REGULATING SUB-ORBITAL FLIGHTS TRAFFIC: USING AIR TRAFFIC CONTROL AS A MODEL?

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ABSTRACT

Private sub-orbital flights carrying space tourists on a short journey into outer space are expected to become a reality soon. Indeed, the private company Virgin Galactic has announced that the first flight of the sub-orbital spaceplane SpaceShipTwo, with paying passengers on board, is scheduled to take place in 2011.

Taking into consideration that the era of private sub-orbital flights is about to begin, it is time to start discussing about the potential issues which this type of activities may raise with regard to space traffic and operations. The main question is how to make sure that these flights are carried out in a safe and orderly manner so as to avoid interferences and collisions not only with each other but also with other space objects. Additional problems are related to the possible interferences that private sub-orbital flights may have with aircrafts during their access into and re-entry from outer space.

A possible mechanism to be used to deal with these issues is provided by the existing aviation practice. The operations of aircrafts in flight are coordinated on a worldwide, regional, and national scale through a system of air traffic control, the main purpose of which is to avoid collisions and to enable the safe flow of traffic in the air.

The present paper will explore the possibility to establish a "sub-orbital flights traffic control mechanism" and will suggest the legal elements to be inserted in such a mechanism.

INTRODUCTION

Private sub-orbital flights carrying paying customers on a short journey into outer space no longer represent a dream or a topic for a science fiction novel. The US company Virgin Galactic is expected to start operating its fleet of five sub-orbital vehicles called SpaceShipTwo in 2012. Tickets for such "space journeys" have already been bought by thousands of potential passengers. Other more ambitious projects envision the possibility to use sub-orbital and orbital vehicles to transport passengers and cargo from one point of the Earth to another.

These types of space ventures certainly generates fascination and interest in the general public. However, they also raise several regulatory and legal issues, particularly the choice of the legal regime applicable to sub-orbital flights, whether air law or space law, or even both. These issues are the result of the hybrid nature of the sub-orbital vehicle, which consists of both an aircraft and a spacecraft, and of the fact that most of its flight time, as long as SpaceShipTwo is taken as a model, is spent in the airspace of a certain State, with only a limit portion of the journey taking place in outer space.

One aspect which is generally only marginally discussed is the regulation of sub-orbital flights traffic. While this may not be considered the most urgent topic to be addressed at the moment, once the number of these flights will grow the management of their traffic flow in and out national airspaces as well as in outer space will become a priority. A coordinated air and space traffic management system will, indeed, be needed to ensure that sub-orbital vehicles do not interfere with or endanger national and international air traffic, while crossing airspace, and do not collide with other spacecrafts or space objects while being in space.

The establishment of a sub-orbital flights traffic control system is certainly challenging. The problems are not much related to the sections of the journey where the vehicles transit through national airspace, as the existing air traffic control rules and procedures will be able to coordinate these operations. The issues arise when taking into consideration the 'in orbit' part of the journey. Indeed, no internationally agreed rules to govern space traffic exist. Developing similar rules will require long negotiations as well as a careful balance among technical, political and economic interests. In this respect, some of the air navigation and traffic control rules applicable to the European airspace may provide some interesting solutions which might be taken as example to regulate the traffic of sub-orbital and orbital vehicles in outer space.

The present paper will discuss the need for establishing a system to manage sub-orbital flights traffic, the feasibility of a similar idea and will put forward some suggestions on how this system could be structured.

DEFINITIONS

Few introductory points need to be briefly analyzed here concerning the terminology that will be used in the paper.

Sub-orbital space flight: The International Civil Aviation Organization (ICAO) has defined "sub-orbital flight" as "a flight up to a very high altitude which does not involve sending the vehicle into orbit".[1] ICAO goes on by making reference to the definition of sub-orbital trajectory applicable under US law according to which "the intentional flight path of a launch vehicle, re-entry vehicle, or any portion thereof, whose vacuum instantaneous impact point does not leave the surface of the Earth".[2] Summarizing, the basic point to be understood about sub-orbital flights is that this term is used with regard to "the launch of an object or objects into outer space without that object or such objects completing one or more orbits around the Earth".[3]

The development of sub-orbital spaceflights was stimulated by the Ansari X Price Competition, which offered a prize of 10.000.000 US $ in 1996 for the first completely privately funded reusable craft that could fly a pilot and two (dummy) persons twice within three weeks to an altitude of over 100 kilometers (as we will see below this is claimed to constitute the lower border of outer space). The price was won by the company Scaled Composites, whose SpaceShipOne vehicle exceeded the altitude of 328.000 feet twice within a 14 days period. SpaceShipOne (SS-1) was carried by an aircraft, the White Knight, to an altitude of 55.000 feet, where SpaceShipOne separated and launched itself to the higher altitude of 112 kilometers. Shortly after SS-1 was launched, the entrepreneur Sir Richard Brunson established a company called Virgin Galactic, which formed a joint venture with Scale Composites. The joint venture owned the intellectual property rights and licensed the technology to Virgin Galactic.

