

IAC-16.D6.1.7.x33219

THE URGENCY OF SPACE TRAFFIC MANAGEMENT IN SCHEDULED COMMERCIAL SPACE FLIGHT

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Abstract

Human space flight activities have grown rapidly in the last decade due to new technological advancements. The success of the Ansari Xprize, presented to the SpaceShipTwo flights, has opened the door to a new era of scheduled commercial space flight. More and more spacecraft are flying through airspace which is still not subject to any Air Traffic Controller; thus putting both aircraft and spacecraft in danger with the chance for mid-air collision between them increasing. Considering this situation, there is an urgency for the establishment of effective space traffic management. Integration between air and space traffic management must be established in order to ensure safety and effectiveness for future space flight. The International Civil Aviation Organization regime, with a great deal of experience in the aviation field, could become the most practical and realistic solution. The phenomenon of scheduled commercial space also raises other important issues, which are the definition of astronaut and the delimitation between airspace and outer space. A clear role of insurance companies must also be established, where their policies must take the burden of any search and rescue operations currently held by state(s). Otherwise many developing states would not cooperate knowing they are paying for the rich who travel for pleasure. The current legal regime under various conventions must be updated in order to harmonize it with recent developments. Further cooperation between space faring states is needed to create new state practices. Today states' resistance to the creation of new convention related to space activities means a bottom to top approach through state practice could become the solution.

Keywords: space traffic management, sub-orbital flight

Acronyms/Abbreviations

Air Traffic Management (ATM)
European Aviation Safety Agency (EASA)
European Union (EU)
Federal Aviation Administration (FAA)
International Civil Aviation Organization (ICAO)
International Telecommunication Union (ITU)
Search and Rescue (SAR)
Space Surveillance Network (SSN)
Space Surveillance System (SSS)
United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

1. Introduction

The first human flight with an airplane was made a century ago by the Wright brothers when many doubted humanity could invent this technology. Since that time, the technology has grown rapidly to the point where mankind could conquer not only the airspace but also outer space. There is no doubt today we are operating a new chapter in the aviation era where space flight has become reality.

SpaceShipTwo flights have shown the world how commercial space flight has become possible. It is just a matter of time before there will be a scheduled space flight where people could travel from Paris to New York in less than two hours. This situation also means that there is an urgency to establish a standard for this

new phenomenon. Obviously the current enacted legal framework must be updated in order to catch up and harmonize it with recent developments.

The invention of sub-orbital flights has raised further legal questions from where does the air law regime end and space law begin; who is an astronaut; to who shall pay for any search and rescue operations. This paper shall discuss these issues surrounding commercial scheduled space flight and its future from a space traffic management perspective. An analysis of whether ICAO would be the most appropriate organization to become the regulator will also be made. No doubt further cooperation between states must be encouraged in order to establish an effective, efficient, and integrated space traffic management.

2. SpaceShipTwo: A Milestone in Commercial Space Flight Era

The existence of SpaceShipTwo can be traced back to the year 1996 when a group of philanthropists and entrepreneurs established the Ansari Xprize competition [1]. This competition was designed to lower the risk and cost of travelling to space by incentivizing the creation of reliable, reusable, privately-financed, manned spaceship that finally made commercial private space travel a reality [2]. The prize was awarded to Mojave Aerospace Ventures for their SpaceShipOne in 2004 and along with it a new brand new private space

industry was launched. Then SpaceShipTwo was developed from the successful SpaceShipOne prototype, manufactured under partnership between Virgin Galactic and Scaled [3].

SpaceShipTwo is a milestone in the commercial space flight era and a stepping stone for the next era, namely scheduled intercontinental commercial space flight. From the previous successful space flights, some millionaires and billionaires were willing to pay a large amount for a chance to experience the outer space within their lifetime. Commercially speaking this situation has shown that there is a market for this sub-orbital flight and also for intercontinental scheduled commercial space flight in the future. The use of sub-orbital trajectories could lead to substantial shortening of flights where New York to Tokyo route could be reached in less than two hours [4].

With the same person, Sir Richard Branson, behind Virgin Galactic and Virgin Atlantic Airways Limited, there is a possibility of an integration between normal and sub-orbital flight within intercontinental flight. For example, a person could fly from New York to Okinawa with a spacecraft from New York to Tokyo, assuming the spaceports are there, then continuing with an aircraft from Tokyo to Okinawa. Such an interesting innovation, not merely from a technological perspective, but also legal perspective.

3. The Current Space Legal Regime

As of today, the Outer Space Treaty of 1967 (the “Outer Space Treaty”) is still considered as the Magna Carta of space law although it was drafted almost half century ago. There are four space law treaties which were made in between 1968-1979 and an additional five United Nations General Assembly Resolutions.

In terms of hard law, the space legal regime has hardly developed since the year of 1979 as states have not been successful in creating a new one to this day. The Rescue Agreement of 1968 (the “Rescue Agreement”) - which will be further elaborated in Part V, the Liability Convention of 1972 (the “Liability Convention”), and the Registration Convention of 1975 (the “Registration Convention”) are supposed to be the most related treaties in regards to the invention of a new space traffic management regarding scheduled commercial space flight.

