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Which Jurisdiction for Private In-space Assembled Autonomous Platforms?

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ABSTRACT

This article builds a model for determining the law applicable to in-space assembled autonomous platforms and the services they are likely to provide. It makes a comprehensive inventory of the new challenges and emerging industry trends in the field of in-space assembly. It identifies some of the most significant industrial projects, which are currently engaged or contemplated. It then examines the status of such private platforms assembled in space in terms of both international rules and state jurisdiction. It suggests an approach that distinguishes the service provided from the physical platform itself, which would enable States to regulate service operation. The conclusion sets out a series of practical recommendations that could be implemented at different levels.

1. Introduction

The development of assembly techniques in space in the more general context of on-orbit servicing should encourage the emergence of private space platforms in the coming years. Equipped with artificial intelligence tools, these platforms could provide innovative services whose legal regime could be all the more difficult to determine as they will be provided by unregistered infrastructures, which are not under the jurisdiction of a State of origin. These services could threaten the sovereignty of States, defy their internal public order, and be the cause of damage on Earth and in space. Such services and technologies cannot therefore be developed without calling for strict regulation.

However, space activities, unlike other activities, do not come under any international regime and depend only on the national regime of the State of attachment. International space law is based on a founding principle, that of the responsibility of States and, beyond the legal dimension, their accountability. It is up to the State of attachment to police itself by regulating in accordance with the principles laid down by the treaties it has signed and to which it is committed internationally

(i) The manufacture of space objects.
(ii) The launch and control procedures in orbit.
(iii) The operation of satellites or satellite constellations.
(iv) The allocation of frequencies serving them and end-of-life deorbiting operations.
(v) The services they provide or the data they produce.

This legal ecosystem only works when a space object or activity can be attached to the jurisdiction of a State. The in-space assembly of new space objects (for instance, space platforms), which are both private and autonomous, gives rise to important legal questions, which has become necessary to address.

By drawing on the legal reasoning proposed by the Grand Chamber of the Court of Justice of the European Union in a recent judgment involving the Airbnb platform [1], this article builds a

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model for determining the law applicable to in-space assembled autonomous platforms and the services they are likely to provide. First, it provides a brief overview of in-space assembly, servicing, and manufacturing (Section 2), and then, it makes a comprehensive inventory of the new challenges and emerging industry trends in the field of in-space assembly (Section 3). It identifies some of the most significant industrial projects, which are currently engaged or contemplated (Section 4). It then examines the status of such private platforms assembled in space in terms of both international rules and state jurisdiction (Section 5). It suggests an approach that distinguishes the service provided from the physical platform itself, which would enable States to regulate service operation (Section 6). The conclusion sets out a series of practical proposals that could be implemented at different levels (Section 7).

2. On-orbit and in-space servicing, assembly, and manufacturing: a brief overview

Before analyzing the industrial and legal challenges arising from placing of private in-space assembled autonomous platforms in orbit, it is worth providing a brief overview of in-space assembly, servicing, and manufacturing, including their advantages and main applications.

2.1. Servicing operations in space

On-orbit servicing refers to on-orbit activities carried out by a spacecraft and consists in either up-close inspection of or the performance of intentional beneficial modifications to another space object [2]. The space vehicle carrying out the servicing operations is called a "servicer," whereas the space object receiving servicing is referred to as the "client" [2]. On-orbit servicing can be carried out in two modes: (i) prepositioned (where servicers are placed in advance in the most-used orbits so as to provide their services anytime, allowing for multimission and multicustomer servicing) and (ii) on an as-needed basis (servicing in less-used orbits, support for deep-space missions, and so on.) [3].

Servicing is a more mature capability compared with in-space assembly and manufacturing [4]. It comprises a wide range of operations and applications as follows:

(i). Contactless support: e.g., the inspection of the client, contactless assessment and resolution of anomalies, and enhancement of the client's capabilities through a wireless connection [2]

(ii). Reparation: e.g., correction of mechanical failures, reparation or replacement of defunct critical components, and maintenance functions [2,5]

(iii). Commodities replacement(including refueling): replenishing of expendable resources and commodities naturally depleted by the client (e.g., propellants, coolants) [2]

(iv). Upgrading, reconfiguration, and refurbishing: enhancement of the client's capabilities beyond the technical constraints of its original design [2]

(v). Orbit modification or maintenance: spatial relocation or repositioning of the client by the servicer at a specific orbit (orbit modification), station-keeping, and attitude control (orbit maintenance) [2]

(vi). Debris mitigation and management: orbital maneuvering and robotic manipulation to remove space debris from highly valuable crowded orbits [e.g., GEO (Geostationary Orbit) or LEO (Low Earth Orbit)] [2].

By replacing, maintaining, or upgrading components, on-orbit servicing enables extension of the operational life and amelioration of the performance of space infrastructure in tandem with technological evolutions on Earth [4,6]. It increases the efficiency of missions and allows for additional utility to be derived from the serviced infrastructure.

2.2. In-space assembly

In-space assembly refers to the activity in which two or more parts (components, modules) are gathered and pieced together in space to form a single functional aggregate structure (such as a platform, a space station, a telescope, or even a habitat) [4]. The assembled structure can not only be a new, stand-alone space object but also serve as an enhancement to an already existing one [2]. Assembly activities can take place in a target orbit (e.g., LEO, GEO) or elsewhere in outer space (e.g., cis-lunar space, Mars surface, interstellar space) [5]. The parts used for the assembly are ready-made structures that are manufactured either on Earth or on orbit [7]. Assembly techniques can be categorized into

(i) Astronaut-assisted assembly (e.g., manual assembly with assembly assistance, such as the robot arm used by the Space Shuttle STS-88 crew to mate the Unity and Zarya modules of the International Space Station [8]).

(ii) Robotic assembly (either remotely controlled or autonomous) [5,9].

In-space assembly entails numerous operational and economic advantages. First, it allows operators to overcome limitations arising from space vehicle mass, load, and volume constraints [4,5]. The fairings of launch vehicles, being limited in size and volume, restrict the dimensions and mass of the payload that can be launched into space. However, by launching individual parts into space separately and assembling them upon delivery, these constraints can be bypassed and allow for the introduction of larger structures in space. This can reduce operating costs and favor the use of medium-lift vehicles, instead of the more costly heavy-lift launch vehicles that would otherwise be required to transfer such

Table 1
Law applicable to the platform as a physical infrastructure in space.