Virgin Galactic soon announced the plan to develop a SpaceShipTwo (SS-2), or, more precisely, a fleet of five SS-2, using basically the same technology of SS-1. SpaceShipTwo, which aims at taxing six passenger per spaceship to an altitude of 120 kilometers and allowing five minutes of weightlessness, was unveiled in 2009 and, after nearly two years of test, is scheduled to become operational in 2012. Virgin Galactic sells US $ 200,000 ticket per person for a seat on board SS-2.

Orbital spaceflights: Orbital space vehicles are intended to offer flights from one point on Earth to another or from Earth to a specific destination in space and back. Ultimately, these journey include at least one full orbit, hence the name "orbital spaceflight". Orbital spaceflight could revolutionize Earth to Earth transportation: for example, by using this means of transportation a passenger could fly from New York to Paris in 71 minutes. [4]However, the technology to perform these type of flights is not ready yet and is expected to take few years before being developed. As a consequence of this fact, attention will be mostly focused on the regulation of sub-orbital traffic, although some consideration with regard to the management of orbital spaceflight will be made too.

APPLICABILITY OF AIR LAW AND SPACE LAW

As previously mentioned, if SpaceShipOne and Two are taken as examples, sub-orbital space activities involve the use of an aircraft and a space vehicle attached to it until the moment of separation. Thus, depending on where such activities take place, either air law or space law, or even both, may apply. The two regimes have historically evolved independently and, consequently, present major differences. Air law is based on the concept of sovereignty. Indeed, air law regards airspace as part of the territory of the underlying State. A well established corpus of Treaty law confirms that "every State has complete and exclusive sovereignty over the airspace above its territory".[5] On the contrary, space law is based on the absence of sovereignty in outer space and on the freedom to explore and use the space environment. Space law principles origin in international law. Progressively, an increasing number of States have enacted national space legislation to better comply with international obligations and to regulate the participation of private operators in space activities.[6]

Considering these differences it is of crucial importance to understand where air space ends and outer space. Unfortunately, there is no clear physical line between airspace and outer space. Nevertheless, the area above 110 km is generally deemed to belong to outer space. On the contrary, the status of the zone between 80 km to 110 km, which is the area which the sub-orbital vehicle is supposed to reach, remains controversial. Traditionally, two approaches address the boundary issue.[7] The "functional" approach makes a fixed boundary irrelevant, instead supporting the adoption of a single spatial regime determined taking into account the nature of the activity.[8] On the other hand, the "spatial" approach attempts to fix a boundary between air and space. None of these approaches has managed to gain global consensus. Recent State practice suggest that the lowest perigee orbit of artificial Earth satellites (approximately 95-110 km above sea level) lies in outer space. [9]

As far as the applicability of air and/or space law is concerned, no doubt exists that from the take-off of the aircraft until the moment in which the spacecraft separates from it, air law is applicable. The whole vehicle, indeed, falls within the definition of "aircraft". [10] After separation, the space vehicle does not "derive support in the atmosphere from the reactions of the air" and should not longer deemed to be an aircraft but rather a space object. The term space object can be understood to refer to any object that is launched or attempted to be launched into outer space. Although the sub-orbital vehicle only reaches an altitude slightly below the lowest satellite perigee, its intention is to reach outer space. Consequently, space law should logically apply to the space vehicles after separation from the aircraft.

The result of this reasoning would be that both air law and space law should apply to regulate a single sub-orbital journey. This solution is rejected by some authors, which consider confusing to apply to different legal regime to the same journey and prefer the adoption of a unified legal regime, space law, to govern the whole journey. [11] Others, by pointing out that most of the journey takes place within the national airspace of a State, suggest that the sub-orbital aeroplane be regulated by air law.[12]

REGULATION OF AIR TRAFFIC

Air law includes comprehensive regulations, both at international and national level, to managing and coordinating passengers transportation by air.