3.1 Article IX of the Outer Space Treaty

A principle of cooperation and mutual assistance among the member states for space activities is promoted, including scheduled commercial space flight. An obligation lies among the member states where private entities launch the spacecraft to undertake international consultations before proceeding with activity if it would cause potentially harmful interference.

This article contains the “due regard principle” which limits space freedom and obliges member states to conduct space activities without unreasonably interfering with or otherwise affecting each other [5]. This is a concept which was introduced for the first time through the air law regime, namely Article 3 of the Chicago Convention [6].

As a consequence, any sub-orbital flight held in the near future has the potential to request other states’ approval. The potentially harmful interference could be translated into threats towards aircraft flying above the states’ controlled airspace to people living below. However, the effectiveness of this provision depends on the spacecraft operators and related parties’ views upon the definition and delimitation on airspace and outer space as well as whether innocent passage for spacecraft exists.

3.2 The Liability Convention of 1972

This convention establishes the definition and criteria of launching state(s). The first three articles make the member state(s) liable for bearing the burden if something goes wrong with a space object, in this context meaning spacecraft, and causes damage. Compensation is the main issue within the Liability Convention.

One weak point is the provision that no compensation will be granted to the nationals of the launching state(s) even though it is caused from a full commercial operation. The Liability Convention only addresses liability at the level of the states involved which leads into impossibility for passengers and/or third parties to claim for compensation directly [7]. When the operator shifts from states to private entities, a new scheme for claiming direct compensation must be established. Furthermore, there is no cap on liability of private operators because the main actors are only states; which could discourage the growth of this new kind of space industry.

Half a century ago the world could not imagine private companies could ever operate a spacecraft. As the situation has rapidly changed, this convention seems ineffective, since a foreign direct investment scheme could outwit the current liability regime; with the intention to relieve the operator state(s) of responsibility, then transferring it to another state through its nationals and/or private entities where the investment takes place.

In the future, further legal terminology potentially occurs on the spacecraft daily operations as whether they are “taking-off” or “launching” when departing for a journey. One implication shall be a situation when the spacecraft crashes while departing, whether it shall be viewed as an “(attempted) launch”. The other legal issue shall be whether the state where the airport lies shall also be regarded as participant in a joint launching; for

example what if the spacecraft is departing from an airport from a country which has no intention to participate in space flights, due to an emergency landing.

The message is clear enough, that a different liability regime must be established between scheduled commercial and ‘world mission’ space flights. Otherwise, the acceptance towards the Liability Convention in the next years is at stake.

A light came in 2013 when the Governor of New Mexico signed into law a liability-waiving regulation for commercial space flights; which is why Virgin Galactic chose Spaceport America in New Mexico as their place of business and launch site [8]. Such a provision that could be further reviewed for revising and updating the current Liability Convention.

3.3 *The Registration Convention of 1975*

The first article of this convention stressed the definition of a “launching state” as provided within the Liability Convention of 1972. Registration of a space object launched into Earth orbit by a state is mandatory for ensuring state responsibility; even though there is still a debate whether a sub-orbital object also needs to be registered considering it is not intended to reach Earth orbit and beyond.

When scheduled commercial space flight has become real, the next issue shall be whether a registration for each departure is effective to cope with this activity. It will be very ineffective and time consuming. A special method of registration is obviously needed when a spacecraft could depart multiple times in a day. The most realistic option is distinguishing commercial spacecraft flying sub-orbital trajectories with other kinds of space objects, such as satellites, based on each purpose; where it could initiate an effective pre-launch notification system.

Obviously the success story of world acceptance of Annex 7 of the Chicago Convention on aircraft nationality and registration could become a guideline for revising the current space object registration regime. It is a challenge to determine whether spacecraft registration, specifically for flying scheduled commercial space flight, shall be more effective when made under the current air law rather than a space law regime.

At the time when these conventions and treaty were signed, scheduled commercial space flight was still a dream. We are light years ahead from when the space conventions were adopted while the development in space activities has grown rapidly. Consequently, this situation means the definitions and requirements embodied therein are not enough to meet the needs and challenges of the present time [9]. There is a real urgency to update and harmonize the current legal

framework to keep it up-to-date with the recent developments of the 21st century. Otherwise, scheduled commercial space flight is merely a dream.

4. **A Dream of Reliable Space Traffic Management**

The current international legal regimes which cover both air and space activities are not well suited for the new phenomenon of scheduled commercial space flight because they were developed at a time where such activities were considered impossible to do [10]. The lack of legal clarity means an urgency for this issue to be addressed in order to establish an appropriate standard in terms of operational and safety [11].

The urgency has led to a dream of space traffic management, especially after the successful commercial sub-orbital flights of SpaceShipTwo. It has been predicted that during the next two decades, a few serious challenges will likely arise from a space traffic management perspective [12]. Without doubt, the issue of safety must be of primary concern.

4.1 *Space Traffic Management: What is in a Name?*

Historically the concept of space traffic management has been discussed in a very vague manner [13]. Since an authoritative definition of “space traffic management” does not yet exist, the definition as proposed by the International Academy of Astronautics in 2001 could serve as a basis:

“Space traffic management means 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 or radio-frequency interference.” [14]

It is clear that the purpose of space traffic management is to provide appropriate means so that space activities can be conducted without any harmful interference. This purpose is in line with the universal freedom to use outer space concept as regulated in the Outer Space Treaty [15].

