Lex Ferenda of the Safety of Space Navigation

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Abstract

Since the beginning of space activities, the low-Earth orbit has remained one of the most sought-after destinations in space. At the time the 1967 Outer Space Treaty was adopted as the foundation of international space law, its drafters could not foresee such a rich variety in space activities. Lex lata therefore only defines the basic principles of the exploration and use of outer space and does not contain a detailed regulation to ensure safety of space navigation. The growing number of satellites and space debris leads to an increase of dangerous approaches in space. Current space regime is no longer able to ensure safety of space activities. This article outlines the need to establish the legal regime of space navigation. The author suggests defining safety zones for space objects in orbit including satellites.

1. Introduction

October 4, 1957, at 22:28 (GMT+3), the world's first artificial satellite, Sputnik-1, was launched into low-Earth orbit (LEO). This day marked the beginning of the space age.[1] Sputnik-1 orbited for 92 days, until January 4, 1958, made 1,440 revolutions around the Earth, and transmitted radio signals for two weeks after the launch.[2]

After 66 years, ever-growing number of launches of space objects into LEO vividly illustrates that the conquest for outer space continues. LEO remains one of the most thought-after destinations in space. For example, in 1957, 2 out of 3 launches of space objects fell on LEO, in 1960 26 out of 38, in 2019 66 out of 102, in 2020 82 out of 114, in 2021 112 out of 146, in 2022 179 out of 186.[3][4][5][6][7][8] As of September 2023, 146 launches have taken place, 118

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1 60 years ago, the Space Age began, Updated October 4, 2017, URL: https://www.nasa.gov/feature/60-years-ago-the-spaceage-began (September 14.09.2023).

2 "Sputnik 1", Encyclopedia Astronautica. Archived from the original on 27 December 2016, URL: http://www.astronautix.com/s/sputnik1.html (September 14.09.2023).

3 Orbital Launches of 1957, Updated January 18, 2023, URL: https://space.skyrocket.de/doc_chr/lau1957.htm

of which were sent to LEO.[9] All the above mentioned indicate that in the future growth of the launch number will steadily continue.

2. Future Space Activities

The number and type of human activities in outer space also grows and expands. For example, besides the ISS, LEO hosts the Chinese orbital space station – Tiangong.[10] Also, in the near future, Russia plans to stock up on its orbital station, which will be located on LEO.[11] It is worth noting that from 1986 to 2001, the USSR, and later Russia, had its own orbital station "MIR", which secured its place in history as the first modular space station that enabled semi-permanent human habitation in LEO.[12][13]

Moreover, the trend to develop space tourism flourishes. According to analytical data, the global space tourism market from 2022 to 2028 will develop with an impressive 16.46% in the year compound annual growth rate.[14]

Thousands of small satellites are orbiting the Earth, and tens of thousands are ready to launch. Man-made stars threaten to greatly complicate the exploration of the universe. The megatrend of the last decade is satellite