At international level a key role is played by the International Civil Aviation Organization (ICAO), a specialized agency of the United Nations established under the Chicago Convention[13] for the purpose of ensuring the safe and orderly development of international civil aviation. ICAO promulgates Standards and Recommended Practices (SARPS), as annexes to the Convention, dealing with navigation, surveillance, licensing, operation, airworthiness, and other issues relating to international civil aviation. In order to ensure uniformity of rules of the air, under the Chicago Convention its 190 Member States are obliged to adopt national legislation which conforms with the SARPS.

With regard to the regulation of air traffic within national airspace reference is to be made to Article 28 of the Chicago Convention. Accordingly, each Contracting State undertakes to the extent practicable to 'provide in its territory, airport, radio services, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with standards and practices recommended or established from time to time, pursuant to the Convention'.[14] Most States have fulfilled this requirement by setting up a national air navigation service provider (ANSP) either in the form of a State agency or, more recently, in the form of an autonomous corporatized or privatized company.

Air Navigation Service(ANS) is a term used to refer to a variety of services offered to support the safe and expeditious navigation of aircraft. Air Traffic Services (ATS) constitutes the main activity of ANSPs. ATS includes three specific services, Air Traffic Control, Flight Information Service and the Alerting Service. The primary objective of Air Traffic Services is to avoid collision by applying vertical and horizontal separation among aircraft operating in a given portion of the airspace.[15]

Historically, States have considered the provision of Air Traffic Services as a sovereign function. As a consequence, the boundaries of Air Traffic Control sectors under the responsibility of ANSPs generally follow political boundaries. This does not mean that States may not decide to delegate ANS to a designated service provider, being a private company of that State or a provider from a foreign State. The delegation by a State of responsibility for the provision of air traffic services over its territory is regulated by agreement among States.[16]

With the increase of international air traffic flow the containment of ANS within national political boundaries has been perceived as a major obstacle towards the operational performance of an overall ANS system. Indeed, ATC sectors delineated by national boundaries often tend to impose unnecessary constraints on the provision of the services. As a result, the need to strike a balance between political understanding of ANS and operational factors has arisen. One answer to the current shortcomings of ANS has been a wider use of cross-border service provision arrangements. Cross-border service provisions occur when an ATSP established on the territory of a given State provides ATS within the airspace over the territory of another country.

The problems related to the relation between ANS and political boundaries have been particularly serious in Europe where, as a consequence of the presence a patchwork of relatively small States having heterogenous ANS service levels and experiencing increasing traffic density, air traffic services have progressively become fragmented and therefore inefficient. [17]To tackle this situation the European Union launched in 2004 the Single European Sky (SES) initiative, which may be seen as an attempt to create a single European airspace which goes beyond national boundaries.[18] The SES ambition is to defragment the European airspace and to promote cross-border service provision at a larger scale through the establishment of Functional Airspace Blocks (FABs). FABs are defined as "an airspace block based on operational requirements and established regardless of State boundaries, where the provision of air navigation services and related functions are performance-driven and optmised with a view to introducing, in each functional airspace block, enhanced cooperation among air navigation service providers, or, where appropriate, an integrated provider".[19] FABs are expected to cover the territory and to involve the ATSP of more than one State. In such cases the FAB has to be established through agreement of the States concerned. These States are requested to jointly designate one or more ATS providers on an exclusive basis within the FAB. [20] The single designated provider may be one existing ATSP of one of the States involved or take the form of a new organization, such as a joint formal undertaking set up by existing national ATSPs as a common affiliated company or a single integrated ATSP.

Liability for ANS

One of the most important as well as debated aspect of ANS is that of liability.[21] Currently, no global or regional convention on the liability of ANS exists: these aspects are regulated by the national laws of the State over the territory of which the services are provided. These laws are based on the traditional model where a national ATSP, generally a State agency or an entity acting on behalf of the State, is charged with ATS responsibility within that State's airspace. Under this model States are primarily liable for damage arising from the failure of their ATS, even when the functional responsibility has been delegated to an autonomous service provider. The State will often retain a right of recourse against the designated service provider to obtain the reimbursement of any damage caused by the service provider.

