

Registration Aspects of Mega-Constellations' Satellites Under International Law

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Abstract

Operation of mega-constellations has become very popular in the private space industry recently. Big space companies like SpaceX or OneWeb have already started launching their satellites of mega-constellations for providing high-speed internet all over the world. For instance, satellite internet constellation 'Starlink' includes over 1,700 satellites; OneWeb has more than 400 satellites. Such space faring nations as China (Tianxian) and Russia (Sphere) also have plans of deployment mega-constellations.

Mega-constellations have many advantages: comprehensive or local coverage of the Earth's territory, multiple satellites simultaneously launch and the high technical performance of the whole constellation. This new applied space activity is very beneficial economically but from the legal point of view there could be some questions, one of them deals with registration process. Some of the registration aspects will be discussed in this paper from the point of international space law and telecommunication law view.

1. Introduction

Most part of different types of space activities got regulation after starting. When the first satellite Sputnik-1 was launched there were not any international legal regulation, specialized national space legislation, or policy. Space activities of XXI century differ significantly from the last period. There are many states which have national plans and programs in space domain; and there are numerous non-state actors, or NewSpace.¹ The main aim of non-state actors to profit from space activities. That is why they are always in search of new types of space activities to obtain income.

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1 See: Ch. Stotler, What Is NewSpace? In Monograph Series IV: NewSpace Commercialisation and the Law, Md T. Ahmad, J. Su (Eds.), Hein, Getzville, 2017, pp. 1-12.

One of the most promising of the practically implemented and profitable space activities is the deployment and operation of satellite constellations, and mega-constellations. But if satellite constellations are being used a considerable period of time, mega-constellations have been popular recently. Such American commercial company like SpaceX has already had mega-constellation ‘Starlink’² and continues to deploy it. Another one is British mega-constellation ‘OneWeb’.³ Other states also have plans to deploy mega-constellations too.

Despite numerous advantages of deployment of satellite constellations and mega-constellation in practice this space activity leads to a number of technical and international legal problems, including impediments to astronomical research both from Earth and in space, space debris’ and traffic management’s challenges, etc.⁴ The need for a special procedure for the registration of mega-constellation among above-mentioned international legal issues.

Considering that *lex lata* contains documents dedicated to the registration aspects in space activities, the below analysis will be dedicated to the registration peculiarities of mega-constellations under international law, especially space and telecommunication law.

1.1. Notion, Characteristics and Types of Satellite Constellations

Accordance with our previous research (A. Abashidze, I. Chernykh, M. Mednikova) “a constellation of satellites means a group of satellites that function together in such a way as to complement each other due to pre-selected orbital-frequency positions at which they are located and provide appropriate ground coverage for various specified purposes.”⁵

Constellations of satellites have many advantages like simultaneously activity, complementarity, full global or local coverage of the Earth’s territory, cost-effectiveness.⁶

Constellations of satellites can be classified according to different parameters, which may be useful for the registration purposes.

Depending on their number, they can be divided into small constellations of satellites (2 or more satellites), and mega-constellations (100+ satellites).

Small constellations of satellites in low-Earth orbit are the telecommunications systems Iridium (USA), or Globalstar (USA), navigation

2 Official Website of Starlink, <https://www.starlink.com/> (accessed 03.08.22).

3 Official Website of OneWeb, <https://oneweb.net/> (accessed 03.08.22).

4 A. Abashidze, I. Chernykh, M. Mednikova, Satellite constellations: International legal and technical aspects, *Acta Astronautica*, 196 (2022) 176-185, <https://doi.org/10.1016/j.actaastro.2022.04.019> (accessed 03.08.22).

5 A. Abashidze, I. Chernykh, M. Mednikova, Satellite constellations: International legal and technical aspects, *Acta Astronautica*, 196 (2022) 176-185, <https://doi.org/10.1016/j.actaastro.2022.04.019> (accessed 03.08.22).

6 *Ibid.*

systems Galileo (European Union), GPS (USA), BeiDou (China), the satellite navigation system GLONASS (Russia).

The deployment of mega-constellations is carried out by the American SpaceX (the Starlink project) and the OneWeb (UK).

Future projects in this area include the Ether project (a part of the “Sphere” project, Russia); the Guowang (China); the Tianxian (China); the Viasat (USA); THE Lightspeed LEO by Telesat (Canada); Amazon’s Project Kuiper (USA); Boeing’s project (USA); Astra’s plans (USA); Mangata Networks (South Korea-U.S.-based startup).

