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Mahulena Hofmann/P.J. Blount (eds.)

Innovation in Outer Space: International and African Legal Perspectives

5th & 6th Luxembourg Workshops on Space and Satellite Communication Law

Nomos

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Faculty of Law, Economics and Finance
University of Luxembourg

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I. General Issues

Innovation in Outer Space: International and African Legal Perspectives – Lessons Learned

Mahulena Hofmann[*] *and P.J. Blount*[*]

As stressed by Karim M. Sabbagh, then CEO of SES, in the introduction to the Workshop on the Innovation in Outer Space: Legal and Regulatory Aspects, innovative technologies are crucial for the development of new space-based services that bring improvements in many areas of the everyday life. The publication *Innovation in Outer Space: International and African Legal Perspectives* is an outcome of research on the impact of innovation on legal instruments on space activities performed by specialists attending two Luxembourg workshops on Space and Satellite Communication Law.[1]

In addition to the analysis of particular subjects related to innovation, in these workshops there was an interest in contributing to the discussion on how innovations in exploration and use of outer space influence legal developments in general: Are the related international legal instruments drafted sufficiently broad not to impede technical developments? Should these instruments be amended to accommodate new situations? From this methodological point of view, the exploration and use of outer space are an object of research par excellence. In outer space, technological innovation is crucial and speedy, and information about successes in using new technologies is shared with the public at a large scale. As a consequence, its correlation with the corresponding legal developments can be well observed.

Francis Lyall generalises these phenomena writing that in outer space, "the need for appropriate law to cope with technologies has been compelling, but it has occurred by and large in reaction to developments, not

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1 The 2016 Workshop had the title "Innovation in Outer Space: Legal and Regulatory Aspects"; the 2017 Workshop was devoted to "Space Serving the Earth: Regulatory Framework in Africa."

in anticipation of those technologies."[2] This need to regulate has been accompanied by the possibility of setting up institutions for the very purpose of keeping the law up-to-date.[3] *P.J. Blount* observes the relationship between technology and law from the perspective how the law can encourage innovation, and he concludes that through the use of broad principles, the central source of the law of outer space – the 1967 Outer Space Treaty[4] – has effectively fostered innovation and change of space technology over the past fifty years.[5]

In contrast to the law of outer space, one of the central instruments of the international telecommunication law – the Radio Regulations – are updated every 3-4 years by the Member States of the International Telecommunication Union (ITU) at the World Radiocommunication Conferences. As outlined by *Mitsuhiro Sakamoto*, these modifications are taken so as to keep the Radio Regulations in step with technological developments, such as the appearance of new services using frequency spectrum that the current instruments do not accommodate.[6]

The next portion of this text covers specific innovations that present challenges for the space and telecommunications law. The first of these is the proliferation of non-GSO systems, such as cubesats and large constellations of non-GSO satellites. As stressed by *John Purvis and Gerry Oberst,* these challenges arise from how these constellations shall use orbits, from the higher risk of space debris, and from their use of radio spectrum.[7] Moreover, projects that plan to employ large numbers of non-GSO satellites shall influence the interpretation of numerous existing provisions of international space law, including those on the registration of space ob-

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2 F. Lyall, "Reaction of International Law to Technical Developments," in this book, p. 19 ff.

3 Ibid.

4 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, UNTS, vol. 610, No. 8843.

5 P.J. Blount, "Innovating the Law: Fifty Years of the Outer Space Treaty," in this book, p. 31 ff.

6 M. Sakamoto, "WRC's Challenge to Meet Technology Development," in this book, p. 53 ff.

7 J. Purvis and G. Oberst, "Non-GSO Constellations: Overview," in this book, p. 113 ff.

jects. According to *Elina Morozova*, the 1975 Registration Convention[8] was formulated to register single satellites and not large constellations within the UN system; therefore, the launching of these constellations will require a set of recommendations outside the letter of the Convention, yet within its spirit, to further improve the regulatory framework.[9]

The arrival of large or mega-constellations will also have implications on the international recommendatory rules on space debris mitigation. As explained by *Marco Ferrazzani*, the Space Debris Mitigation Guidelines,[10] formulated both at the technical and political level with the significant involvement of the European Space Agency, put pressure on operators of new space systems to ensure that satellites are safely deorbited to reduce the amount of new debris created.[11] However, as stressed by *Olga Stelmakh-Dresher*, it appears that no work, as of yet, has been initiated towards better definition of Guidelines that would take into account the launching of large constellations of small satellites, and the solution should be reflected in an updated version of Guidelines.[12]

The next innovative space-based technology dealt with in the workshop was the use of satellite services for command and control of unmanned aerial vehicles (UAVs). *Frans von der Dunk* analyses this technology and argues that current space law extends to the use of UAVs only to the extent that satellites are used for their operations. Specifically, he notes that the 1972 Liability Convention[13] cannot serve as a basis for claims regarding damage caused by the UAVs.[14] In contrast to the use of the UAVs, Earth observation from space can be labelled as a "traditional" use of outer space. Despite this, also this activity is experiencing disruptive changes in

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8 Convention on Registration of Objects Launched into Outer Space, UNTS, vol. 1023, No. 15020.