The ideal space traffic management regime shall comprise four areas: i.) the securing of the information needs; ii.) a notification system; iii.) concrete traffic rules and mechanism for implementation; and lastly iv.) control [16]. However, it seems so far the establishment of space traffic management has not been a high priority for states because no accidental catastrophic collisions between spacecraft in airspace and outer space have occurred since the launch of Sputnik I [17].

4.2 *The Urgency of Space Traffic Management*

There is not a single state which is able to claim and exercise its territorial jurisdiction in outer space under the current space legal regime thus establishing room for innocent passage. The latter raises a question

whether spacecraft could maneuver and choose the path they want, or if there is still a line for that. When space traffic management is concerned, the problem is obvious that there is no answer to such questions as who is the regulator, who is responsible to make the rules and control their implementation, and who is entitled to punish the violations [18].

The absence of space traffic management at present can be explained because there is neither an intergovernmental organization nor trade association that feels responsible for the creation of one international rule [19]. The current Magna Carta of air law, the Chicago Convention of 1944, does not apply to spacecraft passage in the airspace. This is a gap that must be resolved between air law and space law with the utmost care. One positive thing is that the existing space legal framework has laid the foundation for the establishment of space traffic management [20].

The consequences of a lack of space traffic management in the early years of this century has led to a race between twelve countries and their 52 spacecraft and satellites to ‘occupy’ the orbital regime [21]. Also, the development of sub-orbital flights around 100 km in altitude has become a grey area from an air traffic control perspective, indicating the urgency for effective space traffic management [22]. Responding to this issue, the EU Draft Code of Conduct for Space Activities and the United Nations Long Term Sustainability of Space Activities have initiated the guiding principles for further development of the international regime related to sustainable space activities, including the necessity to improve safety aspects [23].

The increasing space traffic makes collision avoidance a major issue which brings to an urgency of transparency of spacecraft and other space objects location and movements [24]. The issue of collision avoidance will be today’s main consideration followed by space debris and space weather issues [25]. The three phases of space traffic which are the launch phase, the in-orbit operation phase, and the re-entry phase are considered as one of the most important issue related to space traffic management where at the same time encouraging a close link to air law must be made [26].

Many space companies besides Virgin Galactic have been established, namely Starchaser, Blue Origin, Armadillo Aerospace, Rocketplane Limited, XCOR Aerospace, and the European Project Enterprise. More will follow indicating that space traffic will be more crowded. The establishment of space traffic management shall lead to access of real-time essential information regarding the space flight as is in the case of ATM [27]. Setting up a high safety standard is one of the main goals and it is hard to imagine the future without space traffic management, leaving scheduled commercial space flight in ‘chaos’.

4.3 *Integration between Air and Space Traffic Management*

In January 2005 the president of the ICAO Council suggested that ICAO would be the ideal organization to regulate the new phenomenon of sub-orbital flights after the successful flight of SpaceShipOne [28]. Before that the ITU had also been proposed as the other option to become the regulator based on its regulatory powers towards satellites and radio frequency [29]. There is a belief that a joint cooperation organization between ICAO and ITU would be the natural and most appropriate body in purpose of an establishment of space traffic management [30].

From the two options, ICAO seems the most realistic choice for today. The world could rely on this organization which has successfully created a legal regime in air transportation sector through its Magna Carta, the Chicago Convention of 1944. Even though ATM in sovereign national airspace lies within the national authority’s hands, it applies as much as possible to ICAO’s standards and recommended practices [31]. As of today, air traffic control under the ICAO regime is using more satellites for navigation purpose leading to an integrated navigation satellite system to cope with the increasing volume of movements in airspace [32]. This could be improved for sub-orbital flight navigation; where the foundation has been laid down and could be expanded for future space traffic control. Thus efforts are not starting from zero.

ICAO’s long experience dealing with the rapid development in the aviation sector could be regarded as a valuable asset for establishing a sub-orbital flight legal regime in the future through hard law with the intention not to replace the existing space law treaties. The UNCOPUOS role for drafting and dealing with an (outer) space legal regime shall be respected and not overruled. A new department within ICAO should be added compromising experts in space safety, security, and the establishment and running of spaceports [33]; like the United States FAA has done so far. New annexes under the Chicago Convention, which are flexible and easily adapted, could be developed to cover sub-orbital flights; indicating there is no need for establishing a new international organization [34].

Annex 19 on “Space Standards” could be promulgated, play a role in the coordination of air and space traffic; as well as helping UNCOPUOS by trying to define the limit of airspace [35]. By having ICAO as the regulator since the early days, the goal to achieve a uniformity and harmonization between air and space traffic management is already on the right track; leaving less room for states or regional initiatives’ authorities to develop their own rules. The usage of English as *de facto* official language shall be maintained; with the aim to reduce the probability of an accident or mid-air collision due to misunderstanding among spacecraft,

spacecraft and aircraft in flight, or spacecraft with ground control. We are now facing a real situation where the potential of mid-air collisions between aircraft and spacecraft are higher.