It is possible to distinguish the classification of satellites constellations depending on the type of orbit: by eccentricity (circular, elliptical, parabolic, hyperbolic), by the height of the geocentric orbit (low-orbit – up to 2,000 km, medium-orbital – from 2,000 to 35,786 km, high-orbit), by inclination (near-equatorial, oblique, polar, circumpolar), by synchrony (synchronous (including geosynchronous), semisynchronous, oversynchronous), etc.

Sometimes satellites of a constellation can be located in different orbits. In that regard it is suggested to differ equal (one type of an orbit is used) and mixed constellation (different orbits are used).

As for the type of satellites included in the constellation, the constellation can consist of both *small satellites* and *traditional* satellites.

It is also proposed to single out the classification of satellite constellations depending on the *goals*: navigation, telecommunication (communications, Internet) and research (for example, to study the spectral radiance shell of the Earth).

Moreover, there are not a universal international legal concept of a ‘constellation of satellites’. In practice, such concepts as ‘constellation of satellites’, ‘formation’, ‘space communication system,’ ‘satellite system,’ ‘mega-constellation,’ ‘large constellation,’ ‘созвездие’ (in Russian), ‘constellation of spacecraft’ etc. can be used.

1.2. Registration

All principles of international space law apply to activities related to the deployment and use of satellite constellations. At the same time the registration procedure of space objects is well regulated in international space law in spite of some ‘grey zones’. For instance, current time when a State of registry shall furnish to the Secretary-General of the United Nations (hereinafter – the UN) with information about a space object. Today, the wording is “as soon as practicable”, that means that States Parties to the Convention on Registration of Objects Launched into Outer Space 1975 (hereinafter – the Registration Convention) can do it in different times.

Concerning Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies 1967 (hereinafter – the Outer Space Treaty), the main provision on registration enshrined in it, is the following (Art. VIII):

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

This provision connects a State who registered a space object not only with jurisdiction and control aspects but with responsibility and liability questions too enshrined in Arts. VI and VII of the Outer Space Treaty.⁷

For instance, concerning liability prof. Armel Kerrest and prof. Lesley Jane Smith write: “The liability of a launching State in terms of Article VII is further linked to the rules on registering space objects contained within Article VIII. Registration of a space object is a primary, but not exclusive, indication of launching State status. Liability of a launching State may arise for space objects that appear in the appropriate registry maintained at national level”.⁸

It is important that the principle contained in Art. VIII of the 1967 Outer Space Treaty, was further developed in the Registration Convention:

*Article VIII of the Outer Space Treaty implies the existence of a national registration for space objects by the State Party to the Treaty. The obligation to register is defined in detail by the Registration Convention. It combines elements of compulsory national and international registration, whereby States Parties to the Registration Convention are entrusted with two essential duties, namely, to maintain an appropriate national registry of space objects according to Art. II paragraph 1 Registration Convention and to furnish the information referred to in Art. IV to the UN Secretary General.*⁹

7 See: M. Gerhard, Article VI, in S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl (Eds.), Cologne Commentary on Space Law in three Volumes (Volume 1 Outer Space Treaty), Carl Heymanns Verlag, Cologne, 2009, item 50-51 “Inter-relation between Articles VI, VII and VIII of the Outer Space Treaty”, pp. 115-116.

8 A. Kerrest, L.J Smith, Article VII, in S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl (Eds.), Cologne Commentary on Space Law in three Volumes (Volume 1 Outer Space Treaty), Carl Heymanns Verlag, Cologne, 2009, item 48, pp. 139.

9 B. Schmidt-Tedd, S. Mick, Article VIII, in S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl (Eds.), Cologne Commentary on Space Law in three Volumes (Volume 1 Outer Space Treaty), Carl Heymanns Verlag, Cologne, 2009, item 25, pp. 152.

Definitely, the Registration Convention is a detailed document which provisions cover different aspects of a registration process, and it makes a link between a launching State and a State of registry.

