Legal Regime of On-orbit Interactions of Spacecraft from Different Jurisdictions

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The article is devoted to the analysis of the legal mechanisms of managing the orbital interactions of spacecraft that are pivotal for the development of space (orbital) systems. Scientific-theoretical research methods: abstraction, idealization, construction of hypotheses and models, documentary analysis and synthesis, objective truth, cognitive-analytical, etc. Results: the origin and contemporary genesis of constituent elements of the legal mechanisms of the management of orbital interactions of spacecraft and the problems of adapting these mechanisms to the trends of the "new space," are analyzed. The scientific aim is to contribute to the development of an adequate and integrated legal regime of the management of space systems and to improve the effectiveness of its institutional framework. Discussion: the evolution of the legal framework of international orbital interactions is analyzed on the background of the contemporary international space activities. The management of space systems needs comprehensive legal regulation and its harmonization with the respective regime of the leading space-faring nations. The inconsistency of international law with the practice of on-orbit interactions of spacecraft under the jurisdiction of different states, creates a risk of international conflict. The article formulates recommendations for improving the legal regime of orbital interactions arising from servicing spacecraft and de-orbiting them, in particular the licensing of such activities, their supervision, and the formation of institutional mechanisms for space systems management.

Keywords: on-orbit servicing, on-orbit interactions, space system, rescue mode, spacecraft, space object, launching state, space-faring state, legal regulation, International Space Station, international space law, national space law.

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Introduction

Current and future projects of the deployment, creation, and operation of complex artificial space objects and/or their groups, such as the Artemis program (NASA, 2014), are significant

in scale, and level of technological challenges. These space objects can serve the purposes of: 1) supply (e.g., solar power plants), 2) industrial manufacturing in 0-gravity, and 3) tourism (Hawking, 2001). Space objects, in particular spacecraft, and their constellations, together with the terrestrial control infrastructure and data interchange with them, form "space (orbital) systems."

The space systems take humanity to a new stage of development, but few space agencies or private companies are able to do it on their own. International cooperation of actors of different levels in the creation and management of such systems aimed at achieving not only economic benefits but also the UN Sustainable Development Goals (Sustainable, 2018), poses new challenges to the regulation of international space activities, among which we highlight:

1) risks of harm to humanity and material valuesin space and on Earth due to the density of pollution of outer space with "space debris" (fragments of launch vehicle stages, boosters and artificial satellites and rocket fuel combustion products); of which approx. 25 thousand objects larger than 10 cm are tracked, while the number of artificial objects of all sizes exceeds hundreds of millions (Search, 2022);

2) irrational financing of space missions with the predominant "one-time" use of launch vehicles and spacecraft; and

3) limited availability of slots in geostationary (GEO) and low Earth (LEO) orbits.

The effective functioning of the present and future space systems also requires the development of space activities for the inspection, maintenance, repair, modernization, refueling, and de-orbiting of spacecraft ("SC") and other space objects ("SO"), often named jointly "space assets" (Waltz, 1993). In the course of these activities, also named "on-orbit servicing" spacecraft interact, namely, meet and can be connected to each other rigidly – for repair, modernization or refueling, or flexibly – when taken out of orbit. Such on-orbit interactions between the spacecraft and other space objects include (1) life extension of the spacecraft in its original design, (2) upgrading the spacecraft (measures aimed at providing functionality to better achieve the mission's objectives) and (3) modification – making changes to the spacecraft to achieve new mission objectives (Saleh et al., 2002).

In space systems, interactions between "cooperating" (actively monitored or providing feedback) and "non-cooperating" space objects are possible. Most modern spacecraft is not designed for orbital maintenance, and do not have docking ports or access panels to the serviced subsystems. In the future, if humanity seeks to ensure the ecology of outer space, it is expected to move to the creation and use of "interoperable" spacecraft, including by adopting appropriate mandatory rules. So, let us examine the legal relations that arise in connection with the interactions between the SC and other SO, both cooperating and not.

It should be noted that the space-faring community, in particular the relevant UN body – the Committee on Peaceful Uses of Outer Space (COPUOS) – is currently improving the existing international legal framework for the interaction of space assets in orbit, including developing guidelines for regulating in-orbit services, but does not keep up with technological progress. However, significant legal issues pertaining to in-orbit interactions of spacecraft under different jurisdictions, remain unresolved, in particular: (1) coordination of orbital maintenance, inspection of spacecraft, etc., (2) distribution of liability for damage caused by interactions in orbit, including the mutual disclaimer, (3) special protection of property and non-property rights to the spacecraft. Therefore, in our article, we will analyze the current problems of legal regulation of the interaction of space objects in orbital systems and, based on it, will suggest improving this regulation.

Problems of modern legal regulation of the interaction of space objects under different jurisdictions

Gaps and inconsistencies in the legal regulation of spacecraft interactions in orbit hinder the development of space systems. The works of domestic (Halunko et al., 2021; Shemshychenko & Semenyaka, 2019) and foreign (International, 2018; Ferrazani & Farand, 2014) academicians were devoted to their research and development of ways to eliminate them.

