LIABILITY APPORTIONMENT IN OUTER SPACE ACCIDENTS: EVALUATING THE ROLE OF INTERNATIONAL ARBITRATION UNDER THE LIABILITY CONVENTION

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ABSTRACT

The fast rise of commercial space activities, besides satellite congestion, and debris generation, has made the chance of collisions and other accidents in outer space significantly higher. The 1972 Liability Convention may be considered the first step in the direction of determining state liability, since it provides for absolute liability without fault for damage caused on Earth and for liability based on fault for incidents occurring in outer space, still, it is quite limited as far as the complexities of present, day space operations are concerned. Among the issues raised by the space operations are the following: how to assess "fault" in a place where there are no uniform technical standards, how to identify the party responsible for several cases of actors, and how to understand the state's responsibility vis, à, vis the increasing number of private space companies. As cases increase both in number and complexity, international arbitration appears to be a suitable tool to overcome the enforcement and adjudicatory gaps existing in the present treaties. Being a neutral and expert, driven forum capable of dealing with multi, party claims, technical evidence, and cross, border contractual disputes, the PCA together with its Optional Rules for Outer Space Disputes, is one of the institutions where such disputes could be settled. In this article, we examine the arbitration potential to act as a Liability Convention supplement agency which would, inter alia, provide certainty, enforceability, and procedural flexibility. Also, the article advocates for the establishment of a global harmonized framework that would integrate treaty obligations with arbitral processes so as to guarantee just and efficient space, related accidents settlement. The reinforcement of arbitration channels is a prerequisite for the construction of a durable and accountable international space liability regime.

Introduction: Growing Risks and Legal Vacuum in Outer Space Accidents

Outer space has dramatically changed from a realm of state, led scientific exploration to a vibrant arena characterized by commercial activities, private investments, satellite constellations, and new ventures like space tourism and resource extraction. The expansion of parties and objects in space at a fast pace has substantially raised the chances of accidents, collisions, interference, and technical failures. With technology making satellite launching cheaper and facilitating the creation of mega, constellations such as Starlink, OneWeb, and Kuiper, the Earth's orbit is getting more and more crowded. This overcrowded space has resulted in a threat of orbital congestion, radio, frequency interference, and space debris generation at a level never seen before, thus making the issues of attribution, responsibility, and liability in case of an accident even more complicated. However, the international legal framework for such incidents is still in its infancy and not sufficiently developed to deal with the new realities of space.

The Outer Space Treaty (OST) of 1967 and the Liability Convention of 1972 are the main instruments that set out the rules relating to the responsibility and liability of states for activities in outer space. These treaties, while innovative at their time, were created in a period of the Cold War when only two superpowers dominated and almost all space activities were conducted by the states. The legal structure mirrors this geopolitical situation by assigning exclusive responsibility to states for their space activities, whether these are carried out directly by government agencies or by non, governmental entities. Now that private sector players are the main drivers in satellite launch, space systems operation, and space commercial mission execution, this state, centric liability model no longer fits the realities of current space operations. Consequently, the existing framework is increasingly under pressure when it comes to issues such as collisions involving privately owned satellites, commercial launch failures, or disputes involving multiple international stakeholders.

On top of that, the Liability Convention distinguishes absolute liability for damage caused on the Earth's surface from fault, based liability for accidents happening in outer space. Even though these concepts seem clear, cut, their practical application raises numerous challenges. "Fault" determination in space is intrinsically a very complicated technical task, and it needs access to orbital data, telemetry, as well as debris tracking information. All this information, however, is very often unavailable due to security concerns or because it is proprietary. Apart

from that, the Convention does not provide a definite method for assigning liability in a multi, party incident, and it does not set out standards for contributory negligence, comparative fault, or apportionment in the case of multiple objects or fragments. As space debris continues to grow, more and more accidents are happening due to fragments left behind by past collisions or anti, satellite tests, which makes the assigning of fault even harder.

The growing number of private actors is also indicative of a major procedural gap: the Liability Convention only permits claims from one state to another, and private companies thus looking for a remedy at the international level are dependent on their national governments. This dependence is a source of obstacles to dispute resolution in the form of diplomacy, politics, and economy. On the one hand, states may not be very eager to file claims against their strategic partners or powerful spacefaring nations, thus a lack of direct recourse for private operators is the consequence. On the other hand, the Convention does not set any compulsory mechanism for dispute resolution, does not establish a dedicated tribunal, and has no procedural rules for resolving complex technical disputes. Instead, it leans on negotiations or the setting up of an ad, hoc Claims Commission, which makes non, binding decisions except for the cases in which the parties agree otherwise.

