

Legal Challenges of Space 4.0: The Framework Conditions of Legal Certainty among States, International Organisations and Private Actors in the Changing Landscape of Space Activities

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Abstract

After more than 60 years of space activities, ongoing scientific and technological progress alongside increased international cooperation, Space 4.0 is entering this field, leaving its hallmark on what appears a new era of space activities. The space community is rapidly changing, and the world continues to face a growing need for dedicated space applications. The growing interest in space leads to an increasing participation of numerous new actors. Governments, private actors and international organisations are eager to fill these gaps in securing the global society's needs. ESA's efforts in this regard are reflected in the Space 4.0 concept, introduced at ESA's Ministerial Council in December 2016 by the ESA Director General. This new conception – building on Industry 4.0 – is designed to host a new era of space activities, setting out to tackle global challenges using the advantages deriving from space and technological progress. These challenges range from climate change to shortage of resources, health, demographic development, digital divide and more. ESA is also highly active within UNISPACE and its objectives: space accessibility, economy, security and diplomacy to contribute to Space 2030 and the UN Sustainable Development Goals. Capacity building reflects the core objective of all international Space 4.0 efforts. This rapid changes and growth are meeting certain needs by bringing space closer to society and inspiring new generations. However, as these developments are taking place in a highly complex net of legal, regulatory and political considerations, they are themselves raising challenges. This paper focuses on the legal challenges raised by the new era Space 4.0 and outlines the framework conditions for

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legal certainty in this rapidly changing environment. It elaborates on the content of Space 4.0 and its implementation, the legal framework for space activities, and how this is currently challenged by two characteristics of the Space 4.0 development, commercialisation of space activities, along with increasing cyber-security concerns in the context of digital divide and big data.

Keywords: Space 4.0, NewSpace, ESA, Capacity Building, Cyber Security, Legal Challenges

1. Introduction

“Space 4.0 marks a new era in which space is an enabler. It enables knowledge, jobs and growth, decision and policy-making, inspiring and motivating the next generations.” (Director General of the European Space Agency, Johann Dietrich Wörner). The European Space Agency (ESA) refers to a global concept of Space 4.0, which covers the NewSpace developments. The successful business endeavors of private entities, such as SpaceX, Virgin Galactic, OneWeb, Planet, Catapult and PLD Space force governments and space agencies to intensify their own efforts and to adapt to rapid changes, and commercial dynamics in the space sector. The traditional space industry makes use of the opportunities offered to them through technological and economic progress.¹ Space 4.0 represent both a challenge and an opportunity for the traditional space players. The role of the historically well-established space faring nations, public agencies and the industry will change from a customer to an innovative competitor. Traditional space actors are likely to adapt new business models and funding mechanisms to tackle the challenges ahead and to compete with the new industry entrants. In the following paragraphs this paper will elaborate on the historical space eras and the ratio of space 4.0, followed by a comprehensive overview of the existing legal framework. As NewSpace actors are primarily motivated by profits and rather less familiar with the legal perspective of their new playground, legal challenges are appearing. Chapter 5 will outline these challenges on the two examples of commercialisation and cyber security. The latter is introduced as a side effect of the growing reliance of society on space data, leading to the evolvment of the big data phenomenon. Rather than offering final solutions to the legal issues of our time, this work is intended to outline the legal dimension, identify the legal challenges and provide potential solutions to them.

1 A. Vernile, *The Rise of Private Actors in the Space Sector*, Springer, Vienna, 2018, p. xxvii.

2. The Historical Background – The Space Eras

From the very beginning of space activities, the governments motivated by political, strategic and scientific objectives were the driving force behind space missions. The current space era, Space 4.0 builds upon the achievements of three previous eras of exploration and use of outer space. *Space 1.0* is defined as the era of *astronomy*, before the first satellites were launched into space.² The following space era, *Space 2.0*, was driven by the *political rivalry* of the Cold War era. The first space superpowers, the United States (US) and the Soviet Union (USSR), engaged in a space race, leading to high investments to establish technological superiority, national security and prestige.³ These fast developments influenced numerous areas, such as innovation, education, policy and economy, and proved that space technologies and applications can have societal benefits. Then, *Space 3.0* was strongly characterised by *international cooperation*. The International Space Station (ISS) is the flagship project of this era and still the greatest common international research project of major space faring nations.

3. The Current Space era – Space 4.0

In December 2016 the ESA at its Council meeting at Ministerial Level in Lucerne adopted the landmark resolution “*Towards Space 4.0 for a United Space in Europe*”⁴ directed at common goals between ESA’s Member States and intended to ensure the success of European space activities for society and industry.