As it was mentioned, from the constellations point of view, the registration process refers to every satellite which is a member of a constellation. One of the most important provisions in that regards is information concerning each space object carried on a registry of a State Party to the Registration Convention (Art. IV), which are:

- (a) *Name of launching State or States;*
- (b) *An appropriate designator of the space object or its registration number;*
- (c) *Date and territory or location of launch;*
- (d) *Basic orbital parameters, including:*
 - (i) *Nodal period;*
 - (ii) *Inclination;*
 - (iii) *Apogee;*
 - (iv) *Perigee;*
- (e) *General function of the space object.*

Moreover, a State Party can provide the Secretary-General of the UN with additional information concerning a space object carried on its registry. Today 3 States signed and 74 ratified it (latest are Oman and Bahrain).¹⁰ Also 4 international organizations made a declaration of acceptance of rights and obligations.¹¹

If a State does not a Party to the Registration Convention, it has another international obligation to provide information about launched space object under UN GA Resolution 1721 B (XVI) of 20 December 1961 “International cooperation in the peaceful uses of outer space.” Prof. Bernhard Schmidt-Tedd and prof. Stephan Mick state that “For State Parties to the Outer Space Treaty which are not party to the Registration Convention, reference has to be made to the UN GA Resolution 1721 B (XVI). Most of the provisions of the Outer Space Treaty are viewed as having acquired the status of customary international law and the general obligation to register space objects is a universally accepted principle, despite discrepancies in detail”.¹²

10 Latest Depository Notifications, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/status/index.html>, (accessed 01.08.22).

11 UN Document A/AC.105/C.2/2022/CRP.10*, https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_10_0_html/AAC105_C2_2022_CRP10E.pdf, (accessed 02.08.22).

12 B. Schmidt-Tedd, S. Mick, Article VIII, in S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl (Eds.), *Cologne Commentary on Space Law in three Volumes (Volume 1 Outer Space Treaty)*, Carl Heymanns Verlag, Cologne, 2009, item 25, pp. 152.

The UN GA Resolution 1721 B (XVI) contains the following:

[General Asseble] “*Calls upon States launching objects into orbit or beyond to furnish information promptly to the Committee on the Peaceful Uses of Outer Space, through the Secretary-General, for the registration of launchings.*”

Today the Secretary-General and the UN OOSA responsibly for the maintenance of the UN Register of Objects Launched into Outer Space accept information under the Registration Convention and the UN GA Resolution 1721 B (XVI).

However, there are other documents which are touch upon registration process. Firstly, it is soft law documents drafted and adopted to develop some provisions of the Registration Convention and other outer space treaties.

UN GA Resolution 62/101 of December 17, 2007 “Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects”. It contains provisions whereby States are encouraged, on a voluntary basis, to provide expanded and uniform information on space objects launched, thus complementing in part the Registration Convention.

For instance, in accordance with para. 2 of the Resolution it can be:

- (i) *The Committee on Space Research international designator, where appropriate;*
- (ii) *Coordinated Universal Time as the time reference for the date of launch;*
- (iii) *Kilometres, minutes and degrees as the standard units for basic orbital parameters;*
- (iv) *Any useful information relating to the function of the space object in addition to the general function requested by the Registration Convention.*

One more resolution is General Assembly Resolution 59/115 of 10 December 2004 “Application of the concept of the ‘launching State’”. The Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space 2019 (hereinafter – the Long-Term Sustainability Guidelines) also contains some provisions dedicated to the registration. The most important challenge of these documents is to encourage States to become parties to the Registration Convention and to motivate States Parties to the Registration Convention fulfill their international obligations. To provide examples, the Long-Term Sustainability Guidelines contains Guideline A.5 to enhance the practice of registering space objects as it is “a key factor in the safety and the long-term sustainability of space activities.”

Besides the COPUOS and the UN OOSA have other instruments posted on the official website in the section of the site titled “United Nations Register of Objects Launched into Outer Space” and “Resources and Reference Material for States & Organizations.” For example, Handbook for developers and operators of small satellites developed by the United Nations Office for Outer Space Affairs, together with ITU, titled the “Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites.”

1.3. Telecommunication law, ITU and registration

Although ITU does not register satellites or constellations. It has other responsibilities having to do with satellites and their management.

ITU is responsible for management of the radio frequency spectrum and satellite orbits in addition to other duties on telecommunications in the framework of the Telecommunication Standardization (ITU-T) and the Telecommunication Development Sectors (ITU-D). ITU Radiocommunication Sector (ITU-R) deals with frequency management. The last includes allocation, allotment, and assignment.

To do it ITU guides States under Radio Regulations which are part of the Administrative Regulations. Radio Regulations are mandatory for ITU Member-States. Radio Regulations contains the complete texts as adopted by the World Radiocommunication Conference and subsequently revised and adopted by World Radiocommunication Conferences, including all Appendices, Resolutions, Recommendations and ITU-R Recommendations incorporated by reference.

Also, part of the ITU mandate is to help ensure satellite systems (including constellations) can operate in outer space, without interfering with each other or with other radio systems.