With the integration of the cross-border dimension in the provision of ANS special legal arrangements are required, since in their absence the liability for the failure of ANS will often remain with the territorial State, with no legal remedy for that State to recover the expenses paid to compensate the damage. In this respect, the most common model followed in Europe follows the "territorial doctrine". Under this model, the State over which territory the damage occur will remain liable, regardless of the fact that the functional responsibility for providing the service has been delegated to a foreign entity. The cross-border agreement will generally foresee a right of recourse against the State of the foreign provider or against the effective provider itself.

A second model is that of "effective service provide" doctrine. In this case, liability claims will be brought directly against the effective service provider. Despite the advantages that such doctrine entails, it is not very popular in Europe, where the territorial approach dominates.

The SES raises complicated liability issues. Indeed, several actors from different legal orders, i.e. States, supervisory authorities, recognized organization, ANSPs, are involved and accidents may be the result of different reasons, such as negligent conduct of foreign ANSP. If an accident occurs to which court the victim should bring the case? How the recourse actions should be dealt with?

The SES regulatory framework does not answer these questions. Some help could be brought by the EUROCONTROL Model Agreement on delegation of ATS, which adopts a 'effective-service provider doctrine' and suggests cases to be brought before the courts of the providing State. However, as indicated above, a similar solution goes against the way liability for ANS is currently regulated in Europe. As a result, liability issues within FABs need to be agreed upon by the States whose airspace belong to that specific FAB.

REGULATION OF OUTER SPACE TRAFFIC

The space law regime does not include a system to regulate outer space traffic which can be compared to the one existing to manage traffic in the air. Actually, one could claim that traffic in the space environment is basically unregulated. Indeed, nothing similar to ICAO's SARPS exists with regard to space activities and no procedures, rules and operational centers to manage and coordinate the flow of active objects in outer space are in place.

At first sight the absence of similar legal and operational instruments could be justified by pointing out the limited dimension of "space traffic", especially if compared to the scale of road and air traffic. There are no congested road in space and there are no take-off and landing of space objects by minutes. However, a more careful analysis reveals a different scenario. Firstly, there are areas of high density, such as low orbit up to 400 km and the Geostationary Orbit. Second, more and more States have access to space. This could eventually result in a larger number of objects in orbit. Third, with the expected beginning of the era of sub-orbital tourism, the number of objects entering and operating in outer space is expected to grow. Additionally, apart from active satellites, outer space is populated by an enormous number of inactive space objects or pieces of it (space debris). Currently, only objects larger than 10 cm are tracked in space. This tracking is mostly operated by the US through its Space Surveillance Network (SSN). The US provides an unclassified set of data from its SSN for free, although these data are not always timely and accurate enough. For this reason the European Union has developed plans to develop its own Space Situational Awareness (SSA) system.[22] The term understanding and maintaining awareness of the Earth orbital population, the space environment and possible threats. SSA is deemed to be essential to the safety of space objects and to ensure their smooth operation.

In order to be a reliable tool to support the management of space traffic, particularly the one concerning sub-orbital and orbital flights, a SSA system should ensure global coverage of the Earth's orbit, ensure a timely sharing of information and creates procedures to communicate with the spacecraft commander. Unfortunately, currently only the US and Russia have a developed SSA system and the technology as well as the political will is not there yet to match the above needs.

Taking into consideration the expected grow of outer space traffic in the coming years and the consequent danger which this may cause to the safety of manned and unmanned space objects, the establishment of a set of rules to manage outer space traffic has gained increasing attention. The bottom line is that the existing space law regime is deemed to be inadequate to ensure the safe and proper management of traffic in outer space. The 1967 Outer Space Treaty[23], the main international treaty governing activities in outer space, sets out the freedom to explore and use outer space. The OST provisions which has the most relevant impact on space traffic is laid down in Article IX, according to which while carrying out space activities States shall pay due regard to the interests of other States and shall inform other States to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities". However, they are clearly inadequate to guarantee the steady and safe management of space traffic flows.