In the near future air slots must be better allocated to both aircraft and spacecraft; showing ICAO's important role as a regulator and arbiter in resolving sub-orbital traffic issues [36]. In order to do so, the Chicago Convention must be amended, expressly extending ICAO's jurisdiction over space [37]. The most likely further limited scenario for ICAO shall be where the following conditions are present [38]:

- i. the sub-orbital flight is between two points signatories of the Chicago Convention;
- ii. the spacecraft will not complete two orbits of the earth; and
- iii. the majority flight time will be spent at an altitude of around 100 kilometers.

The Cold War is already over for decades, no more suspicion towards ICAO, ITU, and UNCOPUOS is needed.

5. Further Legal Issues That Must Be Resolved

5.1 *Distinction between Air and Space: Definition or Delimitation*

The boundary between airspace and outer space is not clearly defined, neither from a physical, geographical, or legal perspective [39]. For many years the UNCOPUOS Legal Subcommittee has failed to reach a consensus regarding the delimitation nor definition of airspace and outer space. UNCOPUOS consensus method, which means to reach general agreement without a formal vote, also slows down the progress. This situation could become a potential problem in the near future when the re-entry of a spacecraft operating in sub-orbital airspace is concerned [40].

The Soviet Shuttle "Buran" passed through the territories of African states and Turkey at an altitude of below 100 km during the last 8,000 km flights in 1988-2002; which today has led to a question whether there exists and where the innocent passage of the spacecraft starts and ends [41]. A spacecraft flying at a height lower than 60 km could endanger air traffic considering present aircraft are already capable of flying above 50 km in altitude [42].

The Soviets had proposed outer space at an altitude of around 100-110 km during the UNCOPUOS meeting in March 1979 before it was rejected by the United States [43]. Before that von Kármán, a German-Hungarian expert on aerodynamics, calculated an altitude of 100 km as the boundary between airspace and outer space which was named after him. At the end, still no consensus has been reached regarding the

delimitation of airspace and outer space from these efforts.

National legislation plays a role, for example the South African Republic Space Affairs Act No. 84 of 1993 defines outer space as the space above the surface of the earth from a height at which it is in practice possible to operate an object in an orbit around the earth [44]. According to the Australian Space Activities Act of 1998, a license is needed for a launch intended to reach an altitude of at least 100 km above the sea level [45]. In the United States, anyone going higher than fifty miles is awarded the astronaut wings [46]. These national space legislations and state practices could be regarded as an expression of *opinio juris* in search on either definition or delimitation between airspace and outer space.

An awareness has been growing that an unlimited air sovereignty would sooner or later obstruct the progress of scheduled commercial space flight and space traffic management [47]. Many states are resistant to the idea of a distinction between airspace and outer space, either by definition or delimitation, because it will affect their sovereignty. Any presence of definition or delimitation shall mean a limitation of states' freedom and sovereignty above their airspace. States should have seen it from another perspective that sovereignty in the airspace was a functional rather than a territorial concept [48].

Thus it would be wrong to think the importance of delimitation between airspace and outer space is merely a matter of academic debate [49].

5.2 *Redefining the 21st Century "Astronaut"*

The world is still using the 'old' definition of astronaut. Article 2 of the Rescue Agreement, as derived from Article 5 of the Outer Space Treaty, defines astronauts as envoys of mankind in outer space which has led the member states into a corridor of moral obligation towards every astronaut on a mission. This is very interesting considering space flight has evolved rapidly within the past half century.

Currently, from a narrow perspective rich people could earn the "astronaut" title by just flying with the SpaceShipTwo or going for a space trip to the International Space Station; while decades ago there were only a few people who could earn the title. These few people were on mission and not for leisure, which makes a clear distinction between them. At least the world has no doubt towards those who had landed on the moon or being on duty for months at the space station to be regarded as astronaut.

A question has arisen whether private space flight passengers should also be considered as astronauts; which means obtaining the same rights and obligations as trained professional astronauts [50]. The leading space enterprise, Virgin Galactic, has described its

passengers as astronauts [51]; which is needed for marketing purposes, and it is predicted other space enterprises will follow. However, when it comes to astronaut's rights, it can be argued that assistance and rescue in emergency situations should not depend on textual interpretation [52].

At the time of the debates, an astronaut is defined as a highly trained state-employed professional [53]. Within the last decade and in absence of any authoritative definition of the term "astronaut", it is proposed to be defined as human beings travelling into outer space for professional reasons of a non-commercial, non-private nature [54]. The proposed definition would deny any paying participant or passenger of sub-orbital flights the status of "astronaut" or "envoy of mankind"

Indonesia, as one of the few developing countries which has national space legislation, enacted since 2013, avoids further defining an "astronaut", even though they had the chance to do so, leaving interpretation open and flexible with development. In the United States, a clear distinction between "crew" and "space flights participants" is made to start solving this legal issue [55]. This distinction through national laws could become a stepping stone for the development of space law and industry; or even further as customary international law. The urgency to redefine "astronaut" according to recent developments is real and state practice from leading space faring states could make the difference.