9 E. Morozova, "Registration of Non-GSO Constellations," in this book, p. 121 ff.

10 Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, endorsed by the Committee on the Peaceful Uses of Outer Space at its fiftieth session and contained in A/62/20, annex.

11 M. Ferrazzani, "The Development of a New Space Economy and of Mega Constellations," in this book, p. 93 ff.

12 O. Stelmakh-Drescher, "Global Space Governance for Space Sustainability," in this book, p. 65 ff.

13 Convention on International Liability for Damage Caused by Space Objects, UNTS, vol. 961, No. 13810.

14 F. von der Dunk, "Unmanned Aerial Vehicles, their Use of Satellite Services and (Space) Law," in this book, p. 155 ff.

technologies and markets that challenge the legal framework based on the 1986 UN Remote Sensing Principles.[15] According to *Ingo Baumann* and *Erik Pellander*, new Earth observation satellites in the form of large constellations of small satellites are emerging. Furthermore, the provision of Earth observation services via the Internet and through platforms with diverse commercial elements can result in legal issues relevant to the IT and e-commerce sectors. In light of this, the question of protection of personal data acquired via Earth observation technologies is becoming more relevant than ever before.[16]

Not only are international legal regimes challenged; regional and national regimes must cope with innovation as well. *Leopold Mantl* analyses this in the European context using the example of the Galileo global navigations system. He notes that the clear division of tasks between the various entities involved in the program is crucial for the success of the program. This division is facilitated by means of delegation agreements concluded by the European Commission, the European GLSS Agency (GSA), and the European Space Agency (ESA).[17]

At the national level, *Fabio Tronchetti* discusses the fact that two States – The Netherlands and Belgium – have modified their legislation to adapt it to the existence of small satellites. These changes became necessary to extend the scope of national space laws from active, manoeuvrable satellites and include "unguided" space objects. These changes make small satellites subject to the same licensing conditions as the larger, "guided" satellites.[18] Other States – the US and Luxembourg – have recently adopted specific legislation to establish authorization procedures for commercial projects that plan on the extraction and utilization of space resources. According to *Mahulena Hofmann,* these steps were necessary to comply with the requirements of Article VI Outer Space Treaty.[19]

To sum up, the contributions presented in the first workshop showed that the provisions of the Outer Space Treaty have been formulated in a

15 Principles Relating to Remote Sensing of the Earth from Outer Space, adopted by the General Assembly in its resolution 41/65 of 3 December 1986.

16 I. Baumann and E. Pellander, "New Legal Issues in Earth Observation Data and Services," in this book, p. 171 ff.

17 L. Mantl, "Galileo Programme – New Legal Developments," in this book, p. 187 ff.

18 F. Tronchetti, "Environmental Law Aspects," in this book, p. 137 ff.

19 M. Hofmann, "Space Resources: Regulatory Aspects," in this book, p. 199 ff.

sufficiently general way to accommodate the innovative uses of outer space. However, new legal norms seem to be needed to interpret more detailed legal regulations. First, in the area of international telecommunication law, new rules are needed to respond to the expansion of new radiocommunication services, which are adopted through a procedure governed by the ITU on a regular basis. Second, new recommendatory guidelines seem to be needed to add precision to the regimes of the Registration Convention and the Space Debris Mitigation Principles in order to accommodate the existence of the large NGO Constellations. Finally, recent developments in national legislation show the need for the development of local provisions to accommodate with innovative technologies, such as those dealing with space resources activities, which are clearly anticipatory of future technological developments.

While innovations in space technology drive and shape the law, it is important to remember that the international space law regime does not endorse innovation for the sake of innovation. Instead, the regime requires that space activities be conducted "for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development."[20] Though the humanist slant of international space law lacks specific requirements on how states should share the benefits of space innovations, space law does require that states pursue the betterment of humankind as a whole through the space activities. As examples, states have in the past pursued cooperative efforts in telecommunications, shared scientific data, and made available remote sensing data to states without Earth observation capabilities. As new innovations in technology emerge, these too should be used for the benefit of all states.

A critical question, then, with regard to innovation is how space innovation has been managed for the common benefit of all countries. This is the question pursued in the second part of the current volume through the specific lens of the African continent. This portion of the text probes how innovative space technologies have benefited the developing economies of the African continent as well as the law and policy mechanisms that guide the use of these technologies, both regionally and domestically. The African experience with space law and policy gives unique insight into

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20 Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, UNTS, vol. 610, No. 205, Art. I.

measuring the success of the goal of bringing benefits to all humankind through space technology.

To this end, *Tare Brisibe* notes that "a historical assessment of the role played by developing countries in the formulation of current international space law, points to the fact that African States created the greatest impact in the law-making process for outer space activities, concerning a variety of pivotal issues," especially those issues that implicated the interests of the developing world.[21] While this is true, he goes on to argue that African states have been hindered in effectively taking advantage of space technologies through a variety of external, international factors and internal, domestic factors. To this end, Brisibe argues that international cooperation among African nations as well as among African and non-African nations will be critical in pursuing the common interests of all states in space.