Consequently, since the early 1980's space traffic has been the object of legal analysis. In 1982 Lubos Perek wrote a groundbreaking paper on this issue.[24] Dr. Jasentuliyana called upon the Committee on the Peaceful Uses of Outer Space (COPUOS) to develop "Space Standards" similar to ICAO's SARPs and to draft a convention creating an international framework for space vehicles.[25] More recently the initiative was taken by the American Institute of Aeronautics and Astronautics (AIAA) which, apart from organizing workshops, commissioned a "Cosmic Study on Space Traffic Management (STM)".[26] The study, presented in 2006, while pointing out the expected increase of outer space traffic and the inadequacy of the current space law regime to adequately manage future space activities, suggests the setting up of a STM regime and a corpus of rules of the road for space traffic. Space Traffic Management is defined by the Study as "the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical and radio-frequency interference."[27] The proposed STM regime should include four components: an information network, a notification system, traffic rules and mechanisms for implementation and control. The first component is considered the basic element for any kind of traffic management in outer space. In order to manage traffic, the Study proposes to improve the capacity and performance of the existing Space Situational Awareness (SSA) technology which, as previously described, is mostly concentrated in the US hands only. A global STM system has to be open and accessible to all actors. The task will be to exactly define the necessary data, to establish rules for data provision and data management as well as rules for an information system on space weather. Only on such a basis, a shared knowledge about what is going on in the Earth orbits, traffic rules can become meaningful. Consequently, a global SSA system, enabling the flow of key information should be established. The second components is the notification system. In this respect, it is recommend that a pre-launch, in-orbit and re-entry notification system, also including information about space manoeuvres, be established. The third element is that of traffic rules. The Study suggests the creation of safety provisions for launches, then turns to space operations with right-of-way rules priorization with regard to manoeuvres, specific rules for the protection of human spaceflight, keep-out zones and re-entry procedures. The fourth components is related to implementation and control. It is proposed that basic provision could be developed in an international treaty, possibly negotiated within COPUOS, and later developed in more specific rules of the road by means of soft law. Enforcement and arbitration mechanisms could be set up as well. Finally, the Study deals with the possibility to establish a supervisory authority to control the implementation of the STM system. While the setting up of a World Space Organization appears to be too complicated, the authors of the Study propose to extend the mandate of ICAO so as to enable it to exercise supervision over traffic in outer space.

The suggestions put forward by the AIAA Cosmit Study, although very valuable, remain only on the paper. So far States have not given signs of any intention to bring these suggestions into reality. Consequently, how to regulate outer space traffic is still an open question.

A SUB-ORBITAL FLIGHTS TRAFFIC CONTROL MECHANISM: A PROPOSAL

Introduction

As it emerges from the previous section a system to manage and control the traffic of sub-orbital spaceflights currently does not exist. The establishment of such a system raises several technical and legal issues and requires to strike a careful balance between the need for preserving existing traffic management rules and procedures, i.e. those coordinating air traffic, and the need for creating new ones.

Before putting forward proposals on how to set up a sub-orbital flights traffic control system, some general considerations are needed. First of all, a step which would certainly enhance safety of sub-orbital flights across their whole journey and enable avoidance of interferences and collisions with aircrafts crossing the same airspace would be to enact Standards and Recommended Practices (SARPs) for sub-orbital and orbital flights. The authority to draft these Space Standards could be given to ICAO itself. In this regard, In 2005, the ICAO Council considered the concept of suborbital flights in relation to the Chicago Convention.[28] The main question explored by the Council was whether suborbital flights would fall within the scope of the Chicago Convention and therefore ICAO's mandate. The Council's working-paper appropriately reasoned that "should suborbital vehicles be considered (primarily) as aircraft[29], when engaged in international air navigation, consequences would follow under the Chicago Convention, mainly in terms of registration, airworthiness certification, pilot licensing and operation requirements. Thus, taking into account that most of the flight time of a sub-orbital vehicle occurs in airspace, there is room to consider it an aircraft and, consequently, to give ICAO the authority to draft Space Standards. These standards should aim at achieving two purposes: 1) to extend to sub-orbital and orbital flights the application of existing safety and navigation aviation standards so as to enable navigation harmonization and collision avoidance with aircraft operating within shared airspace; 2) to define new parameters and procedures applicable to sub-orbital and orbital vehicles, particularly applicable to the in-orbit section of their journey, including *inter alia*: the role and duties of sub-orbital vehicles captains, real-time communication procedures among space vehicles crews and between these crews and air and space officers on the ground, the establishment of an internationally agreed "safety distance" among sub-orbital vehicles in-orbit, flight crew licensing and certification. Secondly, another key element would be the mission planning. The purpose of the mission planning is to develop a mission profile that might enable the safe performance of the sub-orbital journey and avoidance of interference with aircrafts and other space vehicles. The mission profile, which should indicate the routes to be followed by the sub-orbital vehicle when crossing airspace, both in the ascent and re-entry phase, the orbital trajectory and the duration of the flight, should be coordinated with the Air Traffic Control officers responsible for the airspace (or airspaces, in case the orbital vehicle carries passengers from one State to another) which the vehicle is expected to cross and with the authorities responsible for keeping a catalogue of objects in outer space. Contingency plans should also be developed by the vehicle operator in case primary launch and re-entry windows are unavailable (i.e. due to weather) or if the mission must be aborted. Once the mission profile has been completed, it should be filed in the same manner of a flight plan and communicated to all relevant air (and eventually space traffic) authorities both of civil and military nature. This scheme would enable predictability of the sub-orbital or orbital journey, while reducing the risks of interference with other traffic in the air or in outer space.

