70th International Astronautical Congress (IAC), Washington D.C., United States, 21-25 October 2019.

IAC-19-E6.3.13x54790

Does only innovation stimulates New Space?

Dirk-Roger Schmitt[a]*, Sven Kaltenhaeuser[b], Juergen Drescher[c]

[a,b] *Deutsches Zentrum für Luft- und Raumfahrt - German Aerospace Center (DLR), Lilienthalplatz 7, 38108 Braunschweig, Germany*,Dirk-Roger.Schmitt@dlr.de
[c] *Deutsches Zentrum für Luft- und Raumfahrt - German Aerospace Center (DLR), Linder Höhe, 51147 Köln, Germany*
* Corresponding Author

Abstract

New Space offers a variety of opportunities in the development of affordable access to space. Definitions of New Space vary in different countries and have different effects on politics. However New Space is seen differently in the USA compared to Europe. Even in Europe, each state sees its own way to go into the space marked or not. To have access to nearby cost efficient spaceports is regarded as a key element for the development of a New Space industry and regional business development. Existing policies of different European countries for the space access are discussed.

Keywords: New Space, Commercial Space Flight, Innovation, Space Leadership

1. Introduction

Space was controlled traditionally by National Agencies, but nowadays private companies are more and more involved [1]. New Space is said to boost spaceflight based on private initiatives. Basically, it is assumed that globally the private space sector will grow based on private investments. In the meantime conservative business models based on payload transport to orbit have been materialized as viable means of business. This will allow cheaper access to space driven technologies by commercial needs rather than politics.

Certainly, the increased commercial launches planned touristic flights and also point-to-point connections will have interference between aviation and space activities. Naturally, all spacecraft use the airspace for launch and if feasible for re-entry. Hence, the International Civil Aviation Organization (ICAO) made already some statements [2]: Sub-orbital vehicles in point-to-point connections could be regarded as aircraft. However, if rocket propellants are used, they are be considered as rockets (by one State). In case point-to-point traffic will be internationally, flights might be subject to international air-law. There is an ongoing discussion on these statements.

In the meantime an initiative of the ICAO Council for a proposal for the 40th Assembly Resolution is in place to define and clarify the future role of ICAO in order not to inhibit the development and growth of this emerging sector [11].

Beside the legal discussion one effect must be considered: The increased number of launch and re-entry activities worldwide will also have an increased impact on the use of civil airspace during the appropriate mission phases.

2. Developments in the USA

The United States have the leadership and are heading forward in New Space and commercialisation of space activities. Space tourism is also a stimulus for many commercial space activities, but still difficult to be established on a broader scale. Several private companies are developing space technology, services and economy relevant assets, but they have backing with contracts from the governmental agencies and NASA.

It became clear, that there is an increased demand and number of launches and re-entry activities in the near future. Just to mention some examples such companies like Space-X, Blue Origin, Virgin Galactic and Virgin Orbit are paving the way for commercial space transportation.

Fig. 1. SpaceShipTwo carried under White Knight Two

What also has to be mentioned are the increasing activities and services on ground. There is an increased

support from Federal States and local governments to establish spaceports all over the United States. Beside the 6 US Federal launch sites now there are 11 Non-Federal FAA licensed launch sites existing.

2.1 Law and regulation

The FAA has a major role for launches. They do not certify vehicles; instead the "FAA licenses the launch and re-entry event as well as the spaceport. US law tells FAA it cannot regulate the safety of people on board vehicles. An "informed consent regime" allows emerging human space flight industry to grow. Industry can develop voluntary standards to ensure the safe and sustained worldwide growth of the commercial space transportation industry. Public safety can be achieved while enabling industry growth." [3]

The US Government follows a policy to achieve public safety to enable industry to grow, while allowing to implement voluntary standards for civil passengers of spacecraft without further certification requirements of the spacecraft.