5.3 Sub-Orbital Flight and Innocent Passage

The core discussion is the question of the appropriate legal regime(s) that could be applied for sub-orbital flights; whether air law, space law, both of them, or neither of them which lead to the need for a regime *sui generis* [56]. Until now there is no sub-orbital category in both air law and space law [57]. The functionalist approach believes that spacecraft only passing in transit through sub-orbital or orbital space in the course of two points in earth would be in airspace and therefore remain subject to air law provisions [58]. The latter will prevail considering airspace would be the main centre of activities and any crossing of outer space shall be brief and only incidental to the flight [59]. Thus applying air law with special considerations for the time being could become a solution to fill in the legal gap.

Bilateral or multilateral agreements signed by space-faring states with special provisions on sub-orbital flights over foreign airspace could become a solution in light of the legal debates which law shall be applicable for this kind of flight. It will lay down the foundation of some technical issues, such as spacecraft cruising altitude, an agreement not to fly above the restricted zones, and most importantly ensuring safety of spacecraft and aircraft by notifying the designated

authorities of sub-orbital flights. The success of this state practice will become a precedent for how a bottom to top approach could serve as important as efforts to draft or alter current conventions. The next stage shall be ensuring the applicability of Article 3bis of the Chicago Convention for spacecraft considering their speed and nature could lead them to be misidentified as a missile or threat to national security.

Speaking of innocent passage, it is a concept which is derived from maritime law, but not within the air law through the Chicago Convention. The latter regulates passage rights for aircraft but not to any space or hybrid object in airspace. Occasionally, a right of innocent passage through foreign airspace for ascending or returning space objects is postulated as a precondition to exercise the space freedoms [60]. In general space law does not recognize innocent passage (through foreign airspace) concept, and many scholars reject it; although there are some who argue that a customary transit right through foreign airspace might have emerged [61]. The world is now waiting for the ICAO together with UNCOPUOS to act on this issue.

5.4 Search and Rescue Operations: Who Pays?

The system of SAR in the high seas has only become well developed since 1985 with the International Convention on Maritime Search and Rescue of 1979 as the legal basis [62]. Beyond treaty and other legal framework, there is also a tradition of mariners offering help to each other [63]. Today the SAR system is based on close coordination between the International Maritime Organization and ICAO [64]. This is good news for space flight, as the foundation has been laid, especially if ICAO shall be designated as the space flight regulator in the near future. Annex 12 of the Chicago Convention of 1944 containing SAR provision could be further developed as a new cornerstone for future scheduled commercial space flight.

To fill the needs of legal standing of SAR operations, UNCOPUOS could apply more pressure to influential states to establish rescue cooperation in the form of either bilateral or multilateral agreements. The Good Samaritan principle must also be encouraged, even to the least developed non-space faring states. However, this step must be done in parallel with redefining the term "astronaut" to ensure the duty to rescue. Not to be forgotten, further cooperation in research and development of special emergency frequencies which are already established by the ITU Radio Regulations must also not be left behind [65].

The situation shows an urgency to establish a mechanism to fund any potential rescue in the future; where the funds can be used either as compensation to states acting on behalf of the Good Samaritan principle, preparatory measures, or to provide an assistance to third states in need [66]. The latter shall be applicable

for rescuing astronauts, so far including space tourists, on the high seas where member states in a position to help shall do so.

There is always a chance for a dispute on the rescue cost calculations issued by the helping states which could potentially shut the new space flight industry down. Complex negotiations to determine the number shall not be effective and discourage the growth of insurance companies. So far the Rescue Agreement has not been enacted for any SAR operations so no comparison can be made.

Predicting the high frequency of scheduled commercial space flight in the future, most likely many states will be more guarded towards its financial contribution for conducting SAR operations; a different situation compared with airline traffic considering its essential role in developing the economy. It would seem right that commercial enterprises and insurance companies should bear the cost for any SAR operation [67]. However, they need to solve a puzzle how to insure this hybrid creature where the current aviation and space launch vehicles have entirely different approaches [68]. The long process towards a space insurance sector for commercial activity has not yet been developed [69].

The biggest fear among all commercial space flight enterprises is a loss that they cannot recover from, including SAR operation costs which could be very expensive such as was the case with Malaysia Airlines Flight MH370's. Such a cost could take down not only that company but the entire industry [70]. States could create protections such as a subsidy for insurance premiums covering SAR operations during the developmental stages of commercial space travel in order to guarantee the industry's growth.

Indonesia and the Philippines are perfect examples where their naval capabilities are limited and are currently occupied combatting piracy and illegal fishing within their territorial waters. Both countries have a strategic location in terms of conducting SAR operations on the high sea, namely having full access to the Pacific and Indian Ocean. However, they are facing more pressing problems than just rescuing rich 'astronauts' and returning spacecraft with the utmost care when it lands on the sea; especially without any guarantee that those countries' operational costs will be fully compensated and its calculations not being challenged.

This potential problem must be solved immediately by promoting an effective mechanism for non-governmental private actors, such as a space insurance company, to settle directly with rescuing state(s). It is highly recommended for states where private entities conduct scheduled commercial space flight to provide SAR facilities such as ships; thus not only 24/7 transferable funds. The latter shall determine not only

developing states stand towards the sub-orbital flights phenomenon, but also developed states with advance SAR technology who decide not to join the industry.