<u>Regulation of sub-orbital flights traffic in national airspace</u>

The management of traffic flow of sub-orbital vehicles through national airspace, both in the ascent and re-entry phases, does not raise particular regulatory problems. Before separation of the spacecraft, the whole sub-orbital vehicle falls within the definition of "aircraft". Consequently, the responsibility to control that the vehicle does not interfere with aircrafts will fall upon the ANS providers, especially Air Traffic Control officers, responsible over that particular airspace. In this respect, the success of this mechanism would be enhanced if the applicability of safety and navigation aviation standards could be extended to sub-orbital vehicles, as suggested above. It can be pointed out that the launching of space objects has, so far, not affected aviation safety. By means of ad hoc measures, such as creation of 'no fly' zone in the area of planned space launches and descents, launches of space objects and aircraft operations have been kept separated. With the expected increase of space launches, i.e. sub-orbital flights, this procedure may not be acceptable on the long run. A help in this regard could be provided by the suggested sub-orbital flight mission mapping, which could enable the transit of that flight in the national airspace of a State without interfering with civil aviation air traffic.

<u>Regulation of sub-orbital flights traffic in outer space</u>

When one considers how to manage the traffic of sub-orbital flights during their in-orbit phase three options may be suggested: 1) absence of any specific form of regulation; 2) reserving dedicated orbits and orbital trajectory for sub-orbital and orbital spaceflights; 3) setting up an internationally coordinated system to manage and control sub-orbital flights traffic.

Under the first option it is argued that no rules or mechanisms to control sub-orbital and orbital traffic are needed. One could claim that so far outer space activities have been successfully carried out without the presence of similar mechanism and that the beginning of the sub-orbital flights era would not alter the situation. This reasoning could be refused by pointing out that space activities are not so safe as they may look and that the number of activities in space is expected to raise, not only due to the beginning of sub-orbital operations. The current space law legal framework does not ensure safety of space objects and, thus, a system to manage outer space traffic is needed.

The second option recommends to reserve some low Earth orbits specifically for sub-orbital flights traffic. Sub-orbital flights operators would be then given the right to transit through these orbits upon acceptance of their request. This option is modeled on the existing system to allocate geostationary orbital slots run by the International Telecommunication Union (ITU). This proposals presents some shortcomings. First of all, ITU's competence to allocate orbital slots does not extend to low Earth orbits. As a result, a new organization empowered to allocate low Earth orbit traffic rights should be created. Unfortunately, the conditions for the establishment of a similar organization do not seem to exist. Secondly, portioning some of the low Earth orbits would be a very complicated process, due to the high economic and political interests involved. Additionally, the reservation of these orbits for sub-orbital flights only could constitute a violation of two basic space law principles: the freedom of exploration and use outer space and the non-appropriative nature of outer space.

A third option would be to set up a system to coordinate and control the traffic of sub-orbital flights in their in orbit-phase. In this regard two possibilities are available. The first one would be to extend the competence of the existing Air Navigation Services (ANS) and the respective Air Traffic Control, to the upper layers of the atmosphere so as to include the area comprised between 80 to 110 km.[30] The reasoning is the following: all upper airspace is classified by ICAO in classes. For example all the upper airspace over the EU belong to "Class C", which means that therein the flights operating under Instrument Flight Rules (IFR) are "separated" by an Air Traffic Controller from the ground. It is assumed that spacecraft will indeed operate under IFR and they will cross the upper layers of the atmosphere during climb and descent. In fact, most Upper Air Traffic Control Centres (UACCs), at least in theory, are declared to have vertical competence from a defined Flight Level (e.g. FL 195 = 19,500 feet) up to "unlimited", although today in practice they do not execute any task in order to control space flights. Nevertheless, when developing the implementing rules for ATM, the upper limit of its competence could be set around FL 3300-3600 (i.e. 330,000-360,000 ft, around 100-110 km), or even higher (e.g FL 4000, around 120 km) to cover the highest sub-orbital flights and overlap with space controlled areas, although specific rules should be established for this ballistic part of the flight.