3.1 The Ratio of Space 4.0

Space 4.0 represents the evolution towards a new era of space activities, providing a novel playground for both public- and private entities. Space is no longer accessible to just a limited amount of nations but is rather open for everyone. Space 4.0 introduces the next step of the evolution of space activities and aims to solve societal challenges and to overcome international conflicts. Outer space is developing from being a traditionally state and agency driven sector into an era with *participation* as its central element. ESA Director General Jan Wörner recently outlined that the involvement of space and non-space actors in the field, together with a redefinition of the main focus of activities is changing the way space is conceived and perceived. This

2 I. Duvaux-Béchon, U.M. Bohlmann, Space 4.0 - A guiding vision for ESA, ESPI, 80 (2017) 1.

3 See: U.M. Bohlmann, M. Bürger, NewSpace – Putting an end to national prestige and accountability?, IAC-17.E7.2.1.40535, 68th International Astronautical Congress, Adelaide, Australia, 2017, 25-29 September.

4 ESA Director General J. Wörner, Towards Space 4.0 http://esamultimedia.esa.int/multimedia/publications/Towards_Space_4.0/ (accessed 03.08.2017).

is demonstrated by an increased participation of society in the space decision making process.⁵ The inclusion of private actors and the development of new technologies aim at guaranteeing a cheaper and faster access to space and its applications for all. Space becomes accessible even for smaller nations and developing countries as well as private investors, institutions and universities. Examples of new space faring nations are found world-wide, two of them are the commercially supported Chilean Space Agency and various African Space Agencies.⁶ Governments as the traditional space actors are increasingly cooperating with private investors, e.g. through public-private-partnerships (PPPs), so that traditional government contracts are complemented by innovative business models. These mechanisms are often identified under the definition of New Space. While there is no universally agreed definition, it can generally be understood to encompass a range of various, interrelated trends. New entrants in the space market are bringing to the sector innovative industrial approaches and disruptive market solutions. These developments, combined with private investments are leading to new industry verticals and changing the target of the existent space market.⁷

3.2 ESA's concept of Space 4.0i: inform, innovate, interact and inspire

ESA refers to a globally applicable concept of Space 4.0, which refers back to ESA's *raison d'être*, manifested in the first paragraph of the preamble and Art. II ESA Convention.⁸ Already in its funding instrument ESA defined its objective to provide and promote for exclusively peaceful cooperation among its Member States in the field of space research, technology and their application, with that identifying the multitude of resources required for space activities and the respective advantage of international cooperation. The Space 4.0i *Leitmotif* embodies the vision of ESA as THE space agency for Europe, standing for:

- *Innovation*: ESA's activities are driven by its innovation strategy through disruptive and risk-taking technologies, an example are ESA's Business Incubation Centres (ESA BIC's) all over Europe.
- *Information*: The exchange of information in the fields of space research and technology is rooted in Art. III ESA Convention. ESA disseminates the value and knowledge generated by space activities,

5 J. Wörner. Space 4.0 – Raumfahrt für die Gesellschaft in: Bulletin Außen- & Sicherheitspolitik, Edition 2/2018.

6 Z. Meyer, Private Commercialization of Space in an International Regime: A Proposal for a Space District, in: 30 Northwestern Journal of International Law & Business 1, 2010, p. 248.

7 A. Vernile, The Rise of Private Actors in the Space Sector, Springer, Vienna, 2018, Executive Summary.

8 See Art. II of the Convention on the Establishment of the European Space Agency, opened for signature on 30 May 1975 and entered into force on 30 October 1980, https://www.esa.int/About_Us/Law_at_ESA/ESA_Convention (accessed 10.06.2018).

ensuring the availability of data for their use by potential stake- and shareholders.

- *Inspiration*: The Agency inspires current and future generations through the launch of new challenging space endeavours, such as Rosetta, ExoMars or the Moon Village.
- *Interaction*: ESA's reliability as international partner is well known. The Agency bases its work on enhanced cooperation and international partnerships with Member States, international partners, third States, academia as well as space -and non-space industry. ESA's Citizen Debate and Space Talks are prominent examples.

3.3 Space 4.0 and Industry 4.0

Space 4.0 derives from the concept of "Industry 4.0" and has been defined in an analogy to it.⁹ The space industry uses this interconnection to other technological fields for improved spacecraft manufacturing and advanced general-use technologies for space missions. The space sector is consequently influenced through the dynamics of Industry 4.0. Space 4.0 uses the advantages of Industry 4.0, making use of innovation in numerous areas, such as manufacturing technologies, contemporary automation and big data.¹⁰ New business concepts and technological advancements are taking the place of traditional value chains. Smart integrated services, artificial intelligence, digital technologies, revolutionised production, design and management mechanisms, such as 3D printing, are used during space missions. The use of a 3D printing device and the successful use of the autonomous astronaut Crew Interactive MOBILE CompanioN (CIMON)¹¹ aboard the ISS, are two European examples for the integration of Industry 4.0 innovations into space activities. Further, ESA considers the use of 3D printing technology¹² in the frame of its Moon Village¹³.