Characterization of the platform	Applicable law
The platform is a space object	The law of the State that registered this object or of the State exercising quasi-territorial or personal jurisdiction (the "appropriate State" that is internationally responsible for national space activities under Article VI OST).
The platform is not a space object	The law of the State exercising quasi-territorial or personal jurisdiction: • The State that authorized the in-space assembling activity • State of incorporation or of principal place of business • Through ownership and property rights • State of registration of the vehicle that delivered the assembly and manufacturing equipment and materials into space

OST = Outer Space Treaty.

Table 2
Law applicable to the services provided by means of the platform.

Proposed solutions	Applicable law
Solution #1	The law of the State of nationality of the natural or legal person benefiting directly or indirectly from the intermediation service: this could be either the law of the State of nationality/residence of the service recipient or of the service provider.
Solution #2	The law of the State of registration, if the customer of the service is a space object subject to registration.
Solution #3	In some jurisdictions (such as the EU), depending on the nature of the service, specific laws might be applicable.
Solution #4	The "law of the territory of origin" may be applicable on a quasi-territorial or personal basis to the intermediation service as well. This would mean that the intermediation service could be subjected either to the law of the State of nationality/incorporation of the private entity that set forth the in-space assembly (personal jurisdiction) or the law of the State in which the physical platform (or maybe even the assembly facility that put it together) is registered (quasi-territory). In this respect, Article 21 (2) of the ISS IGA may be relevant: "*… for purposes of intellectual property law, an activity occurring in or on a Space Station flight element shall be deemed to have occurred only in the territory of the Partner State of that element's registry …*" Thus, an activity occurring via the in-space autonomous platform may be deemed to have occurred in the territory of its State of registration.

large structures as a single piece [5,6]. Moreover, it can also support deep-space missions, particularly by facilitating the construction of large deep-space telescopes, observatories, and other platforms. Furthermore, in-space assembly can also assist on-orbit servicing missions, for example, through the assembling of structures used to reconfigure, upgrade, or repair other space objects [4].

2.3. In-space manufacturing

In-space manufacturing refers to the sets of processes performed for the on-demand fabrication and production of parts and components in outer space [10]. The input used for the manufacturing process can include feedstock (available printing materials), extracted in situ space resources, or recycled materials (e.g., mission recyclables and objects having reached the end of their life cycle) [4,11].

In-space manufacturing enables an "Earth-independent logistics model," meaning that it decreases the dependence on terrestrial supply chain logistics because it eliminates the need to launch as many components upfront [4,10]. Such mass reduction may, in turn, facilitate longer-duration and deep-space missions by allowing for greater self-sufficiency and adaptability in light of challenges that may arise in the course of such missions.

Moreover, in-space manufacturing can reinforce the optimization of structures for their operation in space [12]. Components being launched from Earth into space are subjected to harsh launch conditions (severe vibrations, acoustic loads, acceleration, shock loads, and thermal loads), which require optimization of these components (e.g., through hardening or ruggedization processes) to handle the launch sequence [7]. This entails efficiency losses due to the additional costs incurred and due to the trade-off between optimizing components for launch rather than for their actual operation in space [12]. In-space manufacturing can alleviate these concerns. In addition, in-space manufacturing can enable the fabrication of materials and parts that cannot be constructed on Earth owing to the adverse effects that terrestrial gravity may have on them (e.g., ultrathin mirrors that would be bent if subjected to gravity forces) [7].

A very promising manifestation of manufacturing is additive manufacturing, also known as three-dimensional (3D) printing. Three-dimensional printing is a process in which digital 3D objects are converted into physical ones: the 3D digital object is created using computer-aided design software or a digital 3D scanner, and then, it is printed by special printers that construct the object by laying down successive layers of material [13]. Despite being a relatively nascent technology [7], additive manufacturing in space can enhance the in-space manufacturing capacities of spacecraft

Table 3
Recommended actions.

To policymakers (on an international level)	To policymakers (on a national/domestic level)	To practitioners and other nongovernmental actors
(i). Reconsideration of the space law terms "launching State," "space object," "launching," and "national space activities" so as to adapt them to the present technological advancements (e.g., take into account in-space assembly or manufacturing, additive printing). (ii). Elaboration of a comprehensive space law convention to address these issues. (iii). Conclusion of international agreements concerning jurisdiction over such services, principles applicable to them, and so on. (iv). Promote the establishment of an International Civil Space Organization that is to deal with the issue of the law applicable to the services provided (e.g., promote the conclusion of an international instrument under the aegis of this international organization) (v). On an EU level: approximation of national space legislation; elaboration of a directive or regulation to regulate the provision of information society services by means of autonomous platforms in space.	(i). Regulate the in-space assembling or manufacturing activities undertaken by persons or entities under their jurisdiction and reinforce registration (e.g., require the registration of the in-space assembled object). (ii). Many legislations define "space activity" only in respect to the launch and landing of spacecraft and space objects, but States are responsible for all activities of private actors in space, although the term "activities" is not defined under space law. It is proposed to domestic policymakers to introduce the term "space intermediary services" in their space legislation. (iii). Consequently, the national legislator should establish a national legal framework to regulate the provision of such services, covering issues such their authorization and supervision (in line with Article VI OST) so as to ensure that they are provided in accordance with international law (Article III OST). (iv). Designate the ancillary services provided as information society services, and thus confer to them relevant sets of rights and duties (e.g., freedom to provide information society services).	(i). Promote the establishment of relevant industry's best practice guidelines and codes of conduct. (ii). Require the conclusion of a contract (e.g., "End-user license agreements") with the service recipient and the service provider before providing the intermediary service: e.g., the terms of the service could stipulate the law applicable to the execution and provision of the service, dispute settlement mechanism, competent litigation, or arbitration forum in case of dispute, law applicable to procedural elements, and so on.

and enable, inter alia, (i) planetary robotics (e.g., improving the mobility of robotic landers by means of printed wheels, gears, and so on), (ii) addition of new functionalities to space objects, and (iii) facilitation of the development of new materials for use in space [5,14].

It is noted that in the present article, the term “in-space assembled platform” will refer collectively to platforms either assembled, manufactured, or 3D printed in space.

3. Challenges and emerging industry trends in the field of in-space assembly

The future development of assembly techniques in space should be the result of the combined effects of seven major events that are currently reshaping the world economy or, more specifically, space activities.

First of all, assembly techniques are at the heart of the 21st-century economy. Even if the international crisis provoked by the coronavirus disease 2019 (COVID-19) pandemic prompts industries to relocate their production lines, there is every reason to believe that this relocation will most likely be only partial and will not call into question this fundamental characteristic of today's industrial capitalism [15]. By gathering the research and development, industrial or commercial know-how, and the industrial property in one location, assembly is now the stage in the production cycle wherein the added value of a company is created, starting with the finished product and the trademark that identifies it and determines its price.

