the development of space activities.

For now, the regulatory system can still be based on classic international law, meaning treaties and agreements between States joint with customary law, general legal principles and scholarly work. Perhaps in the future there will be a need to create a new system, which sees different entities as equals, depending on the type of activities they carry out in outer space, rather than on their binary distinction between ‘States’ and ‘non-governmental’ entities.

Until then, the international community must enhance regulatory practices that allow for industry growth on the one hand, and ensure that outer space is subject to responsible utilisation and use on the other hand. This includes the assurance that space will continue to be accessible to humans on the long-term, for the sake of future generations.

Regulating a Revolution:
Small Satellites and the Law of Outer Space

Summary

Small satellites and especially nano-satellites and standardized CubeSats are believed to be the future of space exploration. First created in the beginning of the former decade by Professors of the California Polytechnic State University, the standardized CubeSats triggered a revolution in the perception of space activities. Today, they mark a new age of affordable small scaled private space missions or simply "NewSpace" activities. They are easy and fast to build, use "off the shelf" standardized components; enjoy a great number of launching opportunities at a fraction of the cost of launching a "normal" size satellite; their operations are simple due to the fact that most of these satellites cannot be manoeuvred; and their operational life in orbit is usually short. These characteristics distinguish small satellites missions from "traditional" satellite missions since they simplified some of the technological aspects relating to spacecraft design, building and launching processes.

The above means that more actors, and especially private entities and developing countries can afford launching small satellites, as opposed to traditional satellites; and the process of building and launching a small satellite is significantly shorter in time compared to executing a traditional satellite mission. Due to these characteristics, small satellites are ideal for educational and scientific missions, training and capacity building projects in developing space-faring nations, technology demonstrations, collaborative space projects and swarms or constellation-based missions.

These innovative space activities raise several policy and legal challenges, namely:

How should these new space activities be defined and regulated within the framework of the international space law treaty regime, originating in the 1960's? This while considering that some practices relating to small satellites missions challenge the traditional legal framework by juxtaposing it with new legal needs. These needs include, for instance, clarifying vague or outdated definitions and terms in the space treaties, such as "space object", the "appropriate State" in relation to state responsibility, and the "launching State" in relation to liability.

Further, the special launching practices of small satellites as auxiliary payloads challenge the coherency of the Outer Space Treaty when relating to the differences between the responsible "appropriate State" of Article VI, the liable "launching State" of Article VII and the "State of registry" of Article VIII. In many cases the State that hosts an entity which owns the small satellite, and therefore, should be considered as the appropriate State, is not

the launching State since it does not take any active role in the launch of the satellite. Such a situation results in a legal gap and ambiguity regarding the State which is liable for potential damage caused by such small satellite.

The main research question of this study is: Is there justification for special treatment for small satellites missions under international space law? The study offers an answer to this question, as well as a concrete solution to deal with the legal challenges identified in the study's chapters.

In the context of small satellites, the question of applicability of international and national space laws arises vis-à-vis the need to find creative legal solutions in order to legally-accommodate the activities of the rapidly developing space sector.

The existing legal framwork, which is mostly comprised of treaty law, is general and applies to all space activities in the same manner in principle. Therefore, apart from the difficulty in applying the law, some aspects of space activities employing small satellites may not be sufficiently addressed by the treaties, as they were not amended or supplemented allowing adaptation to current activities. Other pressing matters such as the proliferation of space debris by launching large numbers of small non-manoeuvrable satellites is not addressed by the treaties at all.

Chapter 1 of the study includes introduction to small satellites activities, it explains and explores what are small satellites, what applications such satellites support, and introduces important terminology.

Chapter 2 summarises and analyses the applicability of the existing treaty law to small satellites operations, as well as recent discussions and developments in international bodies such as UN COPUOS and the ITU with respect to international regulation of small satellites activities.

Chapter 3 includes a deep legal analysis of State responsibility for non-governmental small satellites activities. It refers to Article VI of the Outer Space Treaty as well to basic concepts as "nationality" in general international law. It analyses case studies which illustrates the legal challenges relating to the application of Article VI in the context of small satellites.

Chapter 4 focuses on analysing the applicability of the Liability Convention in relation to small satellites, especially with respect to "fault liability" in outer space.

Chapter 5 addresses the legal concept of registration of space objects in the space treaties, and "jurisdiction and control". It analyses the problematic legal relations between State responsibility, the liability of the launching State and the ability of the latter to exercise jurisdiction and control as the State of registry, in the case of non-governmental small satellites.

