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## REGULATING THE QUASI-MILITARY USE OF LARGE LOW-EARTH ORBIT SATELLITE CONSTELLATIONS UNDER INTERNATIONAL SPACE LAW

This article examines the regulatory dilemma created by the quasi-military use of large low-Earth orbit (LEO) satellite constellations. It argues that the five cornerstone instruments of international space law – the Outer Space Treaty, the Moon Agreement, the Liability Convention, the Registration Convention, and the Rescue Agreement – still provide the basic legal framework for space activities, but they do not fully address the legal consequences of modern commercial constellations that may support military operations. The central problem is not only the direct militarization of outer space, but also the growing use of ostensibly civilian space infrastructure for communication, imaging, targeting support, and other functions connected to terrestrial conflict. The article identifies several regulatory gaps: the abstract character of the principle of peaceful use, the narrow prohibition on weapons of mass destruction, the uncertainty surrounding dual-use objects, the weakness of consultation procedures, the absence of compulsory adjudication, the difficulty of attributing responsibility for private operators, and the limited scope of compensation for non-physical or indirect damage. It further shows that registration practice and recent national space-security policies have not removed these gaps. On this basis, the article concludes that large LEO constellations expose a structural mismatch between treaty rules drafted in the Cold War period and contemporary space activities shaped by private companies, military demand, and dual-use technologies.

**Keywords:** large low-Earth orbit constellations, quasi-military use, international space law, peaceful use of outer space, legal regulation.

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### Халықаралық ғарыш құқығы шеңберінде төмен Жер орбитасындағы ірі жерсеріктік топтамаларды парамилитарлық мақсатта пайдалануды реттеу

Бұл мақалада ірі төмен Жер орбитасындағы спутниктік топтамаларды квазиәскери пайдалану нәтижесінде туындайтын реттеушілік дилемма қарастырылады. Мақалада халықаралық ғарыш құқығының бес негізгі құралы Ғарыш туралы шарт, Ай туралы келісім, Жауапкершілік туралы конвенция, Тіркеу туралы конвенция және Құтқару туралы келісім ғарыш қызметінің негізгі құқықтық шеңберін әлі де қамтамасыз етіп отырғанымен, әскери операцияларды қолдауы мүмкін заманауи коммерциялық спутниктік топтамалардың құқықтық салдарын толық қамтымайтыны негізделеді. Негізгі мәселе тек ғарыш кеңістігінің тікелей милитаризациясында ғана емес, сонымен қатар формалды түрде азаматтық ғарыш инфрақұрылымының байланыс, бейнелеу, нысананы дәлдеуді қолдау және жердегі қақтығыстармен байланысты өзге де функциялар үшін барған сайын кеңінен қолданылуында жатыр. Мақалада бірнеше реттеушілік олқылықтар айқындалады: бейбіт пайдалану қағидатының абстрактілі сипаты, жаппай қырып-жою қаруына қатысты тыйымның тар шеңбері, қосарлы мақсаттағы объектілерге қатысты белгісіздік, консультациялық рәсімдердің әлсіздігі, міндетті юрисдикциялық дауларды шешу тетігінің болмауы, жеке операторларға жауапкершілік жүктеудің күрделілігі, сондай-ақ физикалық емес немесе жанама залал үшін өтемақы көлемінің шектеулілігі. Сонымен қатар мақалада тіркеу тәжірибесі мен ғарыш қауіпсіздігі саласындағы қазіргі ұлттық саясаттар бұл олқылықтарды жоймағаны көрсетіледі. Осы негізде мақала ірі төмен Жер орбитасындағы спутниктік топтамалар қырғи-қабақ соғыс кезеңінде әзірленген шарттық нормалар мен жеке компаниялар, әскери сұраныс және қосарлы мақсаттағы технологиялар қалыптастырып отырған қазіргі ғарыш қызметі арасындағы құрылымдық сәйкессіздікті айқындайды деген қорытындыға келеді.

**Түйін сөздер:** ірі төмен Жер орбитасындағы спутниктік топтамалар, квазиәскери пайдалану, халықаралық ғарыш құқығы, ғарыш кеңістігін бейбіт мақсатта пайдалану, құқықтық реттеу.