Throughout the array of regulations governing interactions in the orbit of CAs belonging to different jurisdictions, we highlight their following levels:

1) international multilateral space treaties, in particular the Outer Space Treaty ("OST"), the Convention on International Liability for Damage to Space Objects ("CL"), Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Agreement, 1968) and the Convention on the Registration of Outer Space Objects (Convention, 1974), which laid the foundations of the regime of the interaction of objects in space systems, however, having been signed long before the «new space» era, they no longer cover important organizational and technological aspects of space activities;

2) intergovernmental multilateral and multilateral agreements, which establish the basic principles of cooperation in space systems, mutual rights and obligations of partners, in particular, define clear parameters of responsibility of states in case of accidents in orbit and contain mandatory rules on jurisdiction and control of space assets, opportunities for access to and ownership of them, as well as intellectual property – which is important for commercial activities and the avoidance of threats to international security;

3) international technical norms, which are mostly optional, directly define technical standards for the interaction of "space assets" in orbit, for example, (1) International Standard ISO 24113 "Space Systems – Prevention of Space Debris" adopted on 10.02.2012 by the European Space Standardization Coordination (ECSS) as a standard ECSS-U-AS-10C (ECSS-U-AS-10C, 2012), which sets out requirements for minimizing the impact of space operations on the orbital environment and relates to the ESA purchase of space systems (launchers, satellites, manned or robotic spacecraft) vehicles) and/or operations of any space system under the responsibility of ESA, and therefore does not apply to space technology outside ESA programs, even in its Member States, and (2) CONFERS Guiding Principles (CONFERS, 2021);

4) national space law of states that play a key role in space activities, primarily the USA (US Commercial, 2015), which is often applied extraterritorially;

5) private-law agreements between the participants of international cooperation on cooperation in space systems, regulating the rights and obligations of participants, their use of assets in orbit, the distribution of financial costs, and liability for damage; the provisions of which should not contradict the norms of multilateral international space treaties, although the latter were adopted at a time when private space activities were not carried out.

Based on the analysis of the above-mentioned legal acts, it can be stated that the current state of legal regulation of the on-orbit interaction of space objects in space systems needs to be modernized. Thus, according to Article VIII of the CL, the state in the register of which is an object launched into outer space, retains jurisdiction and control over such an object... as long as it is in outer space or on a celestial body (Treaty, 1967). This requires the consent of the state registering the space object for operations with it, including "rescue" (refueling, repair, etc.) or removal, as it controls it almost always, despite the possible private ownership over

the object. To resolve collisions related to the on-orbit interactions of spacecraft in cases where one of them can cause irreparable damage to other spacecraft, aircraft or objects on Earth, we think it is justified to construct the current non-existent spacecraft rescue mode similar to the rescue mode according to United Nations Convention on the Law of the Sea (1982).

The issue of the state's liability for damage caused with a spacecraft during on-orbit servicing of a spacecraft registered in another state and for damage caused on the Earth with a space object being actively de-orbited has not been fully resolved. Articles II, III, and V of the CL state that (a) launching States shall be absolutely liable for any damage caused to the Earth's surface, aircraft, or space object of another State; (b) in the case of "damage, caused (…) to a space object of one state (…) by a space object of another, as well as to the infliction of damage to a third state (…) the first two states will be jointly liable," only if the damage was caused through fault, (c) the state of the spacecraft being launched from orbit may not be liable for damage outside the Earth's surface (Convention, 1972). With the independent de-orbting of the spacecraft, such responsibility seems justified; however, it is questionable if pursued with a "foreign" spacecraft, especially on the basis of a contract, with the consent of the owner of the de-orbited spacecraft.

In view of the above, we consider it possible and appropriate to settle such liability through a separate international or private law agreement, subject to the adjustment of the norm of the CL. This will manage the de-orbitation sponsoring state risks of financial liability to third parties. After all, if the damage is caused in outer space, it is necessary to prove guilt under Art. III of the CL, which stipulates that one launching state is liable for damage caused to a space object, property, persons of another launching state only if the damage was caused through fault.

There is also a lack of protection of intellectual property rights and military secrets. The OST does not prohibit spacecraft owners from remotely inspecting other spacecraft and creating their images, including 3-dimensional models; therefore, with the consent of the owner of the spacecraft, an open "inspection" is possible, and without the consent – hidden. One of the first such inspections was carried out in 2005 by the US Air Force microsatellite XSS-11 (David, 2005). The lack of legal regulation of the inspection of space objects under the jurisdiction of different states creates a risk of international conflicts, including military ones, and the transfer of global confrontation between states in outer space.

Issues of protection of property and non-property rights in space objects under different jurisdictions and their interaction may be resolved with the adoption of an international treaty and the establishment, for example, at the UN level, of an authoritative international institutional mechanism authorized to regulate and supervise relevant activities. However, the inability to adopt new binding international agreements governing space activities in recent decades, differences of political opinion and the need for consensual decision-making in COPUOS, as well as the growing number of its members, make it difficult to overcome the legal problems of modern space missions.