3.4 The US developments

The US government started to support the private industry in implementing ideas about space commercialisation already in the last decade. Results are

9 See: K. Schwab, *The Fourth Industrial Revolution*, Penguin 2017.

10 See also: U.M. Bohlmann and G. Petrovici, *Developing Planetary Sustainability – Legal Challenges of Space 4.0*, *Global Sustainability Journal* at Cambridge University Press, upcoming.

11 CIMON - the intelligent astronaut assistant 02 March 2018, https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10306/469_read-26307/year-all//usetemplate-print/, (accessed 10.06.2018).

12 3d Printing our Future in Space and on Earth, 05 March 2018, http://www.esa.int/Our_Activities/Space_Engineering_Technology/TTP2/3D_Printing_our_future_in_space_and_on_Earth, (accessed 10.06.2018).

13 Moon Village, 23 November 2016, <http://blogs.esa.int/janwoerner/2016/11/23/moon-village/>, (accessed 10.06.2018).

the emergence of new space actors and of a new market situation. The support of private investments in space goes back to the destruction of the Columbia Space Shuttle in 2003, when the US government aimed to address private actors to find a new commercially driven access to space. In June 2002, Elon Musk officially founded Space Exploration Technologies Inc. (SpaceX) aiming to innovate and revolutionise space to realise his vision of colonising other planets. SpaceX represents the prime example for a government-private sector arrangement between the Company on the one side and NASA, as well as the Department of Defence (DoD), on the other. In the frame of this agreement, SpaceX is authorised to develop commercial launch services for the global market. In 2006, NASA established its Commercial Crew and Cargo Programme (COTS). At the same time SpaceX celebrated the commercial success of its Falcon 9 launch vehicle so that NASA concluded a contract with the NewSpace enterprise to resupply the ISS.¹⁴ Joint ventures, such as between Airbus and Safran Launcher are aiming to compete with the revolutionary business concepts of *astropreneurs*. In November 2015, the then President of the United States signed into law the U.S. Commercial Space Launch Competitiveness Act (H.R. 2262)¹⁵, aiming to encourage commercial exploitation and recovery of space resources and the discouragement of “government barriers [...]”.

However, this year’s launch of a Tesla Roadster into space touched upon fundamental legal questions in the NewSpace context. The compliance with environmental law and with fundamental principles, such as global commons and benefit sharing, are just a couple of examples out of a range of legal challenges. What can be the legal mechanisms to ensure long-term access to already crowded Earth orbits, while allowing for the installation of mega-constellations? The Trump administration put emphasis on Moon missions and wants to send back the first US astronauts since 1972.¹⁶ How can the international community ensure equitable access and sustainable use of the Moon environment in the upcoming years taking into consideration the interests of multiple private actors, governments and agencies in Moon activities? Is an international regime as recommended by Art. 11 of the Agreement Governing the Activities of States on the Moon and other Celestial Bodies (Moon Agreement)¹⁷ feasible considering the diverging interests of the state community and even if the agreement was ratified by a comparably small number of states?

14 E. Sadeh, *Public-Private Partnerships and the Development of Space Launch Systems in the United States*, Astropolitics, Routledge, 2015, pp. 100-115.

15 See. <https://www.congress.gov/bill/114th-congress/house-bill/2262/text>.

16 Presidential Executive Order 13803 on Reviving the National Space Council, <https://www.whitehouse.gov/presidential-actions/presidential-executive-order-reviving-national-space-council/> (accessed 16.09.2018).

17 1363 U.N.T.S 3 Agreement Governing the Activities of States on the Moon and other Celestial Bodies (Moon Agreement).