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### Регулирование парамилитарного использования крупных спутниковых группировок на низкой околоземной орбите в международном космическом праве

В данной статье рассматривается регуляторная дилемма, возникающая в результате квазивиоленного использования крупных низкоорбитальных спутниковых группировок. В статье утверждается, что пять базовых инструментов международного космического права Договор о космосе, Соглашение о Луне, Конвенция о международной ответственности за ущерб, Конвенция о регистрации и Соглашение о спасании по-прежнему обеспечивают основную правовую рамку космической деятельности, однако они не в полной мере регулируют правовые последствия функционирования современных коммерческих спутниковых группировок, которые могут поддерживать военные операции. Центральная проблема заключается не только в прямой милитаризации космического пространства, но и в растущем использовании формально гражданской космической инфраструктуры для связи, получения изображений, поддержки целеуказания и выполнения иных функций, связанных с наземными конфликтами. В статье выделяется несколько регуляторных пробелов: абстрактный характер принципа мирного использования, узкий запрет на оружие массового уничтожения, неопределённость в отношении объектов двойного назначения, слабость консультационных процедур, отсутствие обязательного юрисдикционного разрешения споров, сложность возложения ответственности на частных операторов, а также ограниченный объём компенсации за нефизический или косвенный ущерб. Кроме того, в статье показано, что практика регистрации и современные национальные политики в области космической безопасности не устранили эти пробелы. На этой основе в статье делается вывод о том, что крупные низкоорбитальные спутниковые группировки выявляют структурное несоответствие между договорными нормами, разработанными в период холодной войны, и современной космической деятельностью, формируемой частными компаниями, военным спросом и технологиями двойного назначения.

**Ключевые слова:** крупные низкоорбитальные спутниковые группировки, квазивиоленное использование, международное космическое право, мирное использование государства, ответственность за ущерб, регистрация, правовое регулирование.

### Introduction

The peaceful use of outer space has been one of the basic assumptions of international space law since the beginning of the space age. Yet this assumption is now under pressure. Large LEO satellite constellations are designed and presented mainly as commercial or civilian systems, but their services can also be used in military and security contexts. Communication, remote sensing, positioning support, and data transmission may become part of a wider operational chain without turning the constellation itself into a conventional weapon. This is precisely why the legal problem is difficult: the activity may fall between ordinary commercial use and direct military action.

The existing treaty framework was formed when outer space was used mainly by states and when the principal strategic concern was the placement of nuclear weapons or other weapons of mass destruction in orbit. Under the auspices of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), the international community adopted the Outer Space Treaty, the Rescue Agreement, the

Liability Convention, the Registration Convention, and the Moon Agreement. Together, these instruments still define the architecture of international space law and set out core principles such as peaceful use, international responsibility, liability for damage, registration of space objects, and cooperation among states (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1967; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 1968; Convention on International Liability for Damage Caused by Space Objects, 1972; Convention on Registration of Objects Launched into Outer Space, 1975; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1979).

The difficulty is that these treaties provide broad principles rather than detailed procedures for the kinds of risks created by large LEO constellations. They do not clearly explain how to distinguish peaceful commercial services from military support functions, how to evaluate indirect harm caused by dual-use satellite services, or how to impose responsibility when a private company operates the rele-

vant constellation. In this sense, the quasi-military use of LEO constellations reveals a legal vacuum inside a treaty system that was not designed for today's scale, speed, and commercialization of space activity.

The purpose of this article is to examine how this regulatory dilemma arises and why the existing legal mechanisms remain insufficient. The article focuses on three questions. First, how do traditional space treaties frame the principle of peaceful use and the prohibition of militarization? Second, where do the main gaps appear in consultation, dispute resolution, state responsibility, liability, and registration? Third, how do new legal and policy practices, including national space-security strategies, affect the international order of peaceful use of outer space?