Chapter 6 summarises the findings of the study and includes analogies to cases where justification to treat certain small scale activities in a special manner was found, referring

to the *de minimis* doctrine. It further includes recommendations and a concrete solution to deal with the legal difficulties which were identified, namely, a draft Optional Protocol to the Outer Space Treaty, aimed to supplement the treaty and internationally regulate non-governmental small satellites activities in more detail.

Een Revolutie Reguleren:
Kleine Satellieten en het Ruimterecht

Samenvatting (Dutch Summary)

Kleine satellieten en met name nano-satellieten en gestandaardiseerde CubeSats worden gezien als de toekomst van ruimteverkenning. De aan het begin van het vorige decennium door professoren aan de California Polytechnic State University voor het eerst uitgevonden CubeSats leidden tot een revolutie in hoe er naar activiteiten in de ruimte gekeken wordt. Heden ten dage luiden ze een 'new age' van betaalbare, kleinschalige privé ruimtemissies in, simpelweg 'NewSpace' activiteiten genoemd. Ze zijn makkelijk en snel te bouwen, gebruiken 'off the shelf' gestandaardiseerde onderdelen; kunnen van een groot aantal lanceermogelijkheden gebruik maken, tegen een fractie van wat het lanceren van een satelliet van 'normale' grootte kost; de bediening van CubeSats is eenvoudig, gezien er met de meeste van hen niet gemanoeuvreerd kan worden; en de tijd dat ze in een baan operationeel zijn is over het algemeen kort. Door deze eigenschappen onderscheiden missies met kleine satellieten zich van 'traditionele' satellietmissies, aangezien een aantal van de technologische aspecten van het ontwerp van ruimtevaartuigen, constructie en lancering door het gebruik van kleine satellieten vereenvoudigd is.

Het bovenstaande houdt in dat meerdere partijen, met name private partijen en ontwikkelingslanden, het zich kunnen veroorloven om kleine satellieten in plaats van traditionele satellieten te lanceren; en het bouwen en lanceren van een kleine satelliet is een significant korter durend proces dan het uitvoeren van een traditionele satellietmissie. Om deze redenen zijn kleine satellieten uitermate geschikt voor educatieve en wetenschappelijke missies, training en capacity building projecten in zich ontwikkelende ruimtevarende landen, demonstraties van technologie, collaboratieve ruimteprojecten en zwermen of netwerk-missies.

Deze innovatieve activiteiten in de ruimte stellen ons voor een aantal beleids- en juridische vraagstukken, namelijk:

Hoe kunnen deze nieuwe ruimteactiviteiten gedefinieerd en gereguleerd worden binnen het raamwerk van de internationale ruimterechtverdragen, die uit de jaren '60 stammen? Daarbij in acht nemend dat bepaalde praktijken met betrekking tot kleine satellietmissies het traditionele juridisch kader onder druk zetten door er nieuwe juridische behoeftes tegenover te stellen. Zo is er bijvoorbeeld behoefte aan het verhelderen van vage of gedateerde definities en termen in ruimteverdragen, zoals 'ruimtevoorwerp', de 'betrokken Staat' in verband met staatsverantwoordelijkheid, en de 'lancerende staat' in verband met aansprakelijkheid.

Daarnaast zetten de bijzondere wijzen van lanceren van kleine satellieten als aanvullende lading de samenhang van het Ruimteverdrag op losse schroeven, daar waar het gaat om de verschillen tussen de verantwoordelijke 'betrokken Staat' zoals genoemd in Artikel VI, de aansprakelijke 'lancerende Staat' zoals genoemd in Artikel VII, en de 'Staat van registratie' zoals genoemd in Artikel VIII. In vele gevallen is de Staat, die als basis fungeert voor de entiteit die de kleine satelliet in eigendom heeft en die derhalve als de betrokken Staat gezien zou moeten worden, niet de lancerende Staat, aangezien zij geen actieve rol heeft in het lanceren van de satelliet. Een dergelijke situatie resulteert in een juridisch vacuüm en ambiguïteit aangaande de vraag, welke Staat aansprakelijk is voor eventuele schade veroorzaakt door zo'n kleine satelliet.

De primaire onderzoeksvraag van dit onderzoek luidt: kan bijzondere behandeling van kleine satellietmissies onder internationaal ruimterecht gerechtvaardigd worden? Dit onderzoek biedt een antwoord op deze vraag, alsook een concrete oplossing voor de juridische vraagstukken die in de afzonderlijke hoofdstukken van dit onderzoek uiteengezet worden.

In de context van kleine satellieten stelt zich de vraag van de toepasselijkheid van internationaal en nationaal ruimterecht, ten opzichte van de noodzaak om creatieve juridische oplossingen te vinden zodanig dat de activiteiten van een zich snel ontwikkelende ruimtesector een juridisch kader geboden kunnen worden.