In an environment of legal fragmentation and procedural uncertainty such as this, international arbitration has been considered a viable means for settling space, related disputes. Arbitration comprises several features that may be of help to the space industry, namely: neutrality, party autonomy, confidentiality, specialized expertise, flexibility of the procedure, and award enforceability under the New York Convention. Due to these advantages, the Permanent Court of Arbitration (PCA) came up with the Optional Rules for Arbitration on Disputes Relating to Outer Space Activities (2011), which are specifically tailored to meet the technical, scientific, and commercial issues in space disputes. These rules form a major step towards having a well, structured dispute resolution system that is capable of dealing with cross, border claims involving states and private entities.

Nevertheless, despite these improvements, there is still a lot of work to be done in terms of exploring the relationship between the Liability Convention and international arbitration. Key questions remain to be answered: Is arbitration a suitable means to fill the gaps left by the treaty? Would the liability framework be changed in a way that allows arbitration of state, to, state claims? In the absence of standard data, sharing protocols, how can arbitral tribunals

figure out who is at fault? And can arbitration be used to strike a balance between the interests of states and those of private actors in an inherently global and strategic domain? This piece of writing intends to examine these questions by exploring the potential of international arbitration in sharing the blame for outer space accidents as well as in dealing with the doctrinal gaps of the Liability Convention. Given the trajectory of the world space environment as more and more commercial and congested, the evolution of a dispute resolution system that is predictable, expert, driven, and enforceable will be a prerequisite for the continuation of space governance, the promotion of investment, and the assurance of safety and sustainability of activities beyond Earth for the long term.

Scope and Limitations of the Liability Convention in Apportioning Liability

The 1972 Liability Convention, formally referred to as the Convention on International Liability for Damage Caused by Space Objects, is the central international legal instrument that deals with liability in case of accidents in outer space. However, this convention, with its restricted scope, and limited practical application, is seemingly ill, equipped to deal with the complexities of contemporary space activities.

The agreement puts forward a two, tiered liability system: one where the liability is absolute for any damage caused by a space object on the Earth's surface or to a flying aircraft, and another where the liability is based on a fault for the damage that takes place anywhere else in outer space. This setup was groundbreaking at the time when the convention was adopted. However, it was conceived for an epoch when only states ventured into space, and space missions were rare, predictable, and controlled.

The current situation, which includes such things as commercial satellites, private launch providers, mega, constellations, space tourism, and fast technological development, reveals the limitations of the agreement. To begin with, the accord places the onus of absolute liability on the launching states only. These states are those which launch, procure the launching, or provide their territory or facilities for the launch. This results in complicating matters when launches are involved with multiple actors, among whom can be private corporations and joint ventures spread across different jurisdictions. The treaty is silent on how to allocate the liability among several launching states and does not provide the criteria by which the determination of each state's share of responsibility can be made. This leaves such an allocation to diplomatic negotiations rather than to predictable legal processes.

Moreover, the fault, based criterion for harm in space is also ambiguous and is without any defined technical or operational check points for ascertaining fault. At the same time, there are no uniform rules on collision avoidance, debris mitigation, data sharing, or space traffic management. Hence it becomes virtually impossible to determine whether a state or its private entity has acted negligently or not. The lack of binding technical standards makes the identification of fault a subjective exercise, heavily reliant on the cooperation and transparency of the states, which is often not forthcoming due to reasons of national security or commercial confidentiality. Furthermore, the accord is only applicable to states as main claimants and respondents despite the fact that space has been overwhelmingly commercialized. In the case of private actors, they cannot directly claim compensation under the agreement. Instead, they have to depend on their state to present the claims on their behalf, a move which states may decline due to political or strategic considerations thus leaving private entities without an effective remedy. This touches upon the fundamental issue of the mismatch between the treaty and the current realities of how private companies operate thousands of satellites, conduct lunar missions, and plan asteroid mining activities.

In addition, very few are the mechanisms for dispute settlement provided for in the Convention. As a matter of fact, the Convention only provides for a Claims Commission, which is a temporary, ad hoc, and non, binding body unless otherwise agreed by the parties. Its decisions do not have any precedential value, and the mechanism has never been utilized, thus indicating the reluctance of states to participate in formal liability proceedings under the treaty. With the increase in congestion and potential accidents of space activities, the lack of compulsory, enforceable dispute resolution procedures substantially weakens the role of the Convention.