### Methodology

This article uses a literature analysis method combined with legal-doctrinal analysis. The literature analysis method is applied to scholarly works, institutional materials, and policy documents that discuss the militarization of outer space, satellite constellations, space debris, registration, and responsibility. The legal-doctrinal part of the research focuses on the text and logic of the five main space treaties. It asks what the rules say, what they leave undefined, and how those undefined areas affect the regulation of large LEO constellations.

The analysis proceeds in three steps. First, the article reviews the treaty provisions that are most relevant to peaceful use, military activity, consultation, registration, liability, and state responsibility. Second, it identifies interpretive problems in the treaty language, especially the meaning of "peaceful use," "weapons of mass destruction," "harmful interference," "damage," and "national activities in outer space." Third, it compares these treaty rules with the practical realities of large LEO constellations, which are often operated by private entities but may provide services of strategic or military value.

This methodological approach is appropriate because the problem addressed in the article is primarily normative and institutional rather than statistical. The article does not seek to calculate the number of satellites or quantify their battlefield effect. Instead, it examines how existing legal categories respond to the dual-use and quasi-military functions of modern constellations. The focus is therefore on legal interpretation, institutional adequacy, and regulatory gaps.

The sources used in the article include the main outer space treaties, scholarly studies on the international legal supervision of mega-constellations, works on space debris and militarization, United Nations materials on treaty application and registration practice, and selected United States space-security policy documents. All in-text references and the bibliography have been converted into APA style to make the article more consistent with academic journal requirements.

### Literature review

The Outer Space Treaty remains the cornerstone of the international legal regime governing outer space. It established the basic principles that outer space should be explored and used for the benefit of all countries, that it is not subject to national appropriation, and that states bear international responsibility for national activities in outer space, including activities carried out by non-governmental entities (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1967). For the purposes of this article, Article IV is especially important because it prohibits the placement of nuclear weapons or other weapons of mass destruction in orbit, on celestial bodies, or elsewhere in outer space.

This prohibition reflected the political conditions of the Cold War. The legal compromise was significant, but it was also limited. The treaty did not prohibit all military uses of outer space. It prohibited a narrower category of weapons and placed stricter limits on activities on the Moon and other celestial bodies than on outer space more generally. As a result, the treaty created a broad peace-oriented legal framework while leaving open the question of whether non-aggressive military support activities are compatible with peaceful use. This ambiguity is repeatedly identified in the literature as one of the central weaknesses of the current regime (Hu, 2024; Zhu, 2018).

The Moon Agreement attempted to develop the peaceful-use principle more strictly for the Moon and other celestial bodies. It prohibits the threat or use of force, hostile acts, and the use of the Moon to commit such acts in relation to Earth, spacecraft, personnel, or man-made space objects (Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1979). However, its limited participation has reduced its practical influence. In this respect, the Moon Agreement shows that a more comprehensive peaceful-use model exists in treaty

law, but it has not become a universally effective regulatory instrument.

The Liability Convention, the Registration Convention, and the Rescue Agreement address different parts of the same governance architecture. The Liability Convention establishes rules on damage caused by space objects; the Registration Convention creates a mandatory system for registering objects launched into outer space; and the Rescue Agreement regulates assistance to astronauts and the return of space objects (Convention on International Liability for Damage Caused by Space Objects, 1972; Convention on Registration of Objects Launched into Outer Space, 1975; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 1968). These instruments are necessary, but they were drafted before the emergence of large commercial constellations and before private operators became central actors in space infrastructure.

The scholarly literature emphasizes that international space law has always had to deal with the dual-use nature of space technology. Satellites can support weather monitoring, disaster response, navigation, and communication, but the same technical capacities can also support military command, surveillance, targeting, and strategic planning. Liu (n.d.) places this question within the broader framework of international public law, where state responsibility and the classification of wrongful acts are central to legal accountability.

Hu (2024) argues that mega-satellite constellations create specific regulatory pressure because their scale and technical structure do not fit easily into older treaty concepts. A constellation is not merely a single space object; it is a networked infrastructure capable of continuous communication and service provision. For this reason, the legal issue is not confined to physical deployment in orbit. It also concerns the functions that the constellation performs and the users to whom these functions are made available.