Cooperation is a touch point issue that is returned to repeatedly for understanding how innovation in space has benefited and can benefit Africa. *Ganiy Ishola Agbaje* surveys space activities and the supporting law and policy across the African continent looking at both regional organizations and individual states. Specifically, Agbaje highlights cooperative regimes that are meant to increase African access to space innovations. For example, she discusses projects such as the African Regional Centre for Space Science and Technology Education in English (ARCSSTE-E), a cooperative effort with the United Nations Office of Outer Space Affairs (UNOOSA) to develop "indigenous capability" in space science and technology.[22] International cooperation can be either regional or global, and both need law and policy structures to support these activities. *Timiebi Aganaba-Jeantry* traces the motives that underpin regional cooperative regimes, and then examines the initiative to establish an African space agency. She notes that space cooperation in the African context may be feasible "because actors are more closely aligned, and it provides for cost sharing and pooling of resources as well as increased influence on a global stage."[23] It is at this global stage that *Petr Havlík* engages in the discussion of international cooperation. He discusses the role of UNISPACE 50 in increasing

21 T. Brisibe, "Africa and Common Interest in Outer Space," in this book, p. 217 ff.
22 G.I. Agbaje, "Space and Telecommunications Activities in Africa: Organisational, Legal and Regulatory Aspects," in this book, p. 231 ff.
23 T. Aganabe-Jeantry, "Realizing a Regional Space Program," in this book, p. 257 ff.

engagement in international cooperation along with specific examples of partnerships between the EU and Africa.[24]

Historically, one of the key space innovations to bring benefits to Africa is that of telecommunications, and future innovations in space telecommunications will continue this trend. As in other regions, telecommunications activities require a great deal of cooperation and coordination among various users and stakeholders. Two authors in the current volume investigate the role of regional telecommunications cooperation in Africa. First, *Kezias Mwale* gives an account of the African Telecommunications Union (ATU) that covers both its organizational structure and legal features. Mwale also discusses the successes of the ATU, but he argues that it could "play a more proactive role in the development and promotion of ICT" by promoting investment and focusing of future innovative technologies.[25] *Edith Flore Sijou* also gives an account of the ATU, but her focus is on the ATU's role in promoting development of ICT technologies across Africa. While she notes several successes in this area, she states that there is a "need to focus on capacity building at all levels, including policy and regulatory environments, infrastructures, human resources, and development of local content services."[26]

While regional and international cooperation play an important role in bringing space innovations to states, states themselves must have law and policy structures that are prepared to take advantage of these innovations. The final two chapters of this volume seek to analyze specific state regimes for implementing space technologies and engaging in international cooperation. The case of Morocco is discussed by *Riffi Temsamani*. Specifically, he discusses the Royal Center for Remote Sensing (CRTS) as central hub for the use of remote sensing technology in Morocco and the policy and law that support it.[27] Finally, *Paschal Agbim* gives a comprehensive overview of the space law regime in Nigeria. Agbim paints a success story in the case of Nigerian space activities, but notes that the law

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24 P. Havlík, "UNISPACE-50 from the Perspective of Regional Cooperation," in this book, p. 273 ff.

25 K. Mwale, "ATU Role in Coordination of Radio Communications in Africa," in this book, p. 279 ff.

26 E.F. Sijou, "African Telecommunication Union in the Perspective of the Recent Developments," in this book, p. 291 ff.

27 R. Tessamani, "Space Activities and Space Law Situation in Africa: Case of Morocco," in this book, p. 303 ff.

itself needs further refinement to cope with innovation, in particular with regards to the licensing and control of private space actors.[28]

This volume highlights the ongoing tension between innovation and technology as seen in the space arena. It has attempted to achieve a balanced view by investigating innovation in terms of new and emerging technologies in the developed world as well as how those technologies bring benefits to the developing world with a specific emphasis on Africa. The march of technology can have the effect of creating obsolescence in the law and uncertainty in governing principles. Space law is not immune to these maladies, and the case studies in this volume survey the challenges that a new generation of space innovation hold for the legal regime governing outer space. As space technologies advance and spread across the globe, one of the key challenges for the space practitioner will be to maintain the law as a flexible and reactive instrument to ensure that space continues to be used for the benefit of all mankind.

Finally, the editors would like to thank the University of Luxembourg and the devoted organisational team for their support during the organisation of both recent Luxembourg Workshops on Space and Satellite Communication Law and *Sandra Cabrera Alvarado* for the preparation of this publication. They would also like to thank SES for its substantial involvement in these programs and for hosting of both events.