Moreover, the convention does not fully encompass the problem of space debris, which is the main cause of most of the potential collisions in orbit. Most of the time, debris is untraceable or is the result of missions carried out decades ago. Therefore it is ambiguous which state, if any, should be held responsible for the liability. In addition, the agreement is silent on the scenarios concerning shared fault or contributory negligence in multi, object collisions that have now become common in low, earth orbit. It also does not consider the present threats such as anti, satellite weapon (ASAT) tests, which result in the rapid spread of debris clouds.

Besides, the convention expects states to behave cooperatively, however, in reality, geopolitical factors and military secrecy often impede the sharing of orbital data, which is necessary to

prove fault. Without mandatory transparency obligations, states may decide to keep critical information to themselves, thus making an objective fault assessment nearly impossible. Moreover, the agreement does not offer any advice concerning insurance, indemnification, or risk, sharing for private operators. This leaves a lot of room for states to fill through their domestic legislation. Consequently, national liability regimes are vastly different from one another, thus creating legal uncertainties for international operators and making multi, jurisdictional launch arrangements more complicated.

On the whole, although the Liability Convention lays down an essential framework of liability based on state responsibility, it is too narrowly scoped and its provisions are too antiquated to effectively be the ones to regulate the risks and the realities of modern space operations. Its shortcomings, particularly with respect to private sector involvement, fault determination, multi, state launches, debris, related damage, and the absence of binding dispute resolution, point out the pressing need for supplementary instruments, most notably international arbitration, to come and fill in the procedural and substantive gaps in apportioning liability for accidents in outer space.

Role of International Arbitration in Resolving Space Accident Disputes

International arbitration has become a key, and one of the main, increasingly necessary means of solving international disputes resulting from space accidents that are not only costly but time, consuming and complex and in which the so, called traditional state, centric frameworks, especially the 1972 Liability Convention, have, in general, not foreseen the need to face the complex and commercialized reality of modern space activities.

The present space environment entails the private launch operators, satellite constellations, space tourism companies, space mining corporations, and multinational joint ventures that usually cross borders, thus creating relationships governed by private commercial contracts instead of inter, state treaties. Collisions, debris, related damages, disruption of satellite services, failed launch operations, or technical malfunctions, if this is what happened, then the disputes would probably involve private entities rather than governments alone. This change makes international arbitration particularly appropriate for such disputes because of its neutrality, flexibility, and effectiveness, which are already proven, in handling high, value, cross, border commercial matters.

Arbitration gives the involved parties an opportunity to select arbitrators who are technically skilled in orbital mechanics, spacecraft engineering, and space law, three areas in which domestic courts are seldom knowledgeable, thus allowing a more informed decision in the cases that involve complex evidence like telemetry data, fault attribution, collision probabilities, and orbital maneuver histories.

The Permanent Court of Arbitration (PCA) is one of the institutions which have seen the upsurge of space disputes and, in response to it, have created the 2011 Optional Rules for Arbitration of Disputes Relating to Outer Space Activities. These rules provide the tailored procedures for confidentiality, classification of sensitive data, expert evidence, and multi, party claims, all of which are essential in disputes involving proprietary technology or national security concerns. Also, the rules facilitate the handling of disputes between states, private parties, and hybrid structures, thus overcoming a big gap left by the Liability Convention that only applies to states and does not offer any binding dispute resolution mechanism.

Besides, arbitration is supported by worldwide enforceability through the New York Convention that makes it possible for arbitral awards to be recognized in more than 160 jurisdictions, which is a big advantage over diplomatic claims commissions under the Liability Convention that depend on political negotiation rather than legal enforceability. Arbitration has already become the most preferred method of resolving disputes in the commercial space contracts, particularly in launch service agreements, satellite manufacturing contracts, frequency coordination agreements, and insurance, related contracts.

Normally, these contracts contain arbitration clauses which identify the institutions to be selected for solving the disputes that are expected to arise from the failed launches, delays, breaches of contracts, or liability for in, orbit damage. One more significant benefit made through arbitration is allowing the inclusion of scientific specialists and independent technical panels who are indispensable for determining the cause of outer space accidents where data transparency is restricted, and evidence is mostly in control of the operators. The tribunals may compel the parties to disclose the vital information, such as the health data of the spacecraft or the collision avoidance maneuvers, which in most cases are not allowed in the inter, state diplomacy and national security sectors.