Studies of space debris and environmental harm point to a related problem: the existing legal system focuses most clearly on tangible or physical damage, while many contemporary space risks may be indirect, cumulative, or operational in character. Gao (2008) discusses legal issues caused by space debris, and this concern is relevant to LEO constellations because dense orbital environments increase the significance of registration, monitoring, and responsibility. Zhu (2018) similarly emphasizes that the militarization of outer space challenges the

peaceful-use principle and requires more precise legal mechanisms.

Registration has become another major point of discussion. Zha (2022) notes that LEO small-satellite constellations challenge the space-object registration system because the basic reporting requirements may not provide enough information about the true function, operational status, or military relevance of a satellite. United Nations materials on the status and application of the five outer space treaties also show that registration practice remains uneven and that large and mega-constellations raise new concerns for treaty implementation (United Nations General Assembly, 2022; United Nations Office for Outer Space Affairs, 2025).

## Results

The first result of the analysis is that the existing treaty framework remains legally central but technologically outdated. The five core treaties continue to provide the language through which states discuss peaceful use, responsibility, liability, registration, and cooperation. However, these treaties were not drafted with large LEO constellations in mind. They were developed in an era when outer space activities were dominated by state actors and when the main security concern was the placement of nuclear weapons or other weapons of mass destruction in orbit.

This creates a gap between the form of the law and the reality of modern space activity. Large LEO constellations are not usually classified as weapons of mass destruction. They may not carry destructive payloads and may not be designed to attack objects in space or on Earth. Nevertheless, they can provide essential support to military operations. Communication networks, imaging services, and data transmission may become part of the operational environment of an armed conflict even if the satellites themselves remain formally civilian or commercial.

The legal consequence is that the principle “what is not prohibited is permitted” may be invoked too easily. If a constellation does not fall under the narrow category of weapons prohibited by Article IV of the Outer Space Treaty, its operator or launching state may argue that the activity does not violate international space law. Yet this formal argument does not fully address the strategic reality that such constellations may contribute to military operations. This is the core of the regulatory dilemma.

The second result is that several key legal concepts remain insufficiently defined. The most im-



portant is “peaceful use.” One interpretation treats peaceful use as “non-military,” while another treats it as “non-aggressive.” Under the non-aggressive interpretation, many military-support activities in space may be considered lawful so long as they are not themselves aggressive or hostile. This interpretation has allowed states to maintain military space programmes while still claiming compliance with the peaceful-use principle.

The concept of “weapons of mass destruction” is also unclear in its application to modern space technologies. The Outer Space Treaty prohibits nuclear weapons and other weapons of mass destruction, but it does not define WMDs in a way that helps classify dual-use constellations. LEO mega-constellations do not fit the traditional image of weapons, but they can improve command, control, communication, reconnaissance, and operational coordination. This functional role is legally significant, yet it is not directly captured by the treaty text.

Further ambiguity appears in the distinction between military and non-military personnel, military and non-military research, and civilian and military infrastructure. Laser systems, imaging equipment, communication networks, and orbital platforms may serve scientific, commercial, or military purposes depending on how they are used. This functional convertibility makes it difficult to regulate large constellations through a simple distinction between peaceful and military activity (Hu, 2024; Zhu, 2018).

The third result is that the current treaty framework does not provide a sufficiently strong consultation and dispute resolution mechanism. Article IX of the Outer Space Treaty refers to appropriate international consultations when a state has reason to believe that an activity or experiment planned by it or its nationals would cause potentially harmful interference with the activities of other states. It also allows a state to request consultation if another state’s planned activity may cause such interference (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1967).

These provisions are important, but they are procedurally weak. They do not set out a mandatory timetable, a compulsory forum, an emergency procedure, or a clear consequence for refusing consultation. Therefore, when a large LEO constellation creates serious interference or strategic risk, an affected state may have no effective remedy other than diplomatic protest. The International Court of Justice depends on state consent, and arbitration

rules for outer space disputes do not create compulsory jurisdiction. As a result, the legal pathway for urgent relief remains limited.