3.5 The European Developments

European NewSpace efforts are rapidly growing. However, while the US is advancing its space programmes very fast and is less risk-averse, Europe is willing to support innovative endeavours while not being willing to bear unlimited risks. Europe is nevertheless an area of excellence from a quantitative point of view, looking at the commercial markets and from a qualitative point of view, considering European space and Earth science and flagship programmes, like Galileo and Copernicus. Europe's strong position in the space sector is caused by its reliance on an economic rationale, which enables its success in launch services (ArianeSpace), telecommunications and remote sensing.¹⁸ In 2016, the European Commission's Space Strategy for Europe¹⁹ formally recognised the need to mainly focus on competition, independence and new funding schemes for private actors linked to a strong Research and Development (R&D) support. In June 2018, the European Commission presented the new 16 billion € EU Space Programme to boost EU space leadership in the next long-term from 2021 until 2027. In addition, it aims at supporting the European actions in areas such as high-performance computing, climate change and security.²⁰ A separation of the EU from ESA as well as political fragmentation within Europe represent a burden that needs to be avoided. The continuous successful cooperation and use of synergies between the EU and ESA is the key for European success in the era of Space 4.0. ESA is a major driver of European NewSpace developments. With its concept of Space 4.0 the Agency clearly aims to catch up in the new era of space activities.²¹ In October 2017, ESA organised the first Global Space Economic Workshop in Paris, bringing together European stakeholder to discuss space led innovation and challenges. ESA has developed a new framework to stimulate new cross-cultural partnerships, created a new multidisciplinary synergy, and encouraged a move away from individual challenges of very specialised ecosystems to mega-challenges that can potentially be resolved through a multitude of approaches. European Member States are actively contributing to the European R&D programme Horizon 2020 and the European Programme to Competitiveness of

18 W. Peters. Effects of commercialisation in the European space sector, *Space Policy Journal* 18, August 2002, pp. 199-204.

19 European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Space Strategy for Europe. COM (2016) 705 final, 26 October 2016, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0705>, (accessed 16.09.2018).

20 European Commission. EU budget: A €16billion Space Programme to boost EU space leadership beyond 2020. 06 June 2018, http://europa.eu/rapid/press-release_IP-18-4022_en.htm, (accessed 16.09.2018).

21 Given the limited space only a few out of numerous European and US project are elaborated here.

Enterprises and Small and Medium-sized Enterprises (COSME) as well as the European Structural Investment Funds. ESA BIC's are strongly supporting innovative space endeavours by fostering exchanges with start-ups in this field and supporting them with expertise and investments. Another example for ESA's cooperative efforts is, the ESA Moon Village. As the ESA Director General outlined, "*The Moon Village is not a single project, nor a fixed plan with a defined time table. It's a vision for an open architecture and an international community initiative*".²² It encourages astropreneurs and start-ups as well as traditional space actors to collaborate in this unique project. A first step was made on 26 April 2018, when ESA and NASA signed a letter of intent (LoI).

4. The Legal Framework within the era of Space 4.0

Space activities enable significant improvement of the standard of living of humankind by using the benefits of space applications and space data. As a result of decades of negotiations, the international community has seen the emergence of new codified legal instruments regulating the peaceful exploration and use of outer space. The *corpus iuris spatialis* has developed as an extremely relevant set of rules within public international law. The five main treaties²³ have been drafted and concluded within the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS)²⁴. The Outer Space Treaty (OST) as *magna charta* of space activities sets out the generally applicable principles of outer space activities, which are further elaborated on in the subsequent multilateral treaties. In addition, the UN GA adopted five sets of principles applicable to the exploration and use of outer space. Nevertheless, those resolutions are considered "soft law" and have a non-legally binding character in the sense of Art. 38(1) Statute of the International Court of Justice.²⁵

22 A vision for global cooperation and Space 4.0, http://www.esa.int/About_Us/Ministerial_Council_2016/Moon_Village?TB_iframe=true&width=921.6&height=921.6, (accessed 16.09.2018).

23 610 U.N.T.S. 205 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty); 672 U.N.T.S. 119 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement); 961 U.N.T.S. 187 Convention on International Liability for Damage Caused by Space Objects (Liability Convention); 1023 U.N.T.S. 15 Convention on Registration of Objects Launched into Outer Space (Registration Agreement); 1363 U.N.T.S. 3 Moon Agreement.

24 Established by UN GA resolution 1472 (XIV) on International co-operation in the peaceful uses of outer space (1959).

25 1 U.N.T.S. 16 (ICJ Statute) <http://www.icj-cij.org/en/statute> (accessed 10.06.2018).

5. Legal Challenges of Space 4.0

The Space 4.0 developments are reflected in fundamental changes in the historical space environment. The world faces a growing need for dedicated space applications. The space community develops innovative and revolutionary space programmes under close consideration of international objectives, such as the UN Sustainable Development Goals (UN SDGs). Nevertheless, the new chapter of Space 4.0 started in a highly complex environment of legal, regulatory and political considerations.

5.1 Legal Challenges of Commercialisation

There are various challenges related to the current governance of private space activities. Private actors are motivated by personal interests to turn their commercial investments in space to profitable ventures. Today's intensity of private involvement in space clearly exceeds what the drafters of the space treaties had foreseen. However, space activities carried out by private entities have been debated in the drafting process of the traditional space law instruments.