28 P. Agbim, "The Nigerian Space Legislation," in this book, p. 313 ff.

Reaction of International Law to Technical Developments

*Francis Lyall**

Abstract

International law always has had to invent, develop, and adapt in order to cope with developments in technology. Initially it may take time to determine jurisdiction in a particular matter, but thereafter it often becomes necessary for states to adopt a common approach. Then developments in the technology force the creation of more sophisticated mechanisms to keep these approaches up-to-date, often requiring the creation of authoritative regulatory bodies.

I. Introduction

The reaction of international law to technical developments has begun to become complex. When I started to work on this paper I was tempted to get its title rephrased. 'Developments in Technology and International Law' might be more accurate, because, usually, the technology comes first. Then as the technology comes into general use commerce gets involved. Indeed, it is often the commercial interests that demand law be invented. Joanne Gabrynowicz has put it well: "Technology that develops into applications tends to catalyze law that addresses the commercialization of the technology."[1]

Once invented law, both national and international, has to be kept relevant as technology continues to change. In many areas we now have institutions for the very purpose of keeping the law up-to-date, even if only approximately. There are excellent discussions of the problems involved, and

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* Professor Emeritus, University of Aberdeen.

1 J.I. Gabrynowicz, "One Half Century and Counting: The Evolution of U.S. National Space Law and Three Long-Term Emerging Issues' 2011 37 *J. Sp. L.* 41-71 at 41.

I recommend them.[2] This paper does not seek either to replicate or update their insights. Instead, I simply outline how technology has been coped with in four areas: the Law of the Sea, the Law of the Air, Telecommunications, and Space Law. Patterns are there to be discerned. At one stage, I had thought to include the Law of War, but it proved to be overwhelming. It is enough to note the relevant documents, namely, the Geneva Conventions of 1949, their predecessors the Hague Conventions of 1907,[3] the myriad agreements outlawing various weapons,[4] and the ICJ Advisory Opinion on the 'Legality of the Threat or Use of Nuclear Weapons,' together with the Declarations, Separate Opinions, and Dissenting Opinions attached to it by each of the fourteen judges.[5] Many of the UN family of specialised agencies could also provide other illustrations of how international law has dealt with developments in technology.

II. The law of the sea

I start with the Law of the Sea. Things were simple in Roman times. 'Mare Nostrum' was just that – 'Our Sea.' The law dealt only with practical matters. Thanks to Tribonian and the other virtuosi of the mediaeval art of cut and paste we have, for example, Digest IV.9, the edict *nautae, caupones, stabularii*.[6] Again, there had been the very early *Lex Rhodia de jactu* of some 800 bc, about merchandise jettisoned for safety reasons that persisted in influence into Roman times (see Digest XIV.2). However, in practi-

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2 See, for instance, J.L. Charney, 'Technology and International Negotiations' (1982) 76 *AJIL* 78–118; J.W. Dellapenna, 'Law in a Shrinking World: The Interaction of Science and Technology with International Law' (2000) 88 *Ky. L.J.* 809–884; M. Lachs, *The Law of Outer Space: An Experience in Contemporary Law-Making*, (Leiden: Sijthoff, 1972; reissued Leiden: Nijhoff, 2010); M. Lachs, 'View from the Bench: Thoughts on Science, Technology and World Law' (1992) 86 *AJIL* 673–99; C.B. Picker, 'A View from 40,000 Feet: International Law and the Invisible Hand of Technology' (2001) 23 *Cardozo L. Rev.* 149–219; and L.B. Sohn, 'The Impact of Technological Changes on International Law' (1973) 30 *Wash. & Lee L. Rev.* 1–18.

3 See the compilation by the International Committee of the Red Cross: https://www.icrc.org/en/war-and-law/treaties-customary-law/geneva-conventions.

4 Cf. the entries in the US State Department list of US Treaties, sv. 'Weapons': http://www.state.gov/s/l/treaty/tif/index.htm.

5 1996 ICJ 226.

6 The edict set out the liabilities of shipmasters, innkeepers, and stable-keepers in respect of goods consigned to them.

cal terms you sailed where you wanted to, provided you had the power to defy any who might object to your presence. Carthage was disposed of, but there were no rules and no Law of the Sea as we now know it. So it went on for centuries. Four centuries ago Venice dominated the Adriatic and most of the Mediterranean. The Battle of Lepanto of 7 October 1571 was not fought over some notion of territorial waters,[7] but seventy-five years earlier Vasco da Gama had shown a new way to the east, and traders from the north and west of Europe used less and less the trans-Mediterranean routes to the east. Ships could carry much more than camel trains. Shipping technology was also improving. Traders demanded security for their global commerce.