Without going into details, the whole process of frequency and orbits management is not fast. Taking into account, that operators of satellites or mega-constellations have to receive an approval of the launch at the national level and States (telecommunication administration) have to receive allotment in the framework of the ITU's procedure. Moreover, satellites of mega-constellations are deployed by several launches during several months or years. In addition, it is worth noting that ITU to struggle with ‘paper’ satellites has very strict deadlines and rules.

Satellite filings must be used within a certain timeframe – 7 years from the date of receipt of the request. Otherwise, their validity expires. Another measure aimed at preventing radio-frequency spectrum warehousing was approved by ITU Member States at the 2019 World Radiocommunication Conference. This is a milestone-based process, whereby non-geostationary satellite systems must deploy 10 per cent of their constellation within 2 years after the end of the current regulatory period for bringing into use,

*50 per cent within 5 years, and then complete the deployment within 7 years.*¹³

2. Material and methods

General scientific methods and methods for legal research were used in this article. The method of legal interpretation was used to apply the provisions of treaties on outer space to the international legal regulation of satellite constellations. Methods of outlining possible legal developments, analysis and synthesis were used to suggest ways to register constellations and mega-constellations.

3. Theory and calculation

Some aspects of the mega-constellation were discussed in scientific papers written by G. Rotola and A. Williams,¹⁴ A.C. Boley and M. Byers¹⁵ and Venkatesan A., Lowenthal J., Prem P.¹⁶ These researchers study impact of satellite constellations on astronomy. In our paper prepared by A. Abashidze, I. Chernykh and M. Mednikova,¹⁷ it is discussed complex international legal aspects of constellations and mega-constellations.

The United Nations Committee on the Peaceful Uses of Outer Space (hereinafter – the UN COPUOS) also has some working papers on the mega-constellations, especially on registration of large constellations and megaconstellations.¹⁸ Moreover, the Scientific and Technical of the UN

13 A. Vallet, ITU and space: Ensuring interference-free satellite orbits in LEO and beyond 9 February 2022, <https://www.itu.int/hub/2022/02/itu-space-interference-free-satellite-orbits-leo/#:~:text=So%20ITU%20doesn't%20approve,transmitted%20and%20received%20by%20satellites>, (accessed 01.08.22).

14 G. Rotola, A. Williams, Regulatory Context of Conflicting Uses of Outer Space: Astronomy and Satellite Constellations, *Air and Space Law* 6 (4) (2021), 545-568.

15 Boley A.C., Byers M., Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth, *Sci Rep* 11 (10642) (2021). <https://doi.org/10.1038/s41598-021-89909-7>.

16 Venkatesan A., Lowenthal J., Prem P. et al. The impact of satellite constellations on space as an ancestral global commons, *Nat Astron* 4 (2020) 1043–1048, <https://doi.org/10.1038/s41550-020-01238-3>.

17 A. Abashidze, I. Chernykh, M. Mednikova, Satellite constellations: International legal and technical aspects, *Acta Astronautica*, 196 (2022) 176-185, <https://doi.org/10.1016/j.actaastro.2022.04.019> (accessed 03.08.22).

18 UN Document A/AC.105/C.2/L.322 “Registration of large constellations and megaconstellations”, Background paper by the Secretariat, 2 February 2022, https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_2l/aac_105c_2l_322_0_html/AC105_C2_L322E.pdf, (accessed 02.08.22); UN Document A/AC.105/C.2/2022/CRP.20 “Discussion paper by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space on the topic of registration of large constellations and megaconstellations”, Paper

COPUOS has an agenda item titled “General exchange of views on dark and quiet skies for science and society”.

4. Results and Discussion

Analysing international legal issues associated with registration of large constellations and mega-constellations, it can be noted a necessity to establish a specialized procedure for registering satellites included in various types of constellations. At the same time, as it was marked in the Working document of the Legal Subcommittee of the UN COPUOS, despite the fact that “the new realities of constellations challenge [the approach to the registration practice],” in order to reflect the particularities of a satellite constellation in the registration system it seems necessary to concentrate on possible adjustments in the registration practice, without changing the system”.¹⁹ The document noted that “constellations are based on a multitude of space objects, launched in different badges, but resulting in a functional unity with a constant renewal of disused objects”.²⁰ To investigate registration practices of satellite constellation it is useful to research first specialized paper titled “Registration of large constellations and megaconstellations” prepared at the beginning of 2022.