In addition, arbitration enables the creation of fault, apportionment models that the Liability Convention does not offer; arbitrators can evaluate the contributory negligence, shared

operational risks, and compliance with international soft, law standards like the Space Debris Mitigation Guidelines, thus providing more balanced results. It becomes very significant when situations are arisen which include disputes over the space debris attributing to a particular satellite, because assigning the origin of the fragments in orbit needs detailed forensic reconstruction which the arbitration panels are structurally more capable of doing than the mechanisms that are treaty, based. Moreover, arbitration can be a link between public international law and private commercial law helping in cases where the state responsibility overlaps with the private conduct i.e. when a private satellite operator causes a collision but the claim has to be technically made against the launching state under the Liability Convention.

Such an arbitrational framework as is flexible gives the opportunity to states to transfer liability to private operators by a contractual agreement, to include indemnity provisions, as well as to set up the binding mechanisms for dispute resolution which ensures that there is accountability beyond the rigid treaty structure. With all its benefits, there are still challenges i.e. problems of sovereign immunity, the binding nature of arbitration for states, confidentiality vs. global governance transparency need, and nonexistence of uniform technical standards for determining "fault". However, these constraints do not undermine the relevance of the increasingly prominent role of the arbitration; on the contrary, they suggest that there is an urgent need for a clearer coordination of the principles of the Liability Convention and the contemporary arbitral practices.

On the condition that commercial activities in outer space will be expedited, in particular mega, constellations, lunar missions, and space mining, the international arbitration would be the most practical, enforceable, and expert, oriented platform for settling the disputes that, otherwise, have the potential to destabilize global space governance.

Harmonizing the Liability Convention with Arbitration Mechanisms

Harmonizing the Liability Convention with Arbitration Mechanisms calls for a careful and detailed consideration of how inter, State liability under a treaty and an increasingly arbitration, driven resolution of commercial space disputes co, exist. The 1972 Liability Convention was conceptualized when space activities were essentially the domain of States only, and its design is that of a classical public international law model where the injured States have to sue the wrong, doing States through diplomatic channels. Nevertheless, this model is becoming less and less relevant as the space economy is being taken over by private satellite operators,

commercial launch providers, space, mining ventures, and multinational investments. The Convention's inflexible procedures, such as the obligatory recourse to diplomatic negotiation of claims and, if not successful, the establishment of a Claims Commission with non, binding recommendations, do not have the capacity to handle complex multi, party and technologically advanced disputes resulting from outer space accidents. Unlike that, arbitration offers procedural flexibility, expert, driven adjudication, confidentiality, and awards that can be enforced worldwide under the New York Convention and, thus, it is very attractive to parties as a forum for settling their disputes of either contractual or tort, based origin arising from space activities.

The problem is how to bring into line the State, centric liabilities under the Liability Convention with the private, contract, based nature of arbitration. One way to coordinate is for States to approve that private parties may start arbitration in case of a dispute that would otherwise be under the purview of the Convention. Although the Convention itself does not disallow States from entrusting the resolution of disputes to arbitral tribunals, it questions whether such entrustment can bind States to results set by private arbitrators, especially since under the Convention, liability is on the States even if the conduct is that of a private party. Yet, by putting arbitration provisions in their agreements with private operators, States will have made sure that any disputes arising from private negligence, breach of contract, or operational misconduct will be solved by arbitration and will not be referred to the international claims under the Convention until they have escalated. Besides, arbitral tribunals may also be given the authority to interpret the Convention indirectly, especially when contractual obligations refer to treaty standards such as "due diligence, " "fault, " or safety obligations originating from the Convention or national space laws.

One major instrument for harmonization is the Permanent Court of Arbitration's Optional Rules for Arbitration of Disputes Relating to Outer Space Activities (2011) which provide a specialized procedural framework tailored to space disputes, complete with provisions on the production of scientific evidence, confidentiality, appointment of experts, and the rights of parties in multi, party claims. These provisions may be adopted by States as well as private parties and serve as a connecting link between binding treaty obligations and the current business environment.

Another option for harmonization is the establishment of hybrid mechanisms through which

international claims commissions set up under the Liability Convention can work together with arbitral tribunals. One example can be a Claims Commission deciding on State responsibility or treaty violation, while an arbitral tribunal calculating the damages or determining the division of the blame between several private actors. This step, wise method avoids double work, is in line with the treaty, and benefits from the procedural efficiency of arbitration.

However, certain doctrinal issues remain unsolved, the most prominent of which is the question of sovereign immunity as States are likely to be against arbitration that results in binding awards to them unless they have expressly waived their immunity. A solution to this would be the incorporation of explicit immunity waivers in bilateral agreements, launch contracts, or national legislation governing private space activities.