Second, the establishment of automated production lines is also one of the characteristics of contemporary industrial capitalism [16]. Automation is expected to become even more prominent in the coming years owing to the decisive contributions of artificial intelligence in production chains and the development of the Internet of Things. The widespread use of 5G or private very-high-speed LTE-type networks should make a major contribution to this. Here, again, the international crisis caused by the COVID-19 pandemic may act as an accelerating factor in this second trend, by encouraging States and industrial players to develop their electronic communication networks and promote robotization of industries [17].

Third, the mastery of assembly techniques in space is a reality as old as the International Space Station itself, whose project was launched in 1983 by US President Reagan after long preliminary studies were carried out over the previous two decades. It should be recalled that the International Space Station is the largest of the artificial objects placed in Earth orbit. Positioned in the low Earth orbit (330–420 km), it is 110-m long, 74-m wide, and 30-m high, and it deploys a mass of some 400 tonnes. Built around two initial modules, one Russian (Zarya) and the other American (Unity), the International Space Station is by nature based on a heterogeneous architecture. It is itself part of a multinational program, launched and piloted by the National Aeronautics and Space Administration (NASA), developed jointly with the Russian Federal Space Agency and involving the European, Japanese, and Canadian space agencies. Despite criticisms being leveled at this ambitious space program, the major contributions of the International Space Station experience are not limited solely to the presence, cohabitation, and succession of astronauts from different geographical or professional backgrounds in space. Its chief contribution will continue to lie in the convergence of assembly techniques in space, using components manufactured as per different national standards and launched by rockets with different characteristics, yet perfectly adjusted in space as if they were the product of a single entity [7,18].

Fourth, the development of on-orbit servicing should encourage the growth of numerous industrial projects [19], whose originality will undoubtedly exceed the mere maintenance of satellites or of satellite constellations in operation (monitoring, refueling, in-orbit interventions). It will extend to activities of a new type, such as using, for example, the unexploited resource that space debris constitutes, as an industrial input to construct components in space or convert it into spare parts [20]. The exploitation of mining resources, now authorized by the legislation of the United States and of Luxembourg, should allow the emergence of a whole storage industry in space, in the same way as the collection of data linked to the development of on-orbit servicing could encourage the development of space clouds. These trends should further pave the way for the development of assembly techniques in space.

Fifth, the emergence of space activities deployed by operators from the information and communication technology (ICT) sector is transforming the traditional approach to space activities. The reason for this is not only that these operators are private companies, which—unlike traditional space actors who operate within the framework of long-term public programs laid down by States—mobilize diversified financing methods and seek short-term profit within the framework of genuine business strategies but also largely—and perhaps above all—due to the new approach that they are introducing into space activities: that of gradual dematerialization, substituting tangible assets for commercial services.

This approach should gradually lead to the distinction between physical infrastructures covered by traditional rules and sophisticated services whose legal regime could be increasingly difficult to determine. It is already evident that the confusing overlap between Earth observation and the satellite systems that make it possible is becoming much less pronounced. The core business of ICT-based space activities today lies in the exploitation of data collected by such systems and, more significantly, in the commercial services that the exploitation of such data allows for. Such services constitute the most lucrative part of these space activities, and it is on these services that incoming operators are positioning themselves, thereby erasing the frontier between space activities and commercial space applications.

Sixth, the commoditization phenomenon in the space industry is encouraging space actors to accord less importance on the physical assets as opposed to the services attached to them. Current industrial and market trends in the space sector gravitate toward mass production and launch of equipment of reduced dimensions (Satlets), which are reproducible and increasingly less expensive. As in the information technology sector, innovation could shift its focus to processes rather than solely to products, and physical assets could, over time, have less value than the commercial services they support. With hindsight, the current revolution in space activities (now commonly known as “New Space”) could in fact be the result of a sequence over the last twenty years [21], articulated around three successive stages:

(i). Commercialization of space activities, in the sense of the development of commercial applications which, in a few years, will have increased the dependence of many terrestrial activities on satellite systems
(ii). Two waves of privatization that the space industry will have experienced: first that of international cooperatives, then that of geostationary satellite constellations, and, more recently, of constellations in the process of being set up, positioned in near space, in low orbits
(iii). Dematerialization and commoditization, as described previously

These three stages must be regarded as three distinct forces that are acting upon and shaking up the space sector, warranting a thorough rethinking of its legal and institutional organization.

Finally, the development of assembly techniques in space should greatly benefit from deep-space exploration programs [22]. Clearly, assembly and manufacturing in space are factors that would significantly contribute to and enhance the flexibility, adaptability, and resilience of missions. These are key points for future lunar and Mars missions and should thus encourage the emergence of new technologies to support these endeavors. Such technologies will include, inter alia, the maintenance and refueling of satellites in space, as well as an increased level of development of techniques of space manufacturing and the assembly of satellite equipment, including future construction of essential components in the short term.

4. In-space assembly: Use-cases, working examples and implementation

Several industrial projects confirming the relevance of the aforementioned anticipations have already emerged.

One of the most ambitious projects is certainly the one launched by the NASA in January 2020, which aims to develop a low-orbit robotic assembly system named “MakerSat.” In this objective, a $142 million contract was awarded to Maxar Technologies, based in Westminster, Colorado, on January 31, 2020 [23]. The winning consortium built around Maxar includes the aerospace company Tethers Unlimited, the West Virginia Robotic Technology Center in Morgantown, West Virginia, and the NASA's Langley Research Center in Hampton, Virginia.

In the first phase, Maxar is expected to assemble a 3-m communications antenna and a 10-m composite structure. For this operation, the capacities of the Restore-L device should be mobilized. The Restore-L (also known as OSAM-1, which stands for “On-orbit Servicing, Assembly, and Manufacturing 1”) is a device developed by the NASA for satellite repair and servicing. It will be equipped to accommodate a robot called the Space Infrastructure Dexterous Robot (SPIDER), whose 5-m robotic arm is expected to assemble the seven elements of the antenna and manufacture the structure. The robotic arm will be built by Maxar in Pasadena, California, whose team has already demonstrated its capabilities by delivering six robotic arms for NASA missions to Mars, including the arms for the Mars InSight lander and for the Mars 2020 rover. The Restore-L and SPIDER are administered by the Technology Demonstration Missions program based at the NASA's Marshall Space Flight Center in Huntsville, Alabama.

The successful completion of this public-private partnership operation will be able to benefit from the experience acquired from several ground tests carried out in 2017 as part of the Dragonfly program.

It is planned that the assembly operation will be carried out in two stages: (i) Robotic assembly and deployment of the antenna, which will then perform Ka band transmission and communications tests with a ground station, and (ii) Tactivation of a MakerSat device to fabricate the lightweight carbon composite beam and attach it to the spacecraft; the shape and strength of the beam will be checked to verify the capability to construct large structures in orbit and determine if the performance of the structures built in space is different from those manufactured on Earth.