4 Orbital Launches of 1960, Updated January 18, 2023, URL: https://space.skyrocket.de/doc_chr/lau1960.htm, (September 14.09.2023).
5 Orbital Launches of 2019, Updated May 9, 2023, URL: https://space.skyrocket.de/doc_chr/lau2019.htm, (September 14.09.2023).
6 Orbital Launches of 2020, Updated August 22, 2023, URL: https://space.skyrocket.de/doc_chr/lau2020.htm, (September 14.09.2023).
7 Orbital Launches of 2021, Updated August 22, 2023, URL: https://space.skyrocket.de/doc_chr/lau2021.htm, (September 14.09.2023).
8 Orbital Launches of 2022, Updated May 9, 2023, URL: https://space.skyrocket.de/doc_chr/lau2022.htm, (September 14.09.2023).
9 Orbital Launches of 2023, Updated May 12, 2023, URL: https://space.skyrocket.de/doc_chr/lau2023.htm, (September 14.09.2023).
10 China launches first section of its massive space station, Updated April 29, 2021, URL: https://www.cnsa.gov.cn/english/n6465652/n6465653/c 6811970/content.html, (September 14.09.2023).
11 Russia may commence deployment of its orbital station after, Updated November 26, 2020, URL: https://tass.com/science/1228377, (September 14.09.2023).
12 15 years ago, the first modular Mir orbital station was flooded in the Pacific Ocean, Updated March 23, 2016, URLhttps://tass.ru/kosmos/2793867, (September 14.09.2023).
13 20 Years Ago: Space Station Mir Reenters Earth's Atmosphere, Updated March 23, 2021, URL: https://www.nasa.gov/feature/20-years-ago-spacestation-mir-reenters-earth-s-atmosphere, (September 14.09.2023).
14 Global Space Tourism Market 2022 to Flourish with an Impressive CAGR of 16.46% in the year 2028, Market Size & Growth with Complete Business Overview and Development Strategies, Updated May 7, 2022, URL: https://english.cas.cn/newsroom/cas_media/202205/t202 20507_305162.shtml, (September 14.09.2023).

constellations. So, the constellation of OneWeb satellites has recently increased to 542 units. Kuiper Systems, a subsidiary of Amazon, will have more than 3,000 satellites. The largest group of microsats - Starlink, owned by SpaceX, has 3,445 operational satellites as of January 2023. And this is just the beginning: SpaceX has a license from the US Federal Communications Commission to launch 12,000 first-generation and 7,500 second-generation satellites.[15]

Ambitious plans have been announced for the launch of space objects from celestial bodies. An increasing quantity of privately-owned commercial space companies are swiftly transitioning their space launch operations to the Moon and other celestial objects. This transition will not only enhance but also, in certain instances, supplant government-led space launch initiatives. The potential for a substantial expansion of deep space exploration missions encompassing the Moon, asteroids, and planets is on the horizon. This expansion will include a wide array of diverse space launch technologies and regulatory frameworks. In the realm of space exploration, a combination of crewed and uncrewed launches will be essential, and sample return missions from asteroids, planets, and their moons will incorporate continually advancing technologies.

3. Current International Legal Regulation of International Space Navigation

Outer space may seem infinite, but the ability to safely navigate space objects in orbits around the Earth is not. Navigating space objects in LEO with the current congestion is already complicated. According to the Union of Concerned Scientists as of 2023, there are 6,718 functioning satellites in outer space, where 5,938 satellites orbit law Earth orbit.[16] The growing number of satellites leads to the emergence of space debris and results in the increase of dangerous approaches in space.

International Space Station (ISS) orbits LEO.[17] The ISS, like everything in low Earth orbit, experiences the resistance of the Earth's atmosphere, which leads to its deceleration and decrease in orbit, which is regularly corrected by the engines of spacecraft docked to it. Avoidance maneuvers represent a routine task for the space station. According to a NASA report from December 2022,

15 The sky in "Starlinks": will astronomers get along with the constellations of microsatellites, Updated January 29, 2023, URL: https://www.forbes.ru/society/484291-nebo-vstarlinkah-uzivutsa-li-astronomy-s-sozvezdiamimikrosputnikov, (September 14.09.2023).

16 UCS Satellite Database, URL:https://www.ucsusa.org/resources/satellitedatabase, (September 14.09.2023).

17 Higher Altitude Improves Station's Fuel Economy, Updated February 14, 2011, URL: https://www.nasa.gov/mission_pages/station/expeditions/expedition26/iss_altitude.html, (September 14.09.2023).

the ISS has experienced a total 32 orbit corrections since 1999 to avoid satellites and trackable space debris.[18]

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the Outer Space Treaty of 1967) regulates legal status of outer space.[19] At the time of its adoption, States only represented main actors of space industry, namely the USSR and the USA.