Moreover, harmonization would be facilitated by more precise and comprehensive international standards for the concept of "fault" in space operations. The Convention does not provide the technical criteria for determining fault, thus making it difficult to be applied in arbitration. By establishing globally accepted standards based on space situational awareness (SSA) data, debris mitigation guidelines, and orbital traffic management standards, it would be possible for arbitral tribunals to evaluate negligence more consistently.

In the end, good harmonization relies on various soft, law measures, such as updated versions of the Convention, model arbitration clauses for space contracts, and multilateral guidelines encouraging States to resort to arbitration as the default means of dispute resolution. As commercial space ventures gain momentum, the coexistence of the Liability Convention and international arbitration is not only feasible but necessary. Arbitration could help overcome some of the limitations of the Convention by providing accuracy in fact, finding, flexibility with respect to the technical nature of the issues, and the possibility of enforcement, while the Convention would ensure accountability under public international law between States. A harmonized model that merges treaty, based responsibility and arbitration, based dispute resolution constitutes the most viable and future, proof way of regulating liability in case of space accidents.

Conclusion and Way Forward: Need for a Comprehensive International Space Liability and Arbitration Regime

The growing commercialisation and congestion of space have highlighted the international

liability framework's deep, seated structural weaknesses, particularly the 1972 Liability Convention. This was a period when space activities were almost entirely under the control of states, and technological complexities were much simpler. As of now, the Convention's state, centric, fault, based and absolute liability standards do not offer sufficiently clear, predictable or enforceable mechanisms for the allocation of responsibility in case of collisions, debris, generating incidents or transboundary harm.

Besides that, the Convention does not take into account multi, party accidents, contributory negligence, shared fault between private and governmental actors, and the scenario that is becoming more and more frequent where debris from one state's private operator causes a chain of events that harm another state's assets. On top of that, the treaty's reliance on diplomatic negotiation and inter, state claims, which is a political, slow, and often inconclusive process, results in an enforcement vacuum that is at odds with the hectic, risky, and capital, intensive nature of modern space operations. Given these circumstances, international arbitration is the most practical, neutral and technically advanced mechanism that can bridge these gaps. It provides expert, driven fact, finding, procedural flexibility, multi, party participation, and cross, border enforceability through the New York Convention.

The Permanent Court of Arbitration's "Optional Rules for Disputes Relating to Outer Space Activities" are a significant move forward as they provide for technical experts, confidentiality protections, and complex evidentiary procedures besides accommodating both state and private entities. Nevertheless, these optional rules are still voluntary and lack treaty, level authority, which hampers their practical implementation. The most pressing matter is a hybrid liability, arbitration regime that combines the Liability Convention's strengths with the arbitration's procedural efficiency.

Such a scenario could represent (a) treaty changes that officially allow states to settle binding arbitration claims under the Liability Convention; (b) setting worldwide uniform standards for determining fault, contributory negligence, orbital data disclosure, and debris attribution; (c) the creation of compulsory investigation panels or independent space accident authorities that provide factual reports to arbitral tribunals; and (d) the emergence of model arbitration clauses for space, related commercial contracts facilitating the synchronization of launch services, satellite manufacturing, insurance, and in, orbit service agreements. Without clear rules on responsibility and dispute resolution and with the rise of mega, constellations, kinetic anti,

satellite (ASAT) testing, and unregulated commercial ventures in lunar and asteroid environments, the risk to commercial interests is not the only one but human access to space as a shared global commons may also be compromised.

For that reason, a full regime would also provide for environmental liability, duties of due regard and space sustainability, mandatory debris mitigation standards, and the legal consequences of non, compliance. On the institutional side, states and private actors will gain from an international Space Arbitration Centre which will be staffed by experts in orbital mechanics, satellite engineering, public international law, and commercial arbitration. Such a platform will guarantee fixed jurisprudence, lessen the politicisation of dispute resolution, and facilitate predictability for investors and insurers, a prerequisite as billions of dollars are flowing into the space economy.

Finally, the solution is not to replace the Liability Convention with a modern one but to modernise and supplement it, thus turning it from a static diplomatic instrument into a dynamic legal system which is capable of resolving complex, multi, party, technologically intricate disputes through impartial arbitration. The future of space governance heavily relies on the international community's acknowledgment that outer space is no longer an exclusive diplomatic arena but a competitive commercial marketplace where accidents are inevitable, liability must be clear, and dispute resolution must be swift, expert, driven and enforceable. It is only through such reforms that we will keep space safe, sustainable, and accessible for all present and future actors.

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