This gap is especially problematic when the relevant constellation is operated by a private company. A victim state or injured party may not be able to obtain an emergency injunction or meaningful preventive remedy against the operator through the existing international space-law framework. In practical terms, the quasi-military use of a commercial constellation may be treated less as a specific space-law violation and more as a general political or security dispute.

The fourth result concerns state responsibility. Under Article VI of the Outer Space Treaty, states bear international responsibility for national activities in outer space, whether those activities are carried out by governmental or non-governmental entities. Non-governmental activities require authorization and continuing supervision by the appropriate state (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, 1967). In principle, this rule should prevent states from avoiding responsibility through private actors.

In practice, however, the situation is more complicated. Large LEO constellations are often operated by private companies that make business decisions, enter into contracts, provide services to different users, and control technical access. Their actions are not always easily attributable to the home government as state conduct. At the same time, the launching state or state of registry may still have obligations of authorization, supervision, and responsibility. This creates a legal space in which responsibility exists in principle but is difficult to enforce in practice.

The issue is not simply that private companies are present in outer space. The deeper problem is that commercial infrastructure can become strategically decisive while remaining formally outside the traditional model of state-operated military satellites. If a constellation operator provides, restricts, or withdraws services during a conflict, the consequences may affect sovereign security interests. The existing rules do not clearly explain how to classify such conduct, how to attribute it, or how to determine the responsibility of the authorizing state.

The fifth result is that the Liability Convention is too narrow for many forms of harm associated with quasi-military constellation use. The convention was designed mainly to address damage caused by space objects, especially physical damage such

as loss of life, personal injury, or damage to property (Convention on International Liability for Damage Caused by Space Objects, 1972). This model is useful for collisions, debris damage, or re-entry incidents, but it is less effective for non-kinetic and indirect harm.

In quasi-military use, a LEO constellation may not physically damage another state's satellite or territory. Instead, it may provide communication or imaging support that changes the course of military operations on Earth. It may also create operational dependence, enable targeting, or expose another state to strategic vulnerability. These harms can be substantial, but they do not easily fit the Liability Convention's definition of damage. The result is a claims gap: there may be real harm, but no clearly applicable compensation mechanism.

The Rescue Agreement reveals a related tension. It requires states to protect and return discovered space objects and to notify the launching authority (Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 1968). In ordinary circumstances, this supports cooperation and safety. In a quasi-military context, however, the obligation to protect and return space objects may sit uneasily beside a state's security interest in neutralizing militarily relevant infrastructure. The existing treaties do not resolve this tension.

The sixth result is that the registration system does not provide enough transparency for large LEO constellations. The Registration Convention requires states to register objects launched into outer space and to provide basic information to the United Nations (Convention on Registration of Objects Launched into Outer Space, 1975). This system helps identify space objects and supports accountability, but it was not designed to reveal the full operational functions of large commercial constellations.

The Convention generally requires information such as the name of the launching state, an appropriate designator or registration number, the date and location of launch, basic orbital parameters, and the general function of the space object. For large constellations, this may be insufficient. A general function such as "communication" or "remote sensing" does not clarify whether the system is being used for ordinary civilian services, direct military support, or a mixed set of functions. This limitation has become more serious as commercial actors and military users increasingly rely on the same infrastructure (Zha, 2022).

Domestic supervision also varies from state to state. Some national systems provide detailed licensing and supervision of private space activities, while others offer weaker or less developed mechanisms. Because Article VI of the Outer Space Treaty leaves implementation largely to domestic law, states may differ significantly in how they supervise private operators. This unevenness creates regulatory friction and may allow quasi-military uses to continue without a clear international response.

The final result is that recent space-security policies have intensified rather than resolved the regulatory dilemma. The United States has treated outer space as an increasingly important operational domain. The 2020 Defense Space Strategy Summary identifies spacepower as necessary for competition, deterrence, and military effectiveness, while emphasizing space superiority and support to national, joint, and combined operations (U.S. Department of Defense, 2020).