This project is a pioneering effort because the final objective, if successful, is to generalize the manufacture of larger or longer structural elements in space, rather than sending them into space after they have been prefabricated on Earth. The advantage of this is that assembly robots could reconstitute spacecraft components that may be too large to fit inside their launcher in finished form. Current prospects include the assembly of space telescopes in orbit or the construction of structures for use during trips to the Moon or Mars.

Without being linked to it, this project is an extension of a previous initiative launched by the NASA in 2016, the Archinaut project (Versatile In-Space Robotic Precision Manufacturing and Assembly System). This initiative, funded to the tune of US$20 million by the NASA, aimed to build a 3D printer capable of operating in orbit. The printer was installed on a “pod” attached to the exterior of the International Space Station. Equipped with a robotic arm, it was designed to fabricate, assemble, and repair structures and machines. Its construction, successfully tested in August 2017 [24], was entrusted to a consortium made up of the companies Made In Space, Northrop Grumman, and Oceaneering Space Systems. As part of the Archinaut project, Made In Space has developed Optimast-SCI, which can be adapted on any smallsat platform, to allow robotized and autonomous manufacturing and assembly of all or part of satellites or equipment in space.

At a lower level, we should also mention the project of the company Actemium Toulouse Robotique & Automation [25]. This company has joined forces with Thales Alenia Space to set up an autonomous factory for the manufacture of photovoltaic panels for satellites sent into space. This project involves setting up automated production lines for the assembly of photovoltaic cells at a rate of 100000 to 200000 units a year. These cells will be placed on the solar panels fitted to the satellites and will produce the electrical energy they need. The first automated production lines to manufacture these photovoltaic cells are destined for the Indonesian telecommunications satellite SATRIA for which Thales Alenia Space has been awarded the contract as a prime contractor.

In the same vein, the American Defense Advanced Research Projects Agency (DARPA), which was at the origin of many cutting-edge technologies, starting with the Advanced Research Projects Agency Networks (ARPANET) network, the forerunner of the Internet, has launched the Phoenix program [26,27]. The objective of the Phoenix program is to rethink the way the United States builds and maintains its fleet of satellites. In the spirit of the DARPA, the future lies in the generalization of the use of robots assembling the modular structures of satlets, which weigh about 6.6 kg and contain all the functionalities of a conventional satellite (power supply, controls, and sensors). The payload orbital delivery, a standardized mechanism designed to bring the launched satellites into orbit, will then ensure that they are put into orbit.

The idea is to first experiment with these techniques on Earth during phase 1, and, then, during phase 2, to use these same techniques directly in space, once the feasibility of the technical aspects, namely, the robotic tools and assembly processes on Earth, has been demonstrated. Beyond this result, the final objective is to reduce the cost of developing and manufacturing satellites that will be assembled in space, including inspection, maintenance, and repair procedures ranging from component upgrade to full replacement. For phase 2 of the Phoenix program, the DARPA has already awarded eight contracts to companies including Busek, Honeybee Robotics, and Oceaneering.

5. Space law trying to catch up with private in-space assembled platforms

The assembly of equipment or platforms in space gives rise to delicate legal problems in determining their legal regime. These problems are exacerbated as soon as such an assembly is carried out in an autonomous and robotic manner. International space law was not designed to allow for flexible legal qualifications that would adapt to the evolution of technological progress. It is in fact based on a legal methodology that gives priority to the connection with the Earth and, consequently, to the link with the jurisdiction of a State. Under these conditions, legal qualifications imply both rigor and pragmatism, which are not always compatible.

In the developments that follow, the focus is placed on infrastructure as a support for services. It is therefore the physical platform itself whose international legal status is analyzed in the light of the international treaties in force. Following this analysis, the developments in Section 6 will consider the legal qualification of the service(s) provided by means of an infrastructure, which, owing to being assembled in space, may remain outside the control of a State.

5.1. Assessing the legal status of private in-space assembled platforms

International space law does not strictly define what constitutes a "space object;" it only provides a partial definition of the term [28]. More specifically, both the Convention on Registration of Objects Launched into Outer Space (hereinafter, "Registration Convention") and the Convention on International Liability for Damage Caused by Space Objects (hereinafter, "Liability Convention") only define the term as "including component parts of a space object as well as its launch vehicle and the parts thereof" [28]. Thus, they allow for a broad interpretation of what a "space object" actually encompasses.

A crucial issue in this regard, however, is to determine whether the act of launching (in the sense of "liftoff" or "takeoff") is required before qualifying an object as a "space object" [29]. The title of the Registration Convention, for example, refers to the registration of objects launched into space; thus, it may not apply to objects that have been directly assembled in space. On the other hand, the Outer Space Treaty (OST), when referring to "objects launched into space," provides that they also include objects that have been "landed or constructed on a celestial body" (Article VIII OST). Furthermore, the act of placing in orbit is referred to only in conjunction with objects carrying nuclear weapons or any other kinds of weapons of mass destruction (Article IV OST).

Nevertheless, considering the ambiguity that surrounds this term, special emphasis should be placed on the dynamic and ever-evolving character of space activities, in the sense that the very nature of this field may actually justify and call for an evolutive interpretation of the space law treaties [30].

First of all, recourse to such an interpretation of the space treaties may be justified under Article 32(a) of the Vienna Convention on the Law of Treaties (VCLT) as a supplementary means of interpretation, wherein interpretation as per Article 31 VCLT would leave the meaning of the term ambiguous or obscure. Furthermore, evolutive treaty interpretation has previously been used by the International Court of Justice (ICJ) in its jurisprudence. For example, in the case concerning the Gabcikovo-Nagymaros Project, the ICJ described the provisions in the Treaty, which it was asked to examine, as evolving and not static, thereby recognizing the potential necessity to adapt the Project in question to the (then) newly developed norms of environmental law [31]. Following this jurisprudence, an evolutive interpretation of the term "space object" as to include in-space assembled objects seems plausible.

ICJ Judge Manfred Lachs also seemed to favor a definition of "space object" that encompasses "parts thereof as may be detached and continue the journey in outer space as separate entities or land on celestial bodies," as well as "[o]bjects which after having landed on a celestial body are put together and become a new entity as 'stations, installations, equipment'" [32]. However, this still leaves open the question of jurisdiction over objects that are assembled while in orbit or in a suborbital trajectory (and not on a celestial body).