A second possibility would be to establish an internationally coordinated mechanism to control sub-orbital flights traffic modeled on the Single European Sky approach. As previously explained, under the SES the European airspace is supposed to be divided in Functional Airspace Blocks (FABS). Each FABS may comprise the airspace of more than one State. The States belonging to each FABs have to designate an Air Traffic Service (ATS) provider on an exclusive basis within the FAB, which may also be a foreign entity.

The idea would be to establish something similar to the FABs, which could be named Functional Outer Spave Blocks (FOSBs,) in low Earth orbit FOSBs would be created for the purpose of controlling sub-orbital and orbital flights traffic, guaranteeing their safety in their in-orbit phase and avoiding collision among them as well as with other space objects and space debris. The establishing of FOSBs would not contravene the Outer Space Treaty, as the sections of the low Earth orbit comprised in a FOSB would not become the property of any State and could be freely used. FOSBs would one be set up to enable safer and more coordinated space activities. In order to bring the idea of FOSBs into reality a technology able to observe, monitor and catalogue what happens in space is needed. This type of technology can be, at least partially, in the one used for Space Situational Awareness (SSA). However, in order to make the idea of FOSBs possible the current SSA technology should be improved, for example a global network of sensors capable of observing the whole Earth should be put in place, data sharing policies should be enhanced. A mechanism to communicate information to captain of sub-orbital flight should be set up too.

The low Earth orbit could be therefore divided in few FOSBs and the responsibility to control traffic within each FOSB could be attributed to a State or group of States possessing SSA technology. These States should control the traffic of sub-orbital flights in the area of their competence and furnish the relevant data to the space vehicle operator. Certainly, the realization of a similar idea would require long negotiation (including also the costs for running a similar service) as well as the definition of a series of technical and operational standards, but it could represent a valuable alternative approach to manage sub-orbital traffic.

Liability for controlling sub-orbital flights space traffic

A crucial issue connected to the possibility of exercising control over sub-orbital flight traffic is that of liability.

Assuming that control over a sub-orbital vehicle transiting through national airspace is exercised by ANS, national law will regulate cases of liability for damage occurring during this phase.

More complex is the situation relating to the in-orbit section of the flight. Generally, liability in terms of space activities is governed by the Liability Convention.[31] The Liability Convention is an elaboration of Article VII of the Outer Space Treaty and is based on the idea of State liability. Accordingly, a State is internationally liable for any damage caused by a space object, regardless of whether it may be owned, operated, launched by a private entity, as long as that State qualifies as the launching State of the space object concerned. The term 'launching State' means: a) a State which launches or procures the launching of a space object; a State from whose territory or facility a space object is launched.[32] Two types of liability are foreseen by the Convention: a) absolute liability for damage caused on Earth or to aircraft in flight; b) fault liability for damage caused to another space object.

Thus, if two sub-orbital vehicles belonging to two different States collide the Liability Convention will be applicable. But what happens in case the collision has been the result of a wrong information provided by a "space control manager" within a FOSBs, assuming that this manager is not the national of any of the States to whom the sub-orbital vehicles belong? Will the Liability Convention cover the full damage or liability of the State providing the space traffic control service should be considered too? And what if the collision happens because the pilot of one of the vehicles does not follow the instruction given by the space traffic manager? Clearly these issues should be addressed and regulated, preferably among the parties involved, before the beginning of sub-orbital flights missions.

CONCLUSION

The era of private sub-orbital flights carrying paying passengers is approaching fast. While not being the most urgent issue to be addressed at the moment, the coordination and control of the traffic of these flight will become a crucial topic in the short future. Ensuring that sub-orbital vehicles do not interfere or collide with civil aircraft as well as other space objects will be essential to ensure safety of transportation by air and space. Unfortunately, the current space law legal framework cannot meet this need.

Therefore, a system to control and manage sub-orbital flights traffic should be established. In this respect, some of the mechanisms currently controlling traffic in the air could provide valuable model to be applied in space.

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[1] Concept of sub-orbital flight. Working Paper presented by the Secretary General to the Council (175th Session), C-WP/12456 of 30 May 2005. See also P. van Fenema, Suborbital Flights and ICAO, 30 Air & Space Law 396, 405 (2005).