However, the Outer Space Treaty does not cover all of space industry issues, especially since space activities affect the interests of all States, including those that do not carry out the former. Therefore, the UN COPUOS adopted additional space treaties:

- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement"),
- Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention"),
- Convention on Registration of Objects Launched into Outer Space (the "Registration Convention"),
- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement").[20, 21, 22, 23]

18 International Space Station Maneuvers to Avoid Another Russian ASAT Fragment, Orbital Debris, Quarterly News, Volume 26, Issue 4 December 2022, URL: https://orbitaldebris.jsc.nasa.gov/quarterlynews/pdfs/odqnv26i4.pdf, (September 14.09 .2023).

19 Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, adopted by the general assembly in its resolution 2222 (XXI), opened for signature on 27 January 1967, entered into force on 10 October 1967. URL: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treat ies/outerspacetreaty.html, (September 14.09.2023)

20 Convention on international liability for damage caused by space objects, adopted by the general assembly in its resolution 2777 (XXVI), opened for signature on 29 March 1972, entered into force on 1 September 1972.

21 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space, adopted by the general assembly in its resolution 2345 (XXII), opened for signature on 22 April 1968, entered into force on 3 December 1968.

22 Convention on Registration of Objects Launched into Outer Space, adopted by the general assembly in its resolution 3235 (XXIX), opened for signature on 1 January 1975, entered into force on 15 September 1976.

23 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, adopted by the general assembly in its resolution 36/68, opened for signature on 18 December 1979, entered into force on 11 July 1984.

Even though main treaties in international space law represent comprehensive and specific norms, they have been adopted and entered into force long time ago when the reality of space activities was significantly different. So, many scientists suppose the international space law needing a great revision.[24]
Even the international legal acts themselves, namely the Liability Convention and the Registration Convention, contain an indication to reconsider their relevance under the UN General Assembly after 10 years from the date of their entry into force.
Therefore, regarding the increase of space objects orbiting the Earth and the expansion of space activities, the current legal regime of outer space cannot ensure the safety of space flights. The author believes that it is necessary to fill in legal gaps by creating an integrated navigation system in outer space to sustain future space activities and further galaxy research.

4. Lex ferenda of the Safety of Space Navigation

Creation of the navigation system requires to analyze the current legal regimes of air and outer space, the legal regulation of air navigation and elements of space navigation.
Nowadays, there is no agreed term for space navigation because its regulation is highly fragmented. Here is an example of separate institutes of space navigation:

- notification of the UN Secretary-General on the launch,
- collision warning system,
- mechanisms for tracking space objects,
- space debris mitigation.[25]

It is worth noting that navigation in outer space is significantly different that the one in airspace. The State of spacecraft registration is responsible for the damage caused by the space object. The State exercises jurisdiction over such an object through the Mission Control Center (MCC). Consequently, maneuvering to avoid dangerous approach to other space objects or space debris is carried out on an individual basis. The author believes that this approach is inefficient. As mentioned above, space debris has repeatedly led to the need to adjust the orbit of the ISS to avoid collisions and prevent damage to the orbital station and people on board.
Soon, it is necessary to introduce legal regulation regarding a collision prevention system likewise the system implemented in air navigation – Traffic Collision Avoidance System, which can track and predict the object moves and promptly warn of hazards.

24 Lyall F., Larsen P.B. Space law: A treatise. Farnham, 2009. P. 82.
25 Schwetje F.K. Managing outer space traffic in the future: a challenge to legal and technical experts. Montreal: McGill University, 1985. 288 p.

The mobility of space objects is limited. The growth of space traffic, the use of new types of space objects increases the risk of collisions of objects in outer space. Consequently, the next important legal element of the organization of the safety of space navigation is the separation of the flows of space traffic through the division of outer space in sections.[26]

According to the author opinion, ensuring the safety of space flights including spacecraft and their "passengers" – cosmonauts, astronauts, taikonauts etc. – is the main goal of space navigation. A secondary goal is to meet the needs of those who own and/or manage space objects, namely, to ensure the economic efficiency of space travel.