Nevertheless, it should also be highlighted that a refusal to consider objects that are manufactured or assembled in space as "space objects" might enter into conflict with the purpose and the object of the international space law treaties and Article 31(1) VCLT.[2] This is due to the fact that such a practice may result in the nonregistration of in-space assembled objects or even in their assimilation into res nullius [32]. The Registration Convention, specifically, was concluded with the intent to assist States in the identification of space objects and ultimately ensure the effective application of international law onto the exploration and use of outer space [28]. The Liability Convention aimed to provide full and equitable compensation for victims of damage resulting from space objects as a means to ensure international cooperation in outer space. Allowing for in-space assembled objects to remain unregistered, and therefore not subjecting them to any State's jurisdiction, would ultimately be contrary to the spirit and the aims of the international space law treaties.

Overall, under a static interpretation of the currently available international space law texts, in-space assembled objects do not constitute "space objects," considering that they do not undergo the process of "launching." Thus, the provisions of international space law would not be applicable to them. However, considering the recent technological advances in the field of spacefaring, an evolutive interpretation of the term "space object," which would include, inter alia, in-space manufacturing and assembly, might prove to be more beneficial.

5.2. Can in-assembled private platforms be attached to the jurisdiction of a state?

5.2.1. Jurisdiction when qualifying private in-space assembled platforms as space objects

Should in-space assembled platforms be considered space objects, then international space law would be applicable. Consequently, as per Article II of the Registration Convention, the "launching" State would come under the obligation to register the space object in its relevant national registry. Failure of the States to fulfill this international obligation might be considered an internationally wrongful act, pursuant to Article 2 of the International Law Commission's articles on Responsibility of States for Internationally Wrongful Acts; see Ref. [33]. Accordingly, it would be the State of registry that would retain jurisdiction and control over the space object in question while it is situated in space or on a celestial body (Article VII OST; also, repeated in the Moon Agreement, Article 12) [34]. The same principle also applies to platforms whose in-space assembly has been undertaken by private entities.

Thus, if private in-space assembled platforms were to be considered space objects, then the States that would exercise jurisdiction over these objects upon registration might be (i) the State that "launches" (places into space) or (ii) procures the launching (placing into space) of a space object or (iii) the State from whose facility a space object is "launched" (placed into space), which in this instance may refer to the facility by means of which the in-space assembly was conducted.

Nevertheless, it must be noted that the aforementioned definition of the launching State, and consequently of the State of registry, presupposes some direct involvement of the State in the launching (placing in space) of the space object (e.g., the procurement by the State or the use of a State-owned facility to manufacture the platform in space). By way of contrast, the determination of the launching State, and ultimately of the State exercising its jurisdiction over the platform, may prove to be more nebulous when the State is not directly involved in the placing of

[2] Article 31(1) VCLT stipulates that "[a] treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose".

the platform into space. This would be the case, for example, if the platform were not launched (placed into space) by a State, nor were its launch (placing into space) procured by a State, nor were the platform launched (placed into space) from a State-owned facility. In fact, the question may be raised whether the fact that the in-space assembled platform is a private one (i.e., privately manufactured, assembled by private means, or privately procured) may entail different legal implications compared with a public one (or a private one in whose placing into space the State was directly involved): for example, is a private in-space assembled object subject to registration or not?

In this respect, it is important to draw a parallel with the discussion surrounding the General Assembly of the United Nations (UNGA's) Resolution 59/115 on the Application of the Concept of the Launching State [35] and in particular the issues identified in relation to the involvement of private actors in the exploration and use of outer space. Prompted by the emergence of new launch systems and new space ventures, the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) established a Working Group to examine the application of the "launching State" concept in a (then) new light. Following this examination, the Working Group recommended that States set forth national laws concerning the authorization and continuing supervision of the space activities of their nationals, as well as rules implementing their international obligations under the Liability Convention, the Registration Convention, and other international agreements [36]. Emphasis was placed in particular on (i) the registration of space objects and the exercise of jurisdiction and control over these, (ii) the authorization and supervision of space activities and the introduction of sanctions in cases of nonobservance of the terms of authorization, and (iii) the minimization of risks of damage and ensuring effective compensation mechanisms should such damage occur. In this respect, it must be recalled that States are internationally responsible for their national activities in space, including activities carried out by nongovernmental actors, which in turn requires States to assure that private space activities conform to the provisions of the OST (Article VI OST).

It is evident that a similar reconsideration of the terms "space object," "launching State," and "national space activities" is imperative today. The advent of new technologies, such as in-space assembly and manufacturing (which allow for the placement into space of objects that have not undergone a "traditional" launching process), highlights the need to adapt these space law notions to the contemporary landscape. This necessity is further accentuated by the ever-increasing involvement of private actors in space, which renders links to State jurisdiction progressively blurry. Despite this, however, it should be recalled that a State may be considered a "launching State" even if it lacks control over a space object; lack of control in turn would mean that, although it would be impossible for this State to prevent damage, it would still incur liability in the event such damage occurs [37].

Accordingly, States ought to enact national regulations with a view to establishing jurisdiction and control over space objects introduced in space by their nationals [38]. Moreover, such regulations should aim at extending the duties set forth by the space law treaties to nongovernmental entities under their jurisdiction as well [38]. For example, such national rules should require the recording of the private space object into the State's national registry (irrespective of the manner in which the object has been introduced into space), which consequently will allow the State to exercise its jurisdiction and control on the object pursuant to Article VIII OST.

In fact, this approach, under which the definition of "launch" also includes the concept of "placing into space," seems to be the one adopted by the United States. The United States Code provides that the term "launch" means to place (or attempt to place) a launch vehicle and its payload in a suborbital trajectory, in Earth orbit, or otherwise in outer space, while "launch vehicle" refers to any vehicle constructed for the purpose of operating (or placing a payload) in outer space or in suborbital trajectories [39]. Thus, the term is not delimited by the act of launching the object from the Earth into space. In addition, the American Space Commerce Free Enterprise Act of 2019 provides that the term "space object" includes any human-made object that is manufactured or assembled in outer space; however, for now, this Act remains at the first stage of the legislative process and has not yet become law [40].

As an alternative, when registration of private space objects has not been carried out, the determination of a State's jurisdiction over a private in-space assembled platform may be established on a personal or quasi-territorial basis [41].

Quasi-territorial jurisdiction refers to a State's exercise of jurisdiction over ships, aircraft, and spacecraft of its registry [42]. Accordingly, if the private facility that assembled the platform is itself a space object listed in a State's national registry, that State may also be able to exercise its jurisdiction over the private in-space assembled platform on a quasi-territorial basis. In this respect, a parallel may be drawn with the legal regime applicable to the International Space Station (ISS), according to which an activity pertaining to intellectual property which occurs in or on one of the ISS's modules shall be deemed to have occurred only in the territory of the State of that module's registry.[3]

Alternatively, the State responsible for the in-space assembled platform may be determined on a personal basis, meaning based on the State of nationality or of incorporation of the private actor that undertook the in-space assembly. It should be recalled, in this respect, that a State's nationals (both individuals and corporate entities) remain at all times subject to the personal jurisdiction of the State, wherever they may be [42].