5.1.1 The United Nation space treaties

Space is an ultra-hazardous environment. The existing legal regime aims to protect space actors but contains also little protection for investors. Private commercial ventures are facing critical obstacles. Astropreneurs are subject to international, regional and national legal regulations.²⁶ Extensive bureaucracy and unclear or diverging interpretations create uncertainty for new space enterprises. As in any other legal regime, legal uncertainty represents a burden towards private investment. An uncertain space law regime hinders the ability of private actors to raise the necessary capital to finance space activities.²⁷ In order to foster the development of innovation and to benefit from the advantages of private investment in space, public space actors need to provide legal certainty on this new playground.

Main issues concerned are liability, responsibility, jurisdiction, control, insurance, licensing and property rights. Central legal challenges arise with the commercial use of outer space and its conflict with the classification of space as province of all mankind. Further, the limits of the freedom of use and exploration of outer space have to be internationally defined. A liability regime considering the consequences of increasing private involvement for the respective governments applicable in case of damage caused by space objects shall be negotiated. Clarification is needed as regards the limits of space resource utilization and the registration practice needs to be improved.

26 M.J. Sundahl, Legal Status of spacecraft, in: R. Jakhu & P. Dempsey, eds. Routledge Handbook of Space Law. London and New York 2017 pp. 47-48.

27 R. Simberg, Property Rights in Space, The New Atlantis <https://www.thenewatlantis.com/publications/property-rights-in-space> (accessed 16.09.2018).

Since its introduction, the existing legal framework has been successful in establishing a legal regime that maintained peace, security and cooperation in outer space. *Sedes materiae* of property rights in space is Art. I OST defining outer space as *res communis omnium*.²⁸ Art. VI OST refers to activities of non-governmental entities in outer space. It provides a dual-system where private actions in space are permissible under the prerequisite of state authority. National activity in this respect is widely defined in the relevant legal literature as activity over which as State enjoys territorial or personal jurisdiction. The *travaux préparatoires* of the OST reflect that the drafters of the treaty had no intention to deviate from general public international law. Further support can be found in Art. VIII OST and Art. II (2) Registration Convention, establishing a genuine link qualifying national space activities. International responsibility for national activities requires the actual possibility of States for exercising jurisdiction and control. It is worth noting that, following the legal principle of *ad impossibile nemo tenetur*, if the impossibility to exercise jurisdiction and control is self-induced a State cannot escape its responsibility.²⁹ Accordingly, the international state community and in particular national states are responsible to assure that national activities are carried out in conformity with the applicable law. Therefore, the activities of private entities also need to comply with liability rules in Art. VII OST and Liability Convention. Another highly important principle is due regard as established in Art. IX OST, Principle 21 Stockholm Declaration, Principle 2 Declaration of the UN Conference on Environment and Development, adopted in Rio de Janeiro in 1992 and Art. 3 of the 1992 Convention on Biological Diversity. States are obliged to conduct activities in a way as not to harm others. This duty of *sic utere tuo ud alienium non leadas* was firstly considered by the Tribunal in the Alabama Arbitration of 1872³⁰ and further reaffirmed by the International Court of Justice (ICJ) in its Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons³¹.

5.1.2 **National Space Law**

The concept of international liability was further elaborated in the *lex specialis* to the OST, namely the Liability Convention, which has a clear

28 The classification of a global commons goes back to Roman law, categorising according to the rights of ownership, see also: S.J. Buck, *The Global Commons: An Introduction* Washington, D.C.: Island Press, p. 6. The principal of global commons will also be discussed in the context of cyberspace

29 B. Cheng, (1998), Art. VI of the 1967 Space Treaty Revisited: International Responsibility, National Activities, and the Appropriate State, *Journal of Space Law* 26 (1998), 25.

30 Alabama claims of the United States of America against Great Britain (U.S.A. v. Great Britain) 1871 R.I.A.A. 127.

31 (1996) ICJ Rep 226, Para. 29.