The Fiscal Year 2024 National Defense Authorization Act summary further reflects the institutional development of the United States Space Force and the integration of commercial and allied space-related capabilities into defense policy (United States Senate Committee on Armed Services, 2024). The 2025 executive order "Ensuring American Space Superiority" also frames space as an area closely connected to national power, security, commercial development, and technological leadership (The White House, 2025).

These developments do not automatically violate international space law. However, they demonstrate how far contemporary practice has moved beyond the original assumptions of the Cold War treaty system. Space is increasingly treated as an operational, commercial, and strategic environment at the same time. The 2025 UNIDIR Outer Space Security Conference similarly emphasized the growing role of commercial actors, dual-use systems, and emerging technologies in space-security debates (Mai & Mathe, 2025).

## Discussion

The results show that the regulatory dilemma of large LEO constellations is structural rather than incidental. It does not arise from a single missing rule. It arises from the interaction of old treaty language, dual-use technology, private operation, state security interests, and weak procedural mechanisms. The existing framework can still identify broad princi-

ples, but it struggles to convert those principles into timely legal control.

The main conceptual problem is that international space law continues to rely heavily on categories that are too rigid for contemporary practice. The distinction between civilian and military use is no longer sufficient when the same constellation can provide commercial internet access, humanitarian connectivity, battlefield communication, and strategic resilience. A more realistic legal discussion has to focus not only on the object itself, but also on its function, users, degree of integration into military operations, and the foreseeability of harmful consequences.

The main institutional problem is the absence of enforceable procedures. Consultation under Article IX of the Outer Space Treaty is important, but it is too weak to handle urgent disputes involving large constellations. Without time limits, compulsory notification standards, emergency review, or a neutral forum, consultation remains politically dependent. This undermines the preventive function of international space law.

The responsibility gap is equally important. Article VI of the Outer Space Treaty provides a legal basis for state responsibility over non-governmental activities, but the effectiveness of this rule depends on domestic authorization and supervision. Where national regulation is weak, uneven, or strategically permissive, private operators may perform functions with geopolitical consequences while international accountability remains difficult to establish.

The compensation gap shows that the Liability Convention is better suited to physical harm than to operational, informational, and strategic harm. In contemporary conflict, a satellite constellation may cause decisive effects without producing physical damage in the traditional sense. This does not mean every military-support function should automatically create liability, but it does mean that the existing legal categories are too narrow to capture the full range of harm created by quasi-military use.

Finally, the discussion suggests that the peaceful-use principle needs procedural support. The principle itself remains valuable, but it cannot operate effectively without clearer registration standards, more meaningful supervision of private operators, stronger transparency obligations, and a more prac-

tical method for addressing disputes before harm becomes irreversible. The regulatory challenge is therefore not to abolish commercial LEO constellations, but to ensure that their strategic use does not erode the international legal order of outer space.

## Conclusion

Large LEO constellations have exposed a fundamental weakness in international space law. The five cornerstone treaties still provide the basic framework for outer space governance, but they were drafted for a different technological and political environment. Their principles remain relevant, yet their procedures are not strong enough to regulate the quasi-military use of commercial constellations.

The analysis shows that the main regulatory difficulties include outdated treaty design, ambiguity of key legal concepts, weak consultation and adjudication mechanisms, unclear attribution of responsibility for private operators, narrow liability and compensation rules, incomplete registration transparency, and the growing importance of national space-security policies. These problems create a legal vacuum in which activities may be strategically significant but difficult to classify as unlawful under existing rules.

The article therefore concludes that the peaceful use of outer space requires more than a general prohibition on weapons of mass destruction. It requires a clearer legal approach to dual-use infrastructure, quasi-military support functions, private operators, and non-kinetic harm. Without such clarification, large LEO constellations will continue to challenge the boundary between lawful commercial activity and military involvement in outer space.

The future development of international space law should focus on making the existing framework more operational. This means clarifying the meaning of harmful interference and damage, strengthening consultation procedures, improving registration requirements for large constellations, and specifying the due diligence duties of states that authorize and supervise private space operators. These steps would not replace the five core treaties, but they would help adapt them to the realities of contemporary outer space activity.

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