There came a collision. Portugal and Spain agreed to close off the sea routes to the East and the West. In *Mare Clausum* John Selden (1635) sought to justify English powers to control areas of the sea round the UK. *Per contra* Grotius' *Mare Liberum* (1609) held that the High Seas were free for all to traverse.[8] A century later the idea of the High Seas was becoming accepted, but where did they lie? In 1702 Cornelius van Bynkershoek sought to provide substance to Grotius' ideas. His *De Dominio Maris Dissertatio* argued that a coastal state's power should extend only as far as it could exercise effective control from the land – what we know as the cannon-shot rule. Bynkershoek did not disclose how far cannons could then shoot. Apparently, it was an Italian, Ferdinand Galiami, who calculated that the range of the most efficient cannon was a league – three nautical miles.[9]

Commentators accepted the three-mile rule for another two hundred years until the preparations for the UN Conference on the Law of the Sea of 1956–1958 disclosed that some states (mostly the newer ones) operated to a different measure. It also found that things other than pure navigation had to be taken into account. So we got the concepts of the Continental

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7 My home, Scotland developed a quaint idea, the 'land kenning.' A 'kenning' stems from the Germanic verb to 'ken' – to know. Scotland claimed fisheries jurisdiction out to the point where you, standing on the deck of a ship, could see the Scottish coast – 14 nautical miles on a clear day thanks to the horizon. Of course that was variable, depending on fog, and quite hopeless at night.

8 Though written earlier Selden's book was not published 1635, a quarter of a century after that of Grotius. James VI and I intervened to prohibit earlier publication because the matter had become diplomatically sensitive. James, a Scot, was a shrewd operator.

9 See the Wikipedia entry for Bynkershoek.

Shelf and the Exclusive Economic Zone, invented to deal with technical developments in off-shore drilling, fisheries and other matters. General agreement proved impossible so 1958 produced four separate Conventions, which attracted very variable numbers of ratifications.[10] Now, four centuries after Selden and Grotius, we have the 320 Articles and 9 Annexes of the package deal of UNCLOS III of 1982, itself amended in 1994, and to which some states including the US, remain non-parties.[11] UNCLOS has established the Law of the Sea Tribunal with jurisdiction to sort out many problems.[12] I am open to advice as to how successful these steps have been.[13]

So much for territorial jurisdiction. What of marine technologies? In fact we have created institutions to keep marine law up to date with technology. As ship technology changed and shipping increased other considerations emerged: safety of life at sea, ship maintenance, common licensing requirements for mariners, competence certification, and so on. Oil pollution became a problem when ships moved from steam to diesel engines. Disparate international agreements emerged to cope with a variety of maritime problems all rooted in technical developments. In 1958 many of these were brought together under the aegis of one of the UN Specialised Agencies, the Intergovernmental Maritime Consultative Organisation (IMCO), the basic instrument of 1948 having taken ten years to be brought into force. Renamed the International Maritime Organisation (IMO) in 1982, it currently has 171 members and three associated mem-

10 Convention on the High Seas (1963, 405 UNTS 82), the Convention on the Territorial Zone and the Contiguous Zone (1964, 516 UNTS 206), the Convention on the Continental Shelf (1964, 499 UNTS 312), Convention on Fishing and Conservation of the Living Resources of the High Seas (1966, 559 UNTS 286), all of 1958. Ratifications varied. These are still in force for parties who have not moved on to the 1982 UNCLOS III Convention, as amended.

11 UN Convention on the Law of the Sea, 1994,1833 UNTS 397; 1999 UKTS 81, Cm 4524, with the Agreement as to the Implementation of Part XI of the Convention, 1999 UKTS 82, Cm 4525; (1982) 21 ILM 1261–1354 with (1994) 33 ILM 1311–1327.

12 See Parts XI and XV and Annex VI to the UNCLOS Convention.

13 China's reaction to the complaint and to the decision in the case brought by the Philippines as to China's actions in the South China Sea, is worrying. See *In the Matter of the South China Sea Arbitration, Philippines v. China*, PCA Case No. 2013–19, 2016.

bers.[14] If you will forgive the pun, the IMO now supervises, discusses, revises, and proposes a whole raft of maritime conventions,[15] such as the 1973 International Convention for the Pollution from Ships (MARPOL) and the 1974 International Convention for Safety of Life at Sea (SOLAS), among others.[16]

III. The law of the air

The development of the Law of the Air is similar, but faster. I leave aside all those explorations of '*cuius est solum.*'[17] When the question of a right to fly came up the immediate point was whether a state could control its airspace, and if so 'how high' was 'up'? Ballooning goes back to the brothers Montgolfier in the Eighteenth century, but those early flights were subject to the vagaries of the wind. However, by the 1890s dirigible airships had come on the scene and were not sticking within national boundaries. German dirigibles flew over the Maginot line. Could that be stopped? Could you simply up-end and apply vertically the concept of a territorial sea? How about a vertical 'cannon-shot' principle coupled with freedom to fly higher? Pierre Fauchille and others set to working things out. Eventual-

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14 Convention on the Intergovernmental Maritime Consultative Organisation, 1948, 289 UNTS 48; 1958 UKTS 54, Cmnd, 589; 9 UST 621, TIAS 4044 (in force 1958).

15 The IMO website is http://www.imo.org. S. Mankabady, *The International Maritime Organization* (London: Croom Helm (now Routledge), 1986).