Returning to the idea of separating the flows of space objects, the author suggests establishing safety zones of space objects.

In fact, the safety zone can be considered as a certain safe volume of airspace around a space object (that is, the space that will separate these objects from other objects in outer space in all physical planes). If there is a threat of a collision in the specified zone and information is received through exchange channels, the State exercising jurisdiction over the object by virtue of the provisions of the Outer Space Treaty must take all measures necessary to eliminate the risk of a collision.

However, if we talk about a collision of two functioning space objects that have the technical ability to maneuver, the uncoordinated actions of one or both States may increase the possibility of the collision. In this regard, it is obvious that the exchange of data between States and the coordination of their actions will be of paramount importance. If it is possible to predict such incidents (for example, within the framework of the previously proposed international organization), efficient maneuvering schemes could be developed, by means of which the distances between space objects would remain above the minimum values of safety zones. Thus, the art of space navigation will consist in ensuring that the specified volumes of safety zones never touch.

The creation of legal prerequisites for security zones would be the most effective measure for safe navigation in outer space.

Security zones should be established in accordance with international law and have the status of international ones, otherwise, the principle of free exploration and use of outer space and celestial bodies will be violated and a precedent will be created according to which States will exercise sovereign rights in outer space.

The proposed norms can be fixed in a separate Annex to the Convention on the Safety of Space Navigation, likewise to the Chicago Convention. The Annex will contain the procedure for establishing safety zones for a space

26 Perek L. "Telecommunications and the Geostationary Orbit: The missing Regulation", Proceedings of the TwentySixth Colloquium on the Law of Outer Space. New York: American Institute of Aeronautics and Astronautics, 1983, p. 33.

object. The parameters and sizes of the zones will vary and depend on the type of object, its location, and its flight speed. Thus, such Convention would consolidate the basic principles of the legal regime of space flights, where its Annexes would create a detailed uniform and comprehensive approach to space navigation.

The establishment of safety zones for satellites in orbit, as well as for newly launched space objects, should prevent collisions of objects and, as a result, avoid property damage, and in the case of manned space flight, human losses. Currently, the data exchange about the frequencies used and satellites orbital positions is regulated by the norms of the International Telecommunication Union (ITU). At the same time, there is no legal mechanism that ensures a minimum distance between the orbital positions of satellites. Consequently, the rapid exchange of the abovementioned details between nearby space objects would be one of the effective methods of collision prevention. Some scientists believe that the provisions on the exchange of information between space objects can be fixed within the framework of the ITU.[27] The option of exchanging relevant data between States based on gentlemen's agreements is not subject to consideration, since it is not regulated by international legal agreements.

The author assumes that it is possible to use a different method – tracking the orbital positions of space objects from Earth. The author suggests creating an international intergovernmental organization ensuring the safety of space navigation, which should combine representative, administrative and operational functions.

For the purposes of operational exchange of data on the location of space objects, the organization would have 4 regional centers, like mission control centers: regional division in Europe, Africa (based on ESA); regional unit in North and South America (based on NASA); regional division in Russia, Middle East, Central Asia (based on the Roscosmos MCC) and a branch of Southeast Asia and Australia (based on the MCC of China).

The main goals of these regional divisions are ensuring space navigation and the safety of space flights, monitoring, and coordinating the movement of space objects in the upper layers of airspace and outer space. To achieve this goal, the following tasks should be assigned to the regional branches of the organization: performing the functions of daily maintenance of space objects navigation, regular exchange of navigation information, settlement, and coordination of emergency.

27 Perek L. "Telecommunications and the Geostationary Orbit: The missing Regulation", Proceedings of the Twenty-Sixth Colloquium on the Law of Outer Space. New York: American Institute of Aeronautics and Astronautics, 1983, P. 34.