To answer on the challenges from mega-constellations, it is suggested to use the information system established on the basis of the UNOOSA registration template: “This information can be delivered under Part D of the UNOOSA registration template (Additional voluntary information)”.²¹ Another variant is to use “the first registration of a space object (satellite) of a constellation.” It will help to contact an operator for all questions of emergency and collision avoidance” which could be occurred with satellites of a mega-constellations. In that regard it is not necessary to register the entire constellation along with the registration of each space object.

ITU also makes changes and introduces new requirements to the management of the radio frequency spectrum and satellite orbits.

For instance, “WRC-19 added mandatory data item A.4.b.1.a of Appendix 4 (Radio Regulations) – an indicator of whether the NGSO satellite system

submitted by the Chair of the Working Group, 30 March 2022, https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_20_0_html/AAC105_C2_2022_CRP20E.pdf (accessed 03.08.22).

19 UN Document A/AC.105/C.2/2022/CRP.20 “Discussion paper by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space on the topic of registration of large constellations and megaconstellations”, Paper submitted by the Chair of the Working Group, 30 March 2022, https://www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_22022crp/aac_105c_22022crp_20_0_html/AAC105_C2_2022_CRP20E.pdf (accessed 03.08.22).

20 Ibid.

21 Ibid.

represents a “constellation”“ and “Term ‘constellation’ would apply to NGSO satellite systems having more than 1 orbital plane where mutual relative position of each orbital plane and mutual relative position of each satellite in its orbital plane is important.”²² Thus, ITU struggles with challenges from mega-constellations too.

5. Conclusions

Under the accomplished work of the UN COPUOS and the ITU, additional variants are suggested to improve the registration process of mega-constellations without changing the current international legal provisions and practice on the registration.

Firstly, a new agenda item of the Legal Subcommittee of the COPUOS, tentatively titled “International legal aspects of the use of satellite constellations” can be adopted.

Secondly, the Outer Space Objects Index can be amended by the new column ‘constellation’ where the information will be shown whether or not a satellite is a member of the constellation. Also, it is possible to add a new filter by membership in a satellite constellation. This filter will show all current constellations (see Fig. 1).

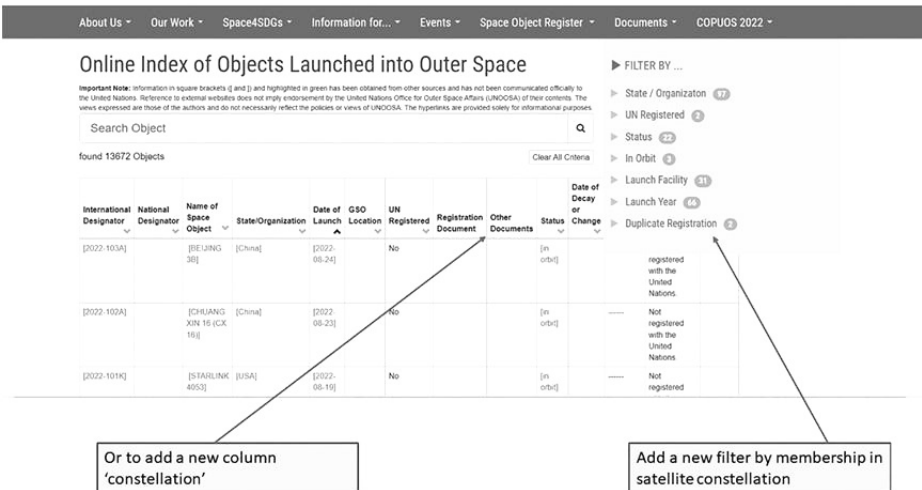


Fig. 1 How to amend Online Index of Objects Launched into Outer Space.

22 V. Beregovskiy, Submission of NGSO satellite systems and networks subject to coordination, 29th World Radiocommunication Seminar, Space Services Department, ITU Radiocommunication Bureau, IRU WRS Online2020, 2020, 30 November – 11 December 2020, <https://www.itu.int/en/ITU-R/space/WRS20space/29%20Submission%20of%20NGSO%20satellite%20systems%20and%20networks%20subject%20to%20coordination.pdf> (accessed 05.08.22).

In the future a new international treaty or soft law document dedicated to satellite constellations can be developed and adopted. At the same time, Art. IV of the Registration Convention 1975 can be amended. However, these variants are unlikely.

Summing up, mega-constellations undoubtedly is a new challenge to the international regulation of space activities. To respond to this challenge, it is necessary to save and to improve the current legal system of international space law.

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