16 See the IMO list at http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/Default.aspx. Major examples are SOLAS, the International Convention for the Safety of Life at Sea, 1974,1980 UNTS 278; 1980 UKTS 46, Cmnd. 7874; 32 UST 47, TIAS 9700, MARPOL, the International Convention for the Prevention of Pollution from Ships, 1973, 1983 UNTS 184; 1974 UKTS Misc. 26, Cmnd. 5748, and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STOW), 1978, 1361 UNTS 190; 1984 UKTS 50, Cmnd. 7543; each with subsequent amending Protocols.

17 F. Lardone, 'Airspace Rights in Roman Law' (1931) 2 *Air L. Rev.* 455-67; J.C. Cooper, 'Roman Law and the Maxim "Cuius est solum" in International Air Law' in I.A. Vlasic ed., *Explorations in Aerospace Law: Selected Essays by John Cobb Cooper*, (Montreal: McGill UP, 1968)) 54-102; H.D. Klein 'Cuius Est Solum, Eius Est … Quousque Tandem?' (1959) 26 *J. Air L. & Com.* 237-54; F. Lyall, 'The Maxim "*Cuius Est Solum*" in Scots Law' 1978 *Jur. Rev.* 147-69.

ly there was the draft Paris Treaty of 1910, which incidentally would have allowed a right to over-fly.[18]

The First World War put an end to such fine thoughts. As I have often said, there is nothing like war for producing developments in technology. Dirigibles were displaced. The future was the airplane. Modern aviation was looming. Immediately after WWI things were sorted out in the Paris Convention of 1919. Note its full title: it is the Convention on the Regulation of Aerial Navigation;[19] 'regulation' being a very clear international law reaction to technical developments. There are three points here. First is the establishment of the right of a state to control; second is the introduction of technical rules as to the use of the technology; and third is the establishment of mechanisms for their up-dating.

On the matter of states' rights, Art. 1 of the 1919 convention cuts to the point. All states, not just the parties to the Convention, had complete and absolute sovereignty over their superjacent air-space. The Paris Convention presents that principle as if it were settled law, not a novelty. Given the pre-War discussions, that was overstated. No matter. Just like the Law of the Sea and the territorial sea, a basic provision was made as to who controlled the use of the air. Of course, to facilitate commerce the impact of absolute sovereignty had to be softened by the freedom of innocent passage for parties to the 1919 Convention (Art. 2).

So much for the territorial question. What about the use of the technology? The 1919 Paris Convention had provisions dealing with technical matters, some of which had been agreed back in 1910. The Convention included Arts. 8–10 on the nationality of aircraft and registration matters, including the requirement that planes bear registration marks; Arts. 11–13 on the certification of airworthiness and competence; Art. 14 on the use of

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18 P. Fauchille, 'Le domaine aerien et le regime juridique des aërostats' (1901) 8 *Rev. Gen. de Droit Int. Pub.*, 414 (also Paris: Dalloz, 1901), and his Report on the 'Projet de convention sur le regime des aërostats en temps de paix' given to the 1910 Paris Session de L'Institut de Droit International, together with a draft convention, (1910) 23 *Ann. L'Inst. de Dr. Int.*, 297-311. 'Draft International Convention on Aerial Navigation', Paris 1910, Appendix to the Report of the Civil Aerial Transport Committee, 1918, 1918 UKSP Vol. V, 17, Cd. 9218. See also J.C. Cooper, 'The International Air Navigation Conference, Paris, 1910' (1952) 19 *J. Air L. & Com.* 12, reprinted, Cooper, *Explorations* (*supra* n. 18) 104-24.

19 Convention on the Regulation of Aerial Navigation, Paris, 13 October 1919, 11 LNTS 173; 1922 UKTS 2, Cmd. 1609; 1 Hudson 359; 13 Martens (3d) 61; (1923) 17 AJIL Supp. 195.

radio; Arts. 15–18 on navigation; Arts. 19–22 on certifications; and so on. These provisions were fairly general. Eight Annexes (A–H) to the Convention spelled out the details.[20] However, the negotiators also recognised that aviation technology would not remain static. An International Commission for Air Navigation (ICAN) was set up to keep matters under review in Art. 34. International law had responded to the new technology, but of course within twenty years war resumed and things had to be rethought.

The Second World War vastly improved aviation technology. A new general treaty and a world-wide rule-making organisation were needed. Article 1 of the Convention on International Civil Aviation, 1944,[21] restated 'absolute sovereignty,' the right of the state to dictate what happened above it, but its accompanying 'Two Freedoms' and 'Five Freedoms' Agreements to permit access and/or overflight under particular conditions were not widely acceptable.[22] Those attempts to grapple with the new potential for commercial international aviation stalled. Bilateral agreements were to rule for decades,[23] though now, thanks to commercial pressures (themselves perhaps classifiable as a technical development), a series of Open Skies Agreements is supplanting many bilateral arrangements. More importantly, and directly on law and technology, the Chicago Convention created the International Civil Aviation Organisation (ICAO) through which many practical aspects of international aviation is regulated. The nineteen annexes to the Convention, known as the Standards and Recommended Practices (SARPs), are complex, technical, and regularly re-

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20 These covered: A) the Marking of Aircraft, B) Certificates of Airworthiness, C) Log Books, D) Rules as to Lights and Signals, and the Rules of the Air, E) the Minimum Qualifications necessary for Obtaining Certificates as Pilots and Navigators, F) International Aeronautical Maps and Ground Markings, G) the Collection and Dissemination of Meteorological Information, and H) Customs Regulations for Aircraft.