5.2.2. *Jurisdiction when a private in-space assembled platform does not qualify as a space object*

When the qualification as a space object is not possible, then, in order for a State to exercise its legitimate jurisdiction over this object, it will be essential to demonstrate a sufficient link between itself and the object over which it is asserting jurisdiction [34]. The possible ways jurisdiction may be asserted are examined in the following section.

5.2.2.1. Platform jurisdiction on the basis of the state of registry of the space object that delivered the assembly and manufacturing equipment: considering the assembled platform and its parts as the payload of the vehicle that launched them into space. Jurisdiction might be exerted by the State of registry of the space object (e.g., spacecraft, rocket) that delivered the component parts and relevant devices of the platform into space.

Space objects can be understood under the Registration Convention as including any tangible human-made material or physical object or device, irrespective of its size, shape, composition, and purpose (e.g., a payload or satellite, a launch vehicle or rocket), that has been launched into Earth orbit or beyond [28]. The parts, materials,[4] modules, or devices (e.g., 3D printing devices)

[3] Article 21(2) of the Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, The Government of Japan, the Government of the Russian Federation, and the Government of the United States of America concerning cooperation on the civil international space station ("ISS IGA"), concluded 29 January 1998.

[4] Reference is made only to the materials originating from the Earth and not to resources developed or extracted in space.

that were launched from Earth into space to assemble the platform constitute part of the payload of the space object. Consequently, this platform may be subjected to the jurisdiction of the State which registered the space object that delivered this payload into space in order for the in-space assembly to take place.

5.2.2.2. The assembling activity: subjecting the in-space assembled platform to the jurisdiction of the state that authorized and is supervising the private entity's outer space activities. Article VI OST provides that States bear international responsibility for national activities in outer space, including the activities of nongovernmental entities. For this reason, private space activities are subject to the authorization and continuing supervision by the respective State. Accordingly, if a private entity intends to undertake the manufacture or assembly of a platform in space, such an activity would require prior authorization and approval by the relevant State.

It should be considered that, through the acts of authorization and continuing supervision, the State is in fact asserting a significant degree of control, direction, or influence over the specific private space activity that it is requested to authorize, thus assimilating it into an activity of the State [43]. More specifically, the act of authorizing the specific activity demonstrates that a State has effective control over the realization of this activity owing to the fact that it has the power to either allow it or prevent it from taking place [44]. Consequently, this control can constitute a basis for the State to exercise jurisdiction over the in-space assembled platform [44], considering that this object is the outcome of the activity that the State has authorized. This can be either the State of nationality of the individual or the corporation (personal jurisdiction), or the State of registry of the space object from which or through which the in-space assembly activity took place ("quasi-territorial jurisdiction") [42].

An example of such licensing of in-space manufacturing activities is found under Russian space law: the Russian legislator has established a licensing (permission) procedure for the pursuit of space activity, and he includes the manufacturing of materials and other products in outer space to the activities that are subject to licensing [45].

5.2.2.3. Personal jurisdiction due to the State's responsibility for the activities of its nationals in space. A State has personal jurisdiction over its nationals, including the legal persons incorporated under its laws [43]. Thus, apart from the State that authorized the in-space assembling activity, jurisdiction may also be asserted by the State in which the private entity that undertook the in-space assembly is incorporated (unless the authorizing State and the State of incorporation are the same, of course) [44,46]. Alternatively, jurisdiction may also be exercised by the State where the private entity's principal place of business is located (i.e., where its center of interests is located and the most important managerial and strategic decisions are taken) [44,46].

This is particularly important, considering that States bear international responsibility for their national activities in outer space, including activities by nongovernmental entities (Article VI OST).

5.2.2.4. Jurisdiction based on ownership and property rights: drawing a parallel with maritime law and the issue of unregistered or flagless vessels. One factor that may prove to be determinant in establishing which State could exercise jurisdiction over an in-space assembled and unregistered platform is the ownership over the said object [34]. A person that manufactures a new object acquires original ownership thereon through the act of "accession," through which said object becomes the manufacturing person's property or asset [13]. In general, movable or immovable property usually needs to be situated within a State's territory in order for the State to exercise its jurisdiction over it. However, an object situated in an area beyond national jurisdiction, such as outer space, may fall under the quasi-territorial jurisdiction of the State of nationality of the person enjoying ownership and property rights over it.

In this respect, a parallel may be drawn with maritime law, specifically unregistered vessels. In the United Kingdom, for example, the concept of ownership is applied to establish ship nationality [47]. Similarly, practice in the United States suggests that where a vessel is not registered, the nationality of the vessel may be established based on the nationality of the vessel's owner [48,49].

Thus, depending on the provisions of municipal law, a State's jurisdiction may be exercised over assets that a State's national claims as its own, including objects that they have assembled in space. For example, French law does foresee a similar possibility: in case a French national, or a legal person having the headquarters in France, aims to obtain ownership over a space object while in outer space, the person needs to obtain a relevant administrative authorization beforehand, which in turn subjects this person and the object in question to the instructions and measures indicated by the relevant French administration [50].

Overall, although in-space assembled private objects may remain unregistered, these objects might still be able to be subjected to a State's jurisdiction (see Table 1). On the one hand, it is suggested that even in-space assembled or manufactured objects must be considered "space objects" under international law, thus giving rise to the State's obligation to register them. On the other hand, if these objects do not constitute space objects, jurisdiction may be able to be asserted:

(i) If the component parts of the platform are considered as part of the payload of the registered space vehicle that delivered them into space.
(ii) Based on the fact that a State, by authorizing the private entity's in-space assembling activity, exercises effective control over the latter.
(iii) Through personal jurisdiction based on the nationality, domicile, or principal place of business of the private entity that carried out the in-space assembly or manufacturing activity.
(iv) Based on the nationality of the person claiming ownership over the in-space assembled platform.

These are all conditions that can be met, given the state of technology and industrial practices. But they may not or they may no longer warrant the case if the trends described previously continue. This could be the case in an ultimate phase of the evolution of the trends described previously. The platforms in question are not assembled in space from components produced on Earth and launched into space. How can the status of these future intelligent platforms, entirely assembled in space, from components not attributable to a state industry or from components produced in space or raw materials extracted from space, be resolved?