Whereas the establishment of international legal and institutional mechanisms is likely to be complex and lengthy, and given the effective actions of the US FAA in regulating commercial space activities (Rathz, 2015), we consider it appropriate to establish appropriate, effective regulation and institutional arrangements at the level of States and/or their unions. In this context, we also consider it appropriate to use the "bottom-up" approach when agreements between private partners for the implementation of international orbital missions encourage states to implement rules into national law and update international law. This rule-making is

outside the scope of public law and does not depend on it, and it is created and managed by private individuals. It follows the growth of international innovation. It is not hampered by the absence or ineffectiveness of special rules in international or national law.

Analysis of the legal regulation of interaction on the International Space Station

Players of the "new space" widely use the "bottom-up" approach, providing arbitration mechanisms for resolving disputes over cooperation in orbital systems with the interaction of spacecraft in orbit, and the application of arbitral tribunals not only international customary law but also national (Graham & Kingston, 2015).

To improve the legal regulation of orbital services, it seems possible to use the method of analogy with the legal regime of the International Space Station (ISS), which is a complex space object created from modules in orbit (rather than launched directly from the Earth's surface). This regime is determined by a set of international agreements governing the ownership of ISS elements and the jurisdiction of partner countries during the flight, the main of which is the Intergovernmental Agreement on Cooperation in the International Space Station (Agreement, 1998).

The legal mechanism of cooperation on the ISS is based on the principle of hierarchy necessary to ensure the implementation of the basic obligations of Partner States, enshrined in both the IAC and the extensive system of supporting documents adopted at both bilateral (memoranda of understanding) and multilateral levels. agreements on the implementation of agreements) (Aslanova, 2012). Despite the unified technical regime of the ISS, as a set of docked space objects, and the homogeneity of the legal regime of its segments, partner countries register their orbital elements separately and extend their jurisdiction over them (territorial principle). States have the right to dispose of the rights of ownership and use of ISS elements in the form of their transfer, sale, or exchange. The IGA equates orbital elements to the territory of the state for the purposes of applying national intellectual property law, extending such a right to the orbital elements of the ISS, which is recognized as a common view in the doctrine that the application of such a right to space activities requires a direct reference to it in national or international law.

According to the CL, the issues of contractual and tortious liability for damage should be resolved depending on the following conditions: 1) if the damage is caused by partners to each other or their individuals and legal entities in connection with "protected" space operations, cross-waiver of liability against each other; 2) in all other cases, when the damage is caused to third states or their persons, the norms of the CL apply, i.e., each of the states will be independently responsible for the damage caused by the SO registered therein (Losekamm et al., 2015).

The IAC, as a legal instrument tested in the creation and operation of the ISS, can be considered a successful model of international regulation of activities in complex space systems. Unlike the universally binding treaty, which must be agreed and ratified by all leading space member states of COPUOS, special multilateral agreements apply only to member states of specific programs or missions and contain their specially agreed parameters (administrative, program, etc.).

Conclusions

Based on the above, we propose to optimize the legal regime of interactions in space systems of objects under different jurisdictions as follows:

1) Improve national regulation of the in-orbit servicing and removal of space debris, as well as its oversight by national or supranational bodies of leading space powers, to ensure management of liability for damage to space systems;

2) Taking into account the multilateral nature of cooperation in space systems when spacecraft built in one state are launched by another and serviced by a third one, provide for redistribution of liability for space damage to the serviced facility or other assets by: (a) contractual disclaimer (similar to the ISS regime) within the orbital ecosystem; (b) joint and several liability for damage caused by partners to third countries in orbital interactions; and (c) replacing modifying the concept of "launching State" in the CL to extend it to in-orbit interactions;

3) Establish a balance between compromising space missions with interactions of spacecraft (e.g., spacecraft inspections) and maintaining the possibility of conducting space activities not prohibited by international law in the interests of national security;

4) Increase the investment attractiveness of space systems by creating effective international and national financial and legal mechanisms to stimulate demand for in-orbit services, in particular: active missions to "manage" space debris (prevention of its formation and decommissioning of existing ones), and give imperative force to restrictions on the formation of space debris and encourage its removal;

5) Establish institutional mechanisms to ensure the fulfillment of obligations by participants in space systems, based on the principle of general (consensus, similar to the ISS) or qualified consent in decision-making, which will form a balance of interests of stakeholders, depending on the role in the project and/or the magnitude of the financial and technical contribution to it (partner parity or subordination in the relationship), and the mode of interaction of space objects may differ from the one established by IGA.

6) Finally, it should be noted that international political factors can have a more radical impact on the projects of the "new space" than their legal regulation. Thus, as a result of the beginning of the Russian war against Ukraine in February 2022, most international space projects with the participation of the former were sharply slowed down or stopped (Kot, 2022). From 2023, the US Department of Defense is prohibited from purchasing services from satellites launched by Russian missiles or missiles with Russian components. At the same time, Ukrainian participants in orbital systems development projects gain a chance to propose the replacement of Russian space technology, such as RD-180 rocket engines, Frigate-M and Brig accelerators.

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