victim orientated purpose and aims *restitutio ad integrum*. Discussions of the space community provided the ground for the UN GA resolution 59/115 of 10 December 2004 “Application of the concept of the “launching State” noting “*an increase in space activities carried out by non-governmental entities, including activities carried out jointly by government agencies and non-governmental entities, as well as partnerships formed by non-governmental entities from one or more countries.*” The Assembly concluded with a recommendation to enact and implement national laws providing for continuous authorisation and supervision of non-governmental space activities. A subsequent Working Group on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space resulted in resolution A/RES/68/74 adopted by the UN GA on 11 December 2013 containing recommendations on national legislation relevant to the peaceful exploration and use of outer space. An opportune trend is the development of national space legislation all around the world. In Europe and the United States national laws provide the respective regulatory base for private space activities. On the national level, States enact their own space legislation due to a variety of reasons, be it to comply with international obligations, to attract new space business, to protect their citizens from harm or their treasuries from liability claims. States need to consider a list of key elements while drafting their national space laws. First of all, national law needs to be clear in wording, meaning that the key terminology applicable to space activities has to be defined. Terms that must be considered *exempli causa* are: space object, space activity, damage and appropriate launching state. National space legislation needs to establish appropriate measures to fulfil the requirements of Art. VIII OST by providing for continuous supervision and control of national space programmes. Moreover, a national registry should be established to provide information to the UN Secretary General, as required by Art. II (1) of the Registration Convention.

The French Space Operations Act of 22nd May 2008 is a European example expressing, that a solid insurance regime for the indemnification of States against private actors is a further element. In addition, due to the increasing commercialisation of space activities, legal areas covering commercial activities are becoming increasingly important. Examples are procurement law (including international and national export control provisions) and (intellectual) property law requirements. As a result, of growing environmental and security concerns, States are advised to further take into account, environmental standards, such as space debris mitigation guidelines and space traffic management concepts. It goes without saying that these aspects must be seen as a general advice. Each individual State will deliberate its specific background conditions and needs in the drafting process of its national space legislation. Decisions are to be made on a case by case basis.

According to Art. 189 (II) Treaty on the Functioning of the European Union³², the matter of national sovereignty anticipates harmonisation of national laws and regulations at EU level.³³ Nevertheless, main regulations for space activities as regards data protection and general economic rules are found in the EU legal framework. The European Draft Code of Conduct for Outer Space Activities was issued in 2008 as a response to the UN GA resolution 61/75 of 06 December 2006, calling for Member States proposals on transparency and confidence building measures (TBCM) to prevent outer space from becoming an area of conflict. National legislators have to consider economic interests. Licensing and liability conditions need to be attractive enough to convince private actors to invest in the countries space activities, while on the other hand ensuring that space activities of private entities do not lead the public authority to extremely high unreasonable risks. The resulting danger would be, that commercially driven private actors become attracted by those States with a rather low bureaucratic burdens, taxes and weak regulatory systems, such a development would be to the detriment of the safety of the space mission.³⁴ Already around twenty States adopted their national legal framework.³⁵ The German Government recently announced in its Coalition Agreement, that it will elaborate a German space law taking into consideration the needs of Space 4.0.³⁶ In conclusion, as the space industry initially already foresaw the involvement of private actors, especially in the field of telecommunication applications, commercialisation is allowed in the historical space law instruments but requires clarification and national implementation to create legal certainty among all involved space actors.

5.1.3 **New legal approaches**

To achieve legal certainty and encourage private investment adequate regulatory frameworks is to be established. Various innovative legal

32 Consolidated version of the Treaty on the Functioning of the European Union, 26 October 2012, OJ L. 326/47-326/390.

33 See, B. Schmidt-Tedd, *Authorisation of Space Activities after the Entry into Force of the EU Reform Treaty*, in: von der Dunk, F.G. *National Space Legislation in Europe, Issues of Authorisation of Private Space Activities in the Light of Developments in European Space Cooperation*, Nijhoff, 2011 pp 297-322.

34 A. Vernile, *The Rise of Private Actors in the Space Sector*, Springer, Vienna, 2018, p. 78, see also: Dempsey, P. Stephen, *National Laws Governing Commercial Space Activities: Legislation, Regulation & Enforcement*. 36 *Northwestern Journal of International Law & Business* 1, 2016. <https://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1792&context=njilb>, (accessed 16.09.2018).

35 K. Will, *Weltraumbau: Aufbruch zu neuen Sternen*. <https://bdi.eu/artikel/news/weltraumbau-aufbruch-zu-neuen-sternen/>, (accessed 16.09.2018).

36 *German Coalition Agreement*, https://www.cdu.de/system/tdf/media/dokumente/koalitionsvertrag_2018.pdf?file=1. p. 58, (accessed 16.09.2018).

approaches are in discussion. Some authors suggest creating ‘*space districts*’. The idea behind is to separate the authorisation of private space activities from governmental burdens. In particular, it is elaborated on in context of space mining programmes to establish a property rights regime for extracted resources. Private space actors would become independent from governmental constraints but would still be bound by the acceptance of the international community.³⁷ However, this approach can be criticised as it creates a high degree of uncertainty for state actors, which are still responsible for the activities of private actors.