21 Convention on International Civil Aviation, Chicago, 7 December 1944, (1944) 15 UNTS 295; (1953) UKTS 8, Cmd. 8742; (US) 61 Stat. 1180, TIAS 1591; 9 Hudson 168; 3 Bevans 944; (1945) 39 AJIL Supp 111; ICAO Doc. 7300/9, 2006.

22 The International Air Services Transit Agreement, 1944: 84 UNTS 389; 1953 UKTS 8, Cmd. 8742; (US) 59 Stat. 1693, 3 Bevans 916. The International Air Services Transport Agreement 1944, 171 UNTS 388.

23 Bin Cheng, *The Law of International Air Transport* (London: Sweet & Maxwell, 1977).

viewed. [24] There, clearly, international law reacts to technical development.

IV. Telecommunications

Once wired electrical communications became possible the development of relevant international law was swift,[25] but here we encounter something interesting. What telecommunications technologies could achieve was and is corseted by the laws of physics. Of course, what happened with the confines of a single state was and is for that state to determine, but what about trans-border communication? Initially a clerk at the end of one cable took down a message and re-keyed it into the cable network of the neighbouring state. Sometimes the clerk had to walk across the border, message in hand. But it made more sense physically to connect the systems. Arrangements were first made among the parts of what was later to become Germany. That required system compatibility within the parameters of physical laws. At the very least voltage and current had to agree, and common codes and protocols adopted for messaging. International standards and procedures were needed.[26] The Austro-German Telegraph Union was created. That model was followed by others. France and the West imitated it. But separate unions made little sense, and so in 1865 the International

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24 The current Annexes are: 1. Personnel Licensing; 2. Rules of the Air; 3. Meteorological Services for International Air Navigation; 4. Aeronautical Charts; 5. Units of Measurement to be used in Air and Ground Operations; 6. Operation of Aircraft; 7. Aircraft Nationality and Registration Marks; 8. Airworthiness of Aircraft; 9. Facilitation; 10. Aeronautical Telecommunications; 11, Air Traffic Services; 12. Search and Rescue; 13. Aircraft Accident and Incident Investigation; 14. Aerodromes; 15. Aeronautical Information Services; 16. Environmental Protection; 17, Security... against Unlawful Interference; 18. Safe Transport of Dangerous Goods by Air; 19. Safety Management.

25 For the history see F. Lyall, *International Communications: The International Telecommunication Union and the Universal Postal Union* (Farnham: Ashgate, 2011: Routledge, 2016); G.A. Codding, Jr., *The International Telecommunication Union: An Experiment in International Cooperation* (Leiden: Brill, 1952; New York: Arno Press, 1972).

26 The first agreement as to the physical inter-connection of systems was the First Supplementary Convention of the Austro-German Telegraph Union [Austria, Bavaria, Prussia, Saxony and Württemberg] Vienna, 14 October, 1851, 106 CTS 371.

Telegraph Union came into being, taking on the area of telephone communication twenty years later.

Forty years later along came the new technology of radio. Because radio is broadcast, not confined to cable, the problems of radiofrequency interference had to be solved. The solution adopted in 1906 included rules as to transmission power, the fine-tuning of frequency use, and the setting aside of particular frequencies for particular purposes.[27] All these were, of course, law accommodating the new technology. Keeping such matters up-to-date was dealt with by what was informally termed the International Radio Union, though it never existed as a formal international organisation. Then in 1932 the wired and wireless services were brought together in the International Telecommunication Union (ITU).[28]

Again, we see the effects of War. The ITU was revivified by the 1947 Atlantic City Convention.[29] Post-War telecommunications technology required increasingly complex legal regulation and many skills were developed. That is why when the use of space opened up, the ITU was both willing and active in dealing with the new facility. Indeed, it was active even before the UN requested it so to be.[30] However, I also note that the 1992/94 restructuring of the ITU into its current form was to a very considerable extent brought about by the inability of the immediately post-war ITU adequately to cope with the increasing demands made upon it by

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27 Radio-telegraphic Convention, Final Protocol and Regulations, Berlin, 1906, 1909 UKTS 8, Cd. 4559; 99 BFSP 321 and 333; (1906) UK Parl. Papers, HC 368, (1906) UK State Papers, vol. CXXXVIX; and http://earlyradiohistory.us/1906conv.htm. The Convention and Final Protocol (but not the Service Regulations) are at 203 CTS 101; 99 BFSP 321; (US) 37 Stat. 15665, TS 568; (1906) 3 AJIL Supp. 330-40; (1923) 3 Malloy 2889; 1 Bevans 556.