[2] *Ibidem*, at 395.

[3] F. von der Dunk, Passing the Buck to Rogers: International Liability Issues in Private Spaceflight, 86 Nebraska Law Review 400 (2007); see also S. Hobe, Legal Aspects of Space Toursim, 86 Nebraska Law Review 439 (2007).

[4] See Great Expectations: An Assessment of the Potential for Suborbital Transportation, ISU (2008)

[5] convention on International Civil Aviation, 7 Dec. 1944, 15 UNTS 295, ICAO Doc. 7300/6., Article 1.

[6] Art. VI, Outer Space Treaty.

[7] On this point see F. von der Dunk and S. Hobe *supra* footnote 3, respectively at 423 and 441.

[8] S. Gorove, Aerospace Object-Legal And Policy Issues for Air and Space Law, 25 J. Space L. 101, 110 (1997); N. Mateesco Matte, Aerospace Law 62-74 (1969).

[9] The Australia's Space Activities Act of 2002 requires a license to launch a space object from Australian territory only if the vehicle is expected to reach an altitude of at least 100 km above sea level.

[10] The definition of aircraft is provided in the Annexes 6, 7, and 8 of the Chicago Convention: "Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface".

[11] T. Masson-Zwann, S. Freeland, Between heaven and earth: the legal challenges of human space travel, Acta Astronautica 66 (2010), 1567.

[12] J.B. Marciacq. Y. Morier, F. Tommasello, Z. Erderlyi, M Gerhad , Accomodating sub-orbital flights into the EASA Regulatory System, EASA publications.

[13] Convention on International Civil Aviation.

[14] In this respect see for all F. Schubert, Legal Aspects of Cross-Border Service Provision in the Single European Sky, 35 (2) Air and Space Law (2010) 113.

[15] See ICAO SARPs Annex 11 (Air Traffic Services), 13th edition July 2001, para. 2.2.

[16] Paragraph 2.1.1, Annex 11, Chicago Convention.

[17] While ATS national procedures are based on the universal regulations of ICAO and, therefore, there should not be substantial differences among them, in practice they may present substantial differences on the understanding and implementation of ICAO regulations. See F. Schubert, at 130.

[18] Regulation (EC) No. 549/2004 of 10 March 2004 of the European Parliament and of the Council, laying down the framework for the creation of the Single European Sky (The Framework Regulation); see also Regulation (EC) 550/2004 of the European Parliament and of the Council of 10 March 2004 on the Provision of Air Navigation Services in the Single European Sky (Service Provision Regulation) as modified by Regulation (EC) No. 1070/2009 of the European Paliament and of the Council of 21 Oct. 2009.

[19] SES Framework Regulation, Art. 2, Definitions, such as amended by Regulation (EC) No. 1070/2009.

[20] SES Service Provision Regulation, Art. 8.4, as modified by Regulation (EC) No. 1070/2009.

[21] M. Chatzipanagiotis, Liability Aspects of Air Traffic Services Provision, Air & Space Law, 32 (September 2007).

[22] "SSA Preparatory Programme", European Space Agency website, 5 December, 2008: ?p://www.esa.int/esaMI/Opera7ons/SEMDPU3Z2OF_0.html.

[23] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, 18 U.S.T. 2410; TIAS 6347; UNTS 205.

[24] Perek, Lubos. Traffic Rules for Outer Space. International Colloquium on the Law of Outer Space (1982), 37.

[25] N. Jasentuliyana*, International Space Law and the United Nations* (Kluwer 1999), pp. 379-382.

[26] C. Contant-Jorgenson, (Secretary of the Study Group), P. Lala, and K.U. Schrogl, (Coordinators of the Study Group), eds. "Cosmic Study on Space Traffic Management", Paris: IAA, 2006.

[27] *Ibidem*. On the issue of space Traffic Management see also K.U. Schrogl, Space Traffic Management-The New Comprehensive Approach for Regulating the Use of Outer Space, ESPI Flash Report No. 3, (2007)

[28] See *supra* footnote 1.

[29] For the definition of aircraft see *supra* footnote 10.

[30] J.B. Marciacq. Y. Morier, F. Tommasello, Z. Erderlyi, M Gerhad, *supra* footnote 12.

[31] Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, U.S.T., 2389, 961 U.N.T.S. 187.

[32] Article I(c), Liability Convention.