Another approach strongly relies on *cooperation* among the various space actors. To understand the requirements of space activities, common objectives and possible impediments, space players need to work together on a realistic set of rules regulating activities within the fourth space era, taking advantage of new technological developments and potential private investments in R&D programmes. However, the international state community has failed to draft a multilateral space treaty since 1979. A tendency over the past years to negotiate soft law instruments became apparent. Even though soft law instruments have a non-legally binding character they might be politically binding and provide guidance in the interpretation of State obligations under binding treaties. The negotiation of further soft law instruments, able to face the challenges of the current space age would be a realistic approach.

Moreover, one has to consider the adoption of a *multilateral agreement* between States to cover matters like the continuous supervision and control in case of a change of ownership.³⁸ Another important regulatory step would be the negotiation of an international space traffic management regime considering the increasing number of space missions increasing number of small satellites and mega-constellations in already crowded Earth orbits. Such a regime might ensure a long-term access to space for traditional actors and newcomers and at the same time the sustainable handling of non-functional space objects that are already in outer space. International space law expert Tanja Masson-Zwaan explained that the adoption of a kind of international governance system is in the interest of all while various national laws solely protect companies from competing claims by their nationals.³⁹

5.2 Legal challenges in the context of cyber security

When discussing the evolution of space activities within the new space era of Space 4.0 one has to elaborate on the increasing importance of data flows

37 A. Vernile, *The Rise of Private Actors in the Space Sector*, Springer, Vienna, 2018, p. 74.

38 F. Lyall, P.B. Larsen, *Space Law: A Treaties*, p. 497.

39 K. W. Who owns what in outer space, <https://www.economist.com/the-economist-explains/2018/06/12/who-owns-what-in-outer-space>, (accessed 15.09.2018).

and related risks. Cyber security is the second major challenge that traditional and new space actors are facing at the moment. Cyber-Security affects the existing law and forces to re-consider traditional law concepts.

5.2.1 Data as the new gold from space

The digital age, represents an era of a growing flood of information, providing the opportunity for society to share information and to have immediate access to a huge package of data. Space is a driver of innovation and growth and an enabler of modern society interconnectivity. Modern society increasingly relies on satellite-based information technology and networks. “Data is the gold from space”.⁴⁰ Increasing investments in space technologies are linked to the expansion of the data economy. The processing of EO data creates a new set of information, examples of this can be seen in Arctic Polar-orbiting satellites, such as ESA’s CryoSat, SMOS, MetOp and the new Sentinel series of satellites: S-1A/B, S-2A/B, S-3A. The accurate sea ice measurement is only possible after consideration of the data of several satellites. This contributes to the massive growth in set of EO data and to an expanding value data chain.

The beneficial global access to multiple sources of information paved the way for vulnerabilities to cyber threats for governments, international organisations, private actors and individuals. Disrupting cyber-attacks against space infrastructure can have hazardous consequences on different levels. In the US, the Government Accountability Office (GAO) designated federal information security as high-risk area already back in 1997. In 2003, the US started to include also systems and assets essential to the nation’s security, economy, public health and safety, also known as critical infrastructures. Vulnerable areas when speaking about space technology are multifaceted and include the ground segment, the space segment and the peripheral systems. Space systems are remotely controlled and reliant on the exchange between ground station and space segment. As a consequence, interference with space objects can have effects to both flight control and payload. Cyber-attacks to the flight control system can lead to an immense damage to other space objects and to third parties. Today’s trade, communication, transportation, education and security actions are conducted within a region not falling under jurisdiction of any nation. Conclusively, both space and cyber space are defined as global commons. Cyber-security encompasses a range of measures aimed at protecting IT systems against unauthorized interference. It goes far beyond the protection of personal data and intellectual property rights. Controlled automated processes, as required for the Internet of Things (IoT) show the eminent impact that IT systems have into people’s private life.

40 M. Chrysaki, *Space: Still an important Matter of National Prestige?*, <http://www.europeanbusinessreview.eu/page.asp?pid=1820> (accessed 02.08.2017).