6. Making the case for services provided from private in-space assembled platforms

The solutions proposed in the aforementioned section for the legal qualification of the platform itself, as a physical support, meet some limitations that invite to consider another legal approach, based on the analysis of the service(s) that this platform can provide.

These platforms, whatever their modalities, capacities, or "virtualities," are called upon to evolve in an environment that remains "the prerogative of all humanity." If States assume international responsibility for the national activities carried out there, including those of nongovernmental entities (Article VI OST), this presupposes that these activities have been subject to their authorization, which is a condition for the continuous monitoring that the appropriate State may exercise. In the present state of the applicable texts, both international and national, a station assembled in space is not subject to a State authorization. The result is a first obstacle to which the fact is added that because the station is private, the regime applicable to it may result simply and solely from commercial agreements between two or more companies.

This difficulty is all the greater if these operators no longer have any connection with the territory of a Stateand if this station governs itself and is capable of analyzing situations and reacting to them spontaneously by providing appropriate services, while operating in full autonomy from terrestrial activities. It is already singular to note that many satellites launched from Earth are not registered. What can we expect from such stations, which will also fail to be duly registered, and for other reasons that are linked to their assembly and their operation, and in a space environment that lies outside the sovereignty of States?

The link to a State's jurisdiction and control, to its laws, and to the principles enshrined in the OST, which the State may have signed and ratified or to which it may have acceded after its entry into force, is certainly no longer so explicit.

The proposal made in the following developments is inspired by a recent judgment of the Grand Chamber of the Court of Justice of the European Union of December 19, 2019 ("Case C-390/18") [1]. This decision is of great interest because of the numerous extensions that can be derived from it in respect to services provided by means of an autonomous and robotic platform assembled in space. It resolves three key issues: (i) what legal regime should be applied to the activities of such a platform (ii) without this regime preventing the States consuming these activities from exercising their sovereign powers of control, (iii) while respecting the principle of free movement without which no international trade is conceivable?

In its decision of December 19, 2019, the Court of Justice of the European Union (CJEU) ruled that a distinction must be made between the service provided by an electronic platform (in this case, Airbnb) and the platform itself. Under certain conditions that it specifies, this service does not necessarily make the operator of the electronic platform a fully-fledged operator subject to the national law of a given State (in this case, the French law applicable to estate agents). The Court considered that the service provided via the Airbnb platform is an information society service, with the result that it is submitted to the provisions of a European directive (Directive 2000/31 or "e-Commerce Directive") that makes the service subject to the law of the country in which the operator of the platform is incorporated.

As the European Union is an integrated market, operators in its Member States can only claim the benefit of the principle of free movement if they comply with the law applicable to them. As a result of harmonization policies of the national legislations of the Member States of the European Union, the law of each State ends up being the same for all. Thus, by requiring service providers to comply with the law of their country of incorporation, the Court of Justice is assuring, on the one hand, that the service provider is subject to harmonized legislation and, on the other hand, that he will not be subjected to rules of more restrictive character on the consumer market for the service.

Following these considerations, it is deemed useful to go into detail on the reasoning proposed by the Court.

6.1. Step 1: decoupling service from the platform

On reading the judgment delivered on December 19, 2019, what seems important to the Court is not the characteristics or functionalities of the physical platform used. It is the nature of the service provided: The fact that this service is provided by means of an electronic platform seems less important than the fact that it is provided at a distance, by electronic means. In other words, the platform only intervenes, in the Court's reasoning, as the technical support of the service, whose main characteristic for the Court is to be provided remotely. The CJEU notes that, although it acknowledges that this technical support plays an essential role in the provision of the service, "the parties come into contact [with each other] only through the electronic platform of the same name".[5]

By generalizing this first axis of the Court's analysis, it is therefore possible to transpose the reasoning to space platforms that will be assembled in space and be used to provide services in orbit without links to Earth.[6] These stations, whatever their functionalities, will be a means of providing services, and their importance must be maintained. It is the service that is the main consideration and not the support that is used to provide it. Legal reasoning does not recognize metonymy, this stylistic technique that Virgil overindulges in the Aeneid and which consists in designating the part for the whole.

And even if the service that is actually provided is ultimately confused with the means by which it is being provided, because the parties can only come into contact through it, it is the service that remains first and the means that must be treated as second.

6.2. Step 2: qualifying platform function

This approach is even more interesting in that the reasoning of the CJEU articulates a second argument: the intermediation service provided by Airbnb by means of the eponymous electronic platform must be dissociated from the real estate transaction proper "insofar as it does not consist solely in the immediate provision of accommodation".[7] In the Court's view, it consists more in making available on an electronic platform "a structured list of short-term accommodation (...) corresponding to the criteria adopted by persons seeking short-term accommodation", so that service and hence the platform itself are regarded only as "an instrument facilitating the conclusion of contracts relating to future transactions." As the Court observes, "it is the creation of such a list for the benefit of both guests with accommodation for rent and those seeking such accommodation that is the essential feature of the electronic platform managed by Airbnb Ireland".[8]

Put differently by the Court itself, the service provided by Airbnb Ireland by means of its electronic platform "cannot be regarded as merely ancillary to an overall service falling within a different legal classification, namely the provision of accommodation".[9] Nor is it indispensable to the provision of that accommodation directly

[5] Para. 47 of the Judgement (C-390/18).

[6] In the legal context of the European Union, this judgment is particularly significant because it achieves this result without attempting to redefine the distribution of powers in a manner such as effected by the Lisbon Treaty, where space activities are concerned. Indeed, space, as well as the attendant technological research and development activities, remains fully entrenched in the realm and jurisdiction of shared competence between the Union and its member states. In complete agreement with Article 4 of the Treaty on the Functioning of the European Union, it remains an area over which "the Union shall have competence to carry out activities and conduct a common policy; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs."

[7] Paras. 53–54 of the Judgement (C-390/18).

[8] Paras. 53–54 of the Judgement (C-390/18).