5.5 Spaceworthiness or Airworthiness?

The big question shall be who has jurisdiction to issue safety licenses and conduct inspections towards a spacecraft for scheduled commercial flights. Based on Annex 8 of the Chicago Convention, national and regional initiatives' authority could have the right to exercise jurisdiction over the airworthiness of the spacecraft considering it is flying with "aerodynamic lift" during the atmospheric part of the flight [71].

So far it is only the United States, through its Commercial Space Launch Act as amended in 2004, which has granted the licensing authority to the FAA; which originally was not established for regulating space flights. It is relatively easy for the United States, in terms of the effectiveness of the act, considering their territorial size where current commercial sub-orbital flights could be conducted without crossing any foreign airspace. Thus no international elements and only within the jurisdiction of one single state, makes the United States capable of regulating an entire spacecraft flight; including to fully determine spaceworthiness or airworthiness.

The EU, as another realistic entity where scheduled commercial space flight could be conducted in the near future, so far has no common view towards the debates on spaceworthiness or airworthiness. If the regional initiative would like to catch up with the United States, they must quickly decide whether an air law regime based on functionalist approach could govern it. A positive answer shall authorize the EASA for licensing on behalf of airworthiness and then establishing EU safety standards.

The latter scenario is needed to avoid EU member states from having different safety standards. Consider when commercial space flights from Paris or Frankfurt to Los Angeles becomes a reality, different airworthiness standards shall discourage the expansion of this kind of flight considering the FAA needs to assess both countries. Not to mention if other EU member states would like to open new flight, such as Spain and Sweden. Considering the high technology needed, one specialized authority is needed. As of today, EASA is the most realistic choice for the EU. While waiting for progress, in parallel, EASA and other stakeholder could promote harmonization of the member states' national legislation on space to recognize EASA's obligation and role clearly.

Ensuring the public that sub-orbital flights are sufficiently safe within the next decade shall attract more participation; leading it to consolidate as a strong branch of the aviation sector [72]. It shall speed up scheduled commercial space flights to become a reality

and everyday occurrence in the future; at least comparable with Concorde or Etihad's residence class suite ticket price.

6. One Step Forward: Promoting Cooperation Among (Spacefaring) States

At present there are only the United States SSN and the Russian SSS that operate numerous and high-power radars around the world capable of monitoring the whole of space, while other countries lack this infrastructure and capability [73]. The United States SSN could provide space situational awareness by tracking more than 16,000 objects by January 2014; while the Russian SSS follows as the second in number [74]. These two entities could be considered as the foundation for monitoring space activities, namely scheduled commercial space flight.

However, it does not mean these entities are now one hundred percent ready. For example, information on space weather which is important for future scheduled commercial space flight is still limited [75]. Research and development related to space activities requires a huge amount of resources and time; thus further cooperation among actors is needed for effectiveness and efficiency. The main areas of space faring state cooperation are data and information gathering, exchange, and management for the sake of sub-orbital flight safety; which could be done only at eye level with mutual trust [76].

If we take a look back to the tragic Columbia accident, it was a miracle that there was no other collateral damage besides the fatalities of the crew. A lesson could be learned from this accident to protect aircraft from spacecraft operation [77]. The FAA has seen the development of sub-orbital flights as a challenge to create a system for a better management of air and space traffic; for example, during a launch they will provide the aircraft an alternative route to the destination and real-time information related to any potential debris hazard [78].

As one of the most influential actors in space activities, the United States through its FAA could show its 'good intention' by sharing its knowledge to ICAO, UNCOUOS, and the world. Transfer of knowledge and technology is needed to establish an effective space traffic management in the future where it could only be achieved through cooperation between space faring states. In these days UNCOUOS could take the initiative by becoming the bridge between space faring states, the ICAO, and other relevant private entities. Promoting such cooperation, together with military, through proposing and giving input towards the drafting or amending of bilateral or multilateral agreements and national space laws is worth it to try. Military involvement is needed to guarantee future sub-orbital

trajectories clear of space debris as a result of (increasing) anti-satellite missile tests.

7. Concluding Remarks and the Way Forward

We are living in a time when sub-orbital flights have become reality. In the near future, it will evolve into scheduled commercial space flight. Unfortunately, these kinds of flights are still not 100% subject to ATC, increasing the chance for mid-air collision between themselves or with aircraft. Predicting this situation, the urgency for space traffic management is real; where ideally it would not only tackle single issues, but regard the regulation of space and sub-orbital activities as a comprehensive 'big bang' concept based on functionality [79].

The establishment of space traffic management, based on the non-interference principle through a comprehensive legal framework, shall determine whether law can catch-up with recent developments. A lot of issues within the current international conventions need to be reworked from the concept of launching state, spacecraft registration, until who an astronaut is.

As of today, ICAO, with ITU and UNCOUOS help, could be considered the most capable and well-prepared international organization to regulate future scheduled commercial space flights. With a great deal of experience in the aviation field, the organization has laid a system which could be developed for space traffic; including SAR operation. An integration between air and space traffic management in the near future shall be the best ending; stressing no need for establishing a new institution which potentially overlaps with ICAO's role as well as the Chicago Convention. The United States has given an example to the world where the FAA could handle sub-orbital flight issues and so far has successfully integrated them within the aviation regime. Other states or regional initiatives could follow this path to ensure harmonization.