5.2.2 **Legal approaches and resilience**

In order to defend the national cyber security interests, namely communication systems from jamming, blinding or destroying of communication satellites, United States vice-president Mike Pence outlined plans to create a Space Force on 09 August 2018. According to the proposal of the Trump administration, the United States Space Force – or recently renamed United States Space Guard⁴¹ – would be a new branch of the military by 2020. Further plans unveil the planning of a United States Space Command and a Space Development Agency as well as the appointment of an assistant secretary of defence for space.⁴² Due to ESA's significant role in famous programmes, such as Galileo, GMES, Copernicus and SSA missions, hackers became increasingly interested. ESA's Computer and Communications Emergency Response Team (ESACERT) continuously observes the impacts in the European satellite system. Further, ESA is working on technical recommendations for its missions, to define their own cyber-security requirements, to protect the mission and the interests of the involved parties.⁴³ From a legal point of view, the existing legal framework is challenged by the uncertainties of the novel cyberspace environment. The allocation of cyber law in the set of international law is still disputed. Its concrete scope of application is rather unclear and the international community is in disagreement if and how cyber law can be applied to outer space activities. Further, this new field of law requires a certain degree of technical understanding. Nevertheless, reference can be made to established space law, namely Art. VI OST. The responsibility of a State would entail the obligation to refrain from accepting, encouraging and engaging in unauthorized cyber-attacks. It is up on the decisions of the individual State, whether it establishes a national cyber-law regime or becomes active in the establishment of international rules. Nevertheless, the applicability of Art. VI OST bears also some unclarities. What is a national interference? Can the State of origin of a cyber-attack be identified? The legal consequence would probably be the liability of the respective state under *lex generalis*, Art. VII OST and under *lex specialis*, Art. II or III Liability Convention. For a certain cyber-security system, international rules need to be elaborated to regulate cross-border cyber-attacks than cannot be covered by national laws due to the matter of State sovereignty. The requirements of an effective cyber-law

41 A. Anzaldúa, *A civilian space "guard" is not a military space "force" in The Space Review* on 03 December 2018. <http://www.thespacereview.com/article/3615/1> (accessed 01.12.2018).

42 E. Durkin, *Space Force: all you need to know about Trump's bold new interstellar plan*. <https://www.theguardian.com/us-news/2018/aug/10/space-force-everything-you-need-to-know>, (accessed 15.09.2018).

43 L. del Monte, *Towards a Cyber-Security Policy for a Sustainable, Secure and Safe Space Environment*, IAC-13.E3.4.8x16989, 64th International Astronautical Congress, Beijing, China, 2013.

regime correspond to those expanded in the context of commercialisation, such as clear definitions and problem areas as well as reflection of innovative developments. Such efforts already exist but need to be expanded. The establishment of the NATO Centre of Excellence for Operations in Confined and Shallow Waters (NATO COE CSW) in 2007 was a first step towards international measures. A result, was the 2013 Tallinn Manual on the International Law Applicable to Cyber Warfare, providing a source for international legal advisors. The Tallinn Manual 2.0 was released this year representing a discussed but most comprehensive analysis on how existing international law applies to cyber operations.

6. Conclusion

As the relevance of space activities is increasingly growing, the law governing these activities gains increasing relevance for both public and private actors. It is clear, that cooperation remains a core element of the peaceful uses of outer space. New legal mechanisms need to avoid unnecessary impediments of private space activities and at the same time have to comply with historical space law principles, such as the province of all-mankind maxim. The national interests of governments, international organisations, space agencies and private actors need to be balanced in this context. On the one hand it is important for traditional space actors to adapt to the developments of the Space 4.0 movement and to facilitate the new advantages of NewSpace, on the other hand, new space players have to accept that the compliance with international accepted standards ensures the survival of their activities in this harsh environment. States are free to offer particularly beneficial legal ecosystems to new space actors to create incentives for private investments, such as competitive advantages in their national legal systems and to provide socio-economic benefits as well as spill-overs. A cloudy and uncertain legal regime jeopardises public-and private space activities and paves the way for vulnerabilities and high-risks. Those are resulting from both cyber-threats and overly motivated but injudicious space endeavours, that are missing to consider the ultra-hazardous and risky space environment for the detriment of their States and all-humankind. What sparks investment in outer space activities is a legal regime providing for profit. It is crystal clear that the international community needs to strike the balance between reforming the existing space law instruments in order to make them ready to tackle the challenges of the new space era, while preserving well-established principles that are successfully ensuring cooperation and peaceful uses of outer space for the benefit of all humankind. The cooperative ratio of projects, such as the ESA Moon Village, should be considered by all space actors world-wide when creating new business models and needs also to be reflected in the adoption of new legal rules regulating the activities of Space 4.0. It is of utmost importance that the international community understands the relevance of exchange and cooperation even though the general environment

within the current space age is highly competitive. Cooperation will enable negotiations over a clear and reliable legal framework for new space activities and as such ensure the long-term execution and success of innovative business plans. Be it in the general context of commercialisation or in relation to cyber-security, traditional and modern space actors share the same concerns, and both are eager to ensure the success of their missions. Strong coordination efforts can be a key to tackle the challenges of this space era.