[9] Para. 60 of the Judgement (C-390/18).

provided by lessors, whether professional or nonprofessional. It only provides one more channel, in addition to other ways and means for the parties to the accommodation contract to meet and conclude. By recognizing its independence, the Court makes it a service that merely provides additional support that serves the objectives of competition and, consequently, of the market. This is because the electronic platform does not intervene in the determination of the price of the hosting service; it is merely a means of facilitation, including all the associated services (photographs of the asset rented, optional instrument for estimating the rental price in relation to market averages taken from the platform, rating system for lessors and lessees). These associated services are considered as part of "the collaborative logic inherent in intermediation platforms. Airbnb Ireland, in this case, allows, on the one hand, housing applicants to make a fully informed choice from among the housing offers proposed by landlords on the platform and, on the other hand, allows landlords to be fully informed about the seriousness of the tenants with whom they are likely to engage".[10]

Could these same arguments not also be transposed to the services that will be provided in orbit by intelligent platforms? There is every reason to think so. To use a terminology used in the vocabulary of yesterday's telecommunications law, when the sector was opened up to competition, and in today's electronic communications law, the service provided by the platform itself is a support service consisting of the provision of an infrastructure. This service must be distinguished from the overall service provided through the platform itself, from which it will gradually be dissociated. If this global service is a service provided in orbit (remote computing, temperature-controlled storage, maintenance or rescue, observation, data storage, and so on), it is this service and its legal status that must be identified, even if this service is so closely linked to the platform equipped with artificial intelligence that it cannot be physically separated from it. Legally, this service will call for a distinct qualification under the principles governing the activity of States in the exploration and use of outer space, including the Moon or celestial bodies.

6.3. Step 3: connecting service to a national legislation

The linking of services provided in orbit by means of an intelligent space platform to the legal regime of a State is an interesting idea, in the dual meaning of this legal connection, which covers, under the terms of Article VIII of the OST: the jurisdiction and control of the appropriate State.

The attachment of an activity, whether terrestrial or spatial, to the jurisdiction of a State implies the submission of that activity to the legal order of that State. In the logic of the Internal Market of the European Union, this connection may be that of "the State in which the service provider is established." Indeed, because the legal orders of each Member State are supposed to integrate the provisions of the regulations or directives of the European Parliament and the Council, these legal orders are made up of harmonized legislative or regulatory texts. This is all the more true because the principle of primacy of Community law gives precedence to the European rule over national law and because this European rule is itself directly applicable. The European citizen can therefore obtain its application by the national court whether or not the national law is in conformity with European law.

This is why, in the logic of European integration, the principle adopted for determining the law applicable to a service activity is that of the law of the country in which the service provider is established or, in the case of broadcasting by means of satellite systems, the law of the country in which the signal is transmitted.

6.4. Step 4: protecting the principle of free movement

In the Airbnb judgment, the Court of Justice does not proceed differently. It sets aside the national law of the country of consumption of the service (in this case French law), on two separate grounds:

(i). The first results from the principle of the free movement of information society services between Member States, of which the Court makes one of the objectives of Directive 2000/31, going so far as to point out that "this objective is pursued by means of a mechanism for monitoring measures liable to undermine it."

(ii). The second is a corollary of the first because it follows from the obligation imposed on Member States by Directive 2000/31 to notify the Commission of measures restricting or likely to restrict the free movement of information society services before their entry into force.

The Court points out that this obligation to notify does not cover "a mere information requirement." It corresponds in truth to "a procedural requirement of a substantive nature justifying the nonapplicability to individuals of non-notified measures restricting the free movement of information society services." As the Court also points out, this is indeed "a standstill obligation on the part of the State intending to adopt a measure restricting the freedom to provide an information society service."

As regards services provided in orbit, the same principles are difficult to apply for two reasons:

(i). One results from the fact that the international order is obviously less integrated than the European Community order; it is based on the full sovereignty of States within the limits of the principles laid down by the OST, and even then, only for those States that have ratified it.

(ii). The other relates to the purpose of the service and, more precisely, to the places where it is provided and its origin. The service is provided in orbit, by means of an intelligent space platform, which may have initiated it spontaneously. Retaining the law of the territory of origin, in this case, outer space, would only result in confusion.

This is why the right approach might be to propose the application in the service of the law of the territory of connection or even of the establishment of its beneficiary (the consumer or customer of the service provided). This could thus be the law of the country of registration, if the customer of the service is a space object subject to registration. The applicable law could also be the law of the country of nationality of the natural or legal person benefiting directly or indirectly from the service. In the field of State aid, we can thus trace back channels, determine the imputability of sums to States, and denounce shell intermediaries. It would suffice to draw inspiration from these legal techniques and methodology, which are now supported by the established case law.

This solution would be all the more effective in that it would enable the State concerned to provide within national law for the control measures it deems useful.

In its judgment of December 19, 2019, the CJEU does not reject this eventuality. Quite the contrary, it recognizes that, in line with the provisions of Article 3(4) of Directive 2000/31, States are entitled to take measures derogating from the principle of the free movement of information society services in respect of a given

[10] Para. 60 of the Judgement (C-390/18).

information society service falling within the coordinated field. However, in addition to the procedural obligation of notification referred to previously, it lays down three substantive conditions on which it intends to exercise control:

(i). The restrictive measure concerned must be necessary to guarantee public policy, the protection of public health, public security, or consumer protection.
(ii). It must be taken against an information society service that effectively undermines or constitutes a serious and grave risk of undermining these objectives.
(iii). It must be proportionate to these objectives.

6.5. Step 5: calling for a new legal order

It goes without saying that these substantive conditions are more difficult to impose and implement in the international order than in the community system. The international legal order is clearly less integrated than the European legal order. However, there is no reason why the same three substantive conditions should not emerge from recommended practices resulting from the approximation of national space legislation.

This approximation could, moreover, originate on European territory in the work of coordination or even harmonization of national space legislation of the Member States, which the Commission could take the initiative on the basis of the powers conferred on it by the Treaty on the Functioning of the European Union.

More generally speaking, the legal mechanism of recommended practices is in common use in the international aviation legal order and could also serve as a precedent: it is the very substance of the Annexes to the Convention of December 7, 1944 on International Civil Aviation. It is true that, unlike international air transport, space activities do not yet have the benefit of a specialized international organization such as the International Civil Aviation Organization.

The development of standards and recommended practices in the space field could certainly constitute, through the timely approximation of some national legislation, the process gradually imposing the need for an International Civil Space Organization [51,52]. Overall, the proposed solutions to the law applicable to the services provided by means of the platform are summarized in Table 2 below.

7. Conclusions

Concluding such an analysis is not easy. As we have seen, the reasoning is very open and must remain so, in particular to enable lawyers to establish their legal qualifications, whatever be the evolution of techniques. Many legal consequences depend on these legal qualifications, from the possibility for States to assert their sovereignty through a regime of control of the services provided on their territories to the delicate questions of liability in the event of an accident caused by such platforms [53].

While it is true that many projects have been launched, often successfully, the assembly of equipment or platforms in space in an autonomous and robotized manner is still in its infancy. Nevertheless, the problem is already there and must be addressed. Its solution, which is not simple, calls for a certain imagination on the part of policymakers and a great deal of caution on the part of practicing lawyers.

Finally, far from being conclusive, Table 3 provides an indicative list of recommendations to policymakers and practitioners, which however cannot be considered exhaustive at this stage of technical progress and legal thinking.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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