Het bestaande juridisch kader, dat voornamelijk uit verdragsrecht bestaat, is algemeen en wordt in beginsel op alle ruimteactiviteiten zonder onderscheid toegepast. Het kan daardoor voorkomen dat, nog afgezien van de moeilijkheid van het toepassen van het recht, bepaalde aspecten van ruimteactiviteiten waarbij kleine satellieten gebruikt worden onvoldoende gedekt worden door de verdragen, aangezien deze niet zijn gewijzigd of aangevuld opdat ze aangepast zouden zijn aan hedendaagse activiteiten. Andere dringende kwesties, zoals de verspreiding van ruimtepuin doordat er grote aantallen kleine, niet-manoeuvreerbare satellieten gelanceerd worden, komen in de verdragen in zijn geheel niet aan bod.

Hoofdstuk 1 van het onderzoek bevat een inleiding omtrent kleine satelliet activiteiten, het legt uit en onderzoekt wat kleine satellieten zijn, welke toepassingen zulke satellieten bieden, en introduceert belangrijke terminologie.

Hoofdstuk 2 biedt een samenvatting en analyse van de toepasselijkheid van bestaand verdragsrecht op ondernemingen met kleine satellieten, alsmede van recente discussies en ontwikkelingen binnen internationale organisaties, zoals VN COPUOS en de ITU, met betrekking tot de internationale regulering van kleine satelliet activiteiten.

Hoofdstuk 3 bevat een diepgaande juridische analyse van staatsverantwoordelijkheid voor non-gouvernementele kleine satelliet activiteiten. Het refereert aan Artikel VI van het Ruimteverdrag en aan grondbeginselen zoals 'nationaliteit' in algemeen internationaal recht. Het biedt een analyse van case studies die de juridische uitdagingen met betrekking tot de toepasselijkheid van Artikel VI op kleine satellieten illustreren.

Hoofdstuk 4 focust op het analyseren van de toepasselijkheid van het Aansprakelijkheidsverdrag met betrekking tot kleine satellieten, in het bijzonder wat betreft de ‘schuldaansprakelijkheid’ in de ruimte.

Hoofdstuk 5 stelt het juridisch beginsel van het registreren van ruimtevoorwerpen zoals geregeld in de Ruimteverdragen aan de orde, alsmede het begrip ‘rechtsbevoegdheid en zeggenschap’. Het biedt een analyse van de problematische juridische verhoudingen tussen staatsverantwoordelijkheid, de aansprakelijkheid van de lancerende Staat en de mogelijkheid die deze laatste heeft om rechtsbevoegdheid en zeggenschap uit te oefenen in haar hoedanigheid als Staat van registratie, waar het non-gouvernementele kleine satellieten betreft.

Hoofdstuk 6 geeft een samenvatting van de resultaten van het onderzoek en trekt paralellen met zaken waarin een rechtvaardigingsgrond gevonden werd om bepaalde kleinschalige activiteiten afwijkend te behandelen, waarbij gerefereerd werd aan de *de minimis* doctrine. Het bevat tevens een aantal aanbevelingen en een concrete oplossing om om te gaan met de geïdentificeerde juridische obstakels, namelijk een concept voor een Optioneel Protocol bij het Ruimteverdrag, met als doel het aanvullen van het verdrag en het in detail reguleren van non-gouvernementele kleine satelliet activiteiten op internationaal niveau.

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Curriculum Vitae

Neta Palkovitz, born in Tel-Aviv, Israel, 1985. I am a commercial lawyer by training and an experienced adviser specializing in space law, regulatory affairs, and policy. Over the years, I have drafted and negotiated various complex agreements, while combining policy engagement and academic work. This combination provides me a valuable overview of the upcoming market and political trends relating to commercial space activities. I have published on regulatory aspects of non-governmental small satellites activities extensively, which led me to pursue a doctoral thesis on the topic on top of my daily legal practice.

I obtained my LL.B. from The College of Management, Israel, and graduated *cum laude* (2004-2008). Since 2009 I am an advocate, member of Israel Bar Association (licensed lawyer). I took coursework for an M.A. in Diplomacy at Tel-Aviv University, Israel (2009-2010), just before leaving Israel to study at Leiden University. There, I have obtained my LL.M. in International Air and Space Law, at the International Institute of Air and Space Law (IIASL), and graduated *cum laude* (2011-2012). I have been a Ph.D. candidate at the IIASL as of 2014 and until the present, 2019. Since 2011, I have been working as the Legal Adviser of ISIS- Innovative Solutions In Space B.V. and the ISIS Group, a private company engaging in designing, manufacturing and launching small satellites. I have also been a lecturer and visiting lecturer at the IIASL.