28 Telecommunication Convention, General Radio Regulations, Additional Radio Regulations, Additional Protocol (European), Telegraph Regulations and Telephone Regulations, Madrid, 9 December 1932; 151 LNTS 4; (US) 49 Stat. 2391, TS 867; 6 Hudson *Int. Leg.* 109; 3 Bevans 65.

29 International Convention on Telecommunications, Atlantic City, 1947; 193 UNTS 191; 1950 UKTS 76, Cmd. 8124; 148 BFSP 684; 63 Stat. 1399, TIAS 1901; 4 Bevans 470. Radio Regulations annexed to the Convention: 194 UNTS 5, with Appendices, 195 UNTS 5; Additional Radio Regulations, 195 UNTS 119; Additional Protocol, 195 UNTS 153; Recommendations and Resolutions adopted by the International Radio Conference, 195 UNTS 175.

30 The 1959 World Administrative Radio Conference adopted definitions of transmitting and receiving stations for space purposes and allocated radio frequencies for space research.

developments in space. The mechanisms had to be re-worked. Now we see the modern regularity of quadrennial ITU conferences, the rolling programmes of the Radiocommunication Sector, and the regulatory output, which we know as the Radio Regulations. Developments in technology and commercial and other pressures have caused the law to develop.

V. Space law

Within two years of Sputnik I (1957) the UN had set up the Committee on the Peaceful Uses of Outer Space (UNCOPUOS). Within ten years came the Outer Space Treaty of 1967,[31] followed in the next twelve by the other four space treaties.[32] Clearly, international law was reacting well to new technologies. However, as we all know rule-making for space by treaty has virtually ceased. UNCOPUOS just does not have the same competence as the IMO or ICAO. Instead, the processes of soft law have taken over, and I would suggest that, allowing change as it does, for the present at least soft space law may have advantages.[33] On the other hand where clear rules are needed I have already noted how the ITU swiftly took on board the radio needs of space. The Radio Regulations do react to new needs.

VI. Conclusion

The need for appropriate law to cope with technologies has been compelling, but it has occurred by and large in reaction to developments, not in anticipation of those technologies.[34] Very often it has been commercial

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31 *Cologne Commentary on Space Law*, Vol. 1 (Cologne: Carl Heymanns Verlag, 2009), S. Hobe, B. Schmidt-Tedd, K-U. Schrogl, eds., (G.M. Goh, asst. ed.).

32 *Cologne Commentary on Space Law*, Vol. II (Cologne: Carl Heymanns Verlag, 2013), S. Hobe, B. Schmidt-Tedd, K-U. Schrogl, eds., (P. Stubbe, asst. ed.).

33 *Cologne Commentary on Space Law*, Vol. III (Cologne: Carl Heymanns Verlag, 2015), S. Hobe, B. Schmidt-Tedd, K-U. Schrogl, eds., (P. Stubbe, asst. ed.); I. Marboe, ed., *Soft Law in Outer Space: The Function of Non-binding Norms in International Space Law*, (Vienna: Böhlau Verlag, 2012).

34 At last year's workshop I spoke of the ITU Radio Regulations setting aside the far-side lunar crater Daedelus as an interference-free zone for radio-astronomy and the search for extra-terrestrial intelligence.

pressures that have both provoked and exploited technical development. It has also been those pressures that have demanded the responses of international law. I repeat Joanne Gabrynowicz: "Technology that develops into applications tends to catalyze law that addresses the commercialization of the technology."[35]

Patterns run through my examples. First, it was always necessary to determine the question of jurisdiction – who could take action in response to technical developments. Sometimes this has been slow as with maritime and marine matters. Second, comes a recognition that it makes sense that state reaction to technology should be harmonised, if not made uniform. Third, there comes the need to provide mechanisms through which change in technology is matched by developments in the international regulation, thus we have the IMO, ICAO, and the ITU.

Some final points, first, one I have already made both here in Luxembourg and elsewhere. When international law responds to developments in technology, it really does need to be formed by experts in those technologies. Second, such experts themselves need far-seeing advisers. Entrepreneurs and commercial enterprises will exploit flaws and *lacunae* in international rules; a phenomenon that seems ingrained in the very nature of modern commercial practice. Someone has to spot these opportunities in draft so they are avoided. 'Flags of convenience' should not have happened. The 'paper satellite' problem should have been foreseen and avoided.[36] Last, there can be a difficulty at the national level. Commercial enterprises do forum-shop to incorporate in states where congenial supervision can be expected. It is one thing for a state to have a 'business friendly' attitude, but quite another to attract by deliberately offering a less-demanding regime. I am worried by the propensity of states to compete to attract business.

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35 *Supra* n. 2.

36 D. Riddick, 'Why does Tonga own Outer Space?', 19 *Air & Sp. Law*, 15-29; J.C. Thompson, 'Space for Rent: The International Telecommunication Union, Space Law and Orbit/Spectrum Leasing' (1996) 62 *J. Air Law and Comm.* 279-311.

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