UNCOUOS should work together with ICAO to resolve the main issue: distinction between air and space. A clear distinction could be made between pure activities in outer space and transportation between two points on earth leading up to the journey in outer space [80]. The latter shall help to determine which law is applicable for spacecraft conducting scheduled commercial flights through sub-orbital trajectories; then answering the next question of whether airworthiness or spacworthiness should be the right term. Innocent passage for spacecraft in foreign airspace is currently being tested.

Further cooperation among space faring states is needed to create new state practices. Private entities must also be invited to join and given more authority, realizing they are the new (main) actors. Today states' resistance toward a creation of new legal framework related to space activities, in the sense of hard law, has

made a bottom to top approach through state practice as the most effective solution.

Finally, efforts towards space traffic management is real and not a castle in the sky. Developing states' views towards space traffic management and the most relevant issue, SAR, must be well considered in order to establish a successful new legal regime.

Acknowledgement

The author would like to thank the Secure World Foundation for its 2016 IAC Young Professionals Scholarship.

References

- [1] A Brief History of Human Spaceflight, <http://www.virgingalactic.com/human-spaceflight/history-of-human-spaceflight/>, (accessed 24.07.16).
- [2] Ansari Xprize, <http://ansari.xprize.org/>, (accessed 24.07.16).
- [3] *Supra* n. 1.
- [4] Walter Peeters, From Suborbital Space Tourism to Commercial Personal Spaceflight, *Acta Astronautica* 66 (2010) 1631.
- [5] Alexander Soucek, *Space Law Essentials*, Linde Verlag, Wien, 2010, p. 26.
- [6] *Ibid.*
- [7] Tanja Masson-Zwaan and Steven Freeland, Between Heaven and Earth: The Legal Challenges of Human Space Travel, *Acta Astronautica* 66 (2010) 1598.
- [8] Alexander Soucek, *supra* n. 5, pp. 3-4.
- [9] Maureen Williams, On the Need to Regulate Space Traffic Management, IAC-03-IISL.4.03, 54th International Astronautical Congress, Bremen, Germany, 2003, 29 September - 3 October.
- [10] Tanja Masson-Zwaan and Steven Freeland, *supra* n. 7, 1597.
- [11] *Ibid.*
- [12] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *Cosmic Study on Space Traffic Management*, International Academy of Astronautics, Paris, 2006, p. 28.
- [13] Nicholas L. Johnson, *Space Traffic Management Concepts and Practices*, *Acta Astronautica* 55 (2004) 804.
- [14] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 17.
- [15] Nicholas L. Johnson, *supra* n. 13, 804.
- [16] Julie Abou Yehia and Kai-Uwe Schrogl, *European Regulation for Private Human Spaceflight in the Context of Space Traffic Management*, *Acta Astronautica* 66 (2010) 1623.
- [17] Nicholas L. Johnson, *supra* n. 13, 805.
- [18] Arnel Kerrest, *Space Traffic Management: Comparative Legal Aspects*, IISL/ECSL Symposium, 2002.
- [19] Peter van Fenema, *Legal Aspects of Launch Services and Space Transportation*, in: Frans von der Dunk and Fabio Tronchetti (Eds.), *Handbook of Space Law*, Edward Elgar Publishing Limited, Cheltenham, 2015, p. 405.
- [20] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 39.
- [21] Nicholas L. Johnson, *supra* n. 13, 806.
- [22] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 28.
- [23] Yu Takeuchi, *Space Traffic Management as a Guiding Principle of the International Regime of Sustainable Space Activities*, *Journal of East Asia and International Law* 2 (2011) 334.
- [24] Francis Lyall and Paul B. Larsen, *Space Law: A Treatise*, Ashgate Publishing Limited, Farnham, 2009, p. 566.
- [25] Yu Takeuchi, *supra* n. 23, 334.
- [26] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 19.
- [27] *Ibid.*, p. 20.
- [28] Peter van Fenema, *supra* n. 19, p. 411. See also Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 51.
- [29] Karl-Heinz Böckstiegel (Ed.), 'Project 2001' - Legal Framework of the Commercial Use of Outer Space: Recommendations and Conclusions to Develop the Present State of the Law, Carl Heymanns, Cologne, 2002, pp. 259-281. See also Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 45.
- [30] Maureen Williams, *supra* n. 9.
- [31] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl, *Report The IAA Cosmic Study on Space Traffic Management*, *Space Policy* 22 (2006) 285.
- [32] I.H.Ph. Diederiks-Verschoor and Vladimir Kopal, *An Introduction to Space Law*, Kluwer Law International, Alphen aan den Rijn, 2008, p. 15.
- [33] Ruwantissa Abeyratne, *Commercial Space Travel: Security and Other Implications*, *Journal of Transportation Security* 6 (2013) 259-260.
- [34] Ram S. Jakhu, Paul Stephen Dempsey, and Tommaso Sgobba (Eds.), *The Need for an Integrated Regulatory Regime for Aviation and Space - ICAO for Space?*, Springer-Verlag/Wien, Mörlenbach, 2011, p. x.
- [35] Tanja Masson-Zwaan and Rafael Moro-Aguilar, *Regulating Private Human Suborbital Flight at the International and European Level: Tendencies and Suggestions*, *Acta Astronautica* 92 (2013) 248.
- [36] Ruwantissa Abeyratne, *supra* n. 33, 264.
- [37] Ram Jakhu, Tommaso Sgobba, and Paul Dempsey, *The Need for an Integrated Regulatory Regime for*

- Aviation and Space: ICAO for Space?, Springer, Vienna, 2012, p. 138.
- [38] P. Paul Fitzgerald, Inner Space: ICAO's New Frontier, *Journal of Air Law and Commerce* 79 (2014) 34.
- [39] Alexander Soucek, *supra* n. 5, p. 19.
- [40] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 39.
- [41] *Ibid.*
- [42] Robert F.A. Goedhart, The Never-Ending Dispute: Delimitation of Air Space and Outer Space, *Frontiers, Gir-sur-Yvette Cedex*, pp. 9 and 38.
- [43] *Ibid.*, pp. 4-6.
- [44] I.H.Ph. Diederiks-Verschoor and Vladimir Kopal, *supra* n. 32, p. 20.
- [45] Stephan Hobe, Bernhard Schmidt-Tedd, and Kai-Uwe Schrogl (Eds.), *Cologne Commentary on Space Law Vol. I: Outer Space Treaty*, Carl Heymanns Verlag, Köln, 2009, p. 31.
- [46] Francis Lyall, Who is an Astronaut? The Inadequacy of Current International Law, *Acta Astronautica* 66 (2010) 1615.
- [47] Robert F.A. Goedhart, *supra* n. 42, p. 137.
- [48] *Ibid.*
- [49] I.H.Ph. Diederiks-Verschoor and Vladimir Kopal, *supra* n. 32, p. 15.
- [50] Stephan Hobe, Bernhard Schmidt-Tedd, and Kai-Uwe Schrogl (Eds.), *supra* n. 45, p. 96.
- [51] Future Astronauts, <http://www.virgingalactic.com/future-astronauts/>, (accessed 29.07.16).
- [52] Alexander Soucek, *supra* n. 5, p. 28.
- [53] Francis Lyall, *supra* n. 46, 1613.
- [54] Stephan Hobe, Bernhard Schmidt-Tedd, and Kai-Uwe Schrogl (Eds.), *supra* n. 45, p. 97.
- [55] Francis Lyall, *supra* n. 46, 1614.
- [56] Alexander Soucek, *supra* n. 5, p. 93.
- [57] *Ibid.*
- [58] Ruwantissa Abeyratne, *supra* n. 33, 262.
- [59] *Ibid.*, 263.
- [60] Alexander Soucek, *supra* n. 5, p. 80.
- [61] *Ibid.*
- [62] Ram S. Jakhu, Paul Stephen Dempsey, and Tommaso Sgobba (Eds.), *supra* n. 34, p. 96.
- [63] Francis Lyall, *supra* n. 46, 1616.
- [64] Ram S. Jakhu, Paul Stephen Dempsey, and Tommaso Sgobba (Eds.), *supra* n. 34, p. 96.
- [65] Gabriella Catalano Sgrosso, Legal Status, Rights and Obligations of the Crew in Space, *Journal of Space Law* 26 2 (1998) 176.
- [66] Stephan Hobe, Bernhard Schmidt-Tedd, and Kai-Uwe Schrogl (Eds.), *supra* n. 45, p. 99.
- [67] Francis Lyall, *supra* n. 46, 1616.
- [68] John Loizou, Turning Space Tourism into Commercial Reality, *Space Policy* 22 (2006) 290.
- [69] Ana Cristina van Oijhuizen Galhego Rosa, Aviation or Space Policy: New Challenges for the Insurance Sector to Private Human Access to Space, *Acta Astronautica* 92 (2013) 236.
- [70] Michael Bouchey and Jason Delborne, Redefining Safety in Commercial Space: Understanding Debates Over the Safety of Private Human Spaceflight Initiatives in the United States, *Space Policy* 30 (2014) 56.
- [71] Darcy Beamer-Downie, Considering the Unthinkable - A Review and Discussion of Current International Law and Suggestions Regarding How We Deal with a Catastrophic Incident in Space, *Acta Astronautica* 92 (2013) 256.
- [72] Rafael Moro-Aguilar, National Regulation of Private Suborbital Flights: A Fresh View, *FIU Law Review* 10 2 (2015) 711.
- [73] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 35.
- [74] Stefan A. Kaiser, Legal and Policy Aspects of Space Situational Awareness, *Space Policy* 31 (2015) 6.
- [75] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (Eds.), *supra* n. 12, p. 37.
- [76] Stefan A. Kaiser, *supra* n. 74, 7-8.
- [77] Ram S. Jakhu, Paul Stephen Dempsey, and Tommaso Sgobba (Eds.), *supra* n. 34, pp. 91-93.
- [78] Ram S. Jakhu, Paul Stephen Dempsey, and Tommaso Sgobba (Eds.), *supra* n. 34, pp. 93-94.
- [79] Julie Abou Yehia and Kai-Uwe Schrogl, *supra* n. 16, 1623.
- [80] P. Paul Fitzgerald, *supra* n. 38, 20. See also Henri Wassenbergh, Access of Private Entities to Airspace and Outer Space, *Annals Air & Space* 24 (1999) 311-316.