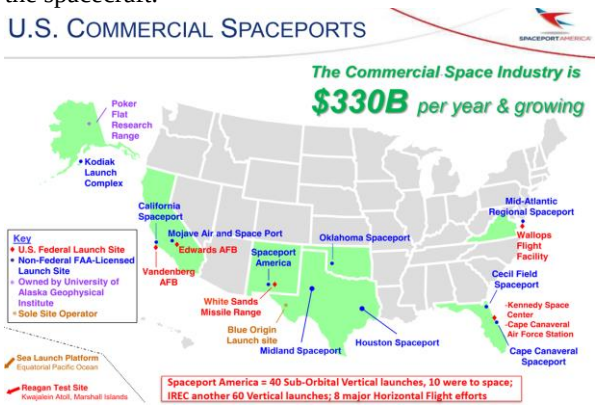

Fig. 2. US Federal and Non-Federal Spaceports. (source: Spaceport America).

In the US it can be observed, that the development of New Space has been driven by Government policy, by private initiatives taking the chances the Government is offering, by more and more affordable and cheaper technology and by the mood of agencies to let the business grow by trying to implement practicable regulations.

3. Europe

Europe is quite different than the United States. Although there are a lot of activities leading to a joint European position in politics, space policy, regulation, and laws, there still exists a lot of fragmentation. Besides that, Europe has a lot of areas with a high population density: Western Europe: ~180 p/km² vs. North America ~ 15 p/km² (Source: World Population Review). This yields to higher margins to be maintained for the safety of the population on ground during commercial launch and re-entry operations. Also the civil airspace over Europe is mostly crowded and congested by commercial aviation, leaving no space for higher risk operations. In this case, the establishment of dynamic temporary restricted airspace is investigated [4]. Today's aviation demonstrates high safety standards. The Total Loss Risk remains by 0.5×10^{-6} per flight while the risk of mid-air collision is at 1×10^{-8} (IATA Accident Statistics). To compare: The automobile industry achieves $<10^{-7}$ per drive in Germany. According to the FAA the human spaceflight history exhibits one catastrophic failure per 100 missions, i.e. 10^{-2}. Thereby Space Law (based and derived by Outer Space Treaty (1967)) approaches the regulation by 3rd party emphasis, state liability, and no international safety standards. In contrast, the Chicago Convention (1944) is focussed to passenger emphasis, operator liability, and ICAO standards for airworthiness, licensing, and operations.

It will be a complex task to put these different constraints and risk perceptions together in one operational concept especially in Europe. There are more public concerns than existing entrepreneurial willingness to take risks.

To have access to local nearby cost efficient spaceports is regarded as a key element for the development of a New Space industry especially in Europe. Here, the fragmentation maybe a benefit, because it allows different solutions at different locations.

3.1 ESA

A lot of coordination work is done in Europe by the European Space Agency (ESA). ESA is stimulating Start-ups in Incubation Centres. Also micro-launcher initiatives and initiatives for micro satellites are supported. ESA as well takes care in monitoring parts injected from launches into the airspace as well as in tracking spacecraft or parts from them which are deorbiting into the airspace [5].

3.2 EASA

The European Aviation Safety Agency (EASA) is looking to the situation from their position to regulate any traffic in the airspace. An EU-framework exists for aviation. That means existing aviation rulemaking, certification, standardisation processes could be profitably used. Regulations should be based on aerospace laws, regulations, standards, best practices, and experience. But finally the European Commission (EC) has to decide how to proceed [6].

3.3 EUROCONTROL

Eurocontrol has the mission to support European aviation and is performing the function of Network Manager for the European ATM network. Through its Network Manager Operations Centre (NMOC) it optimises traffic flows by constantly balancing capacity

supply and demand using a variety of solutions that include airspace design and airspace management. Airspace management solutions envisaged in the future include dynamic mobile areas in the airspace. This technology can be applied to integrate higher airspace operations of spaceplanes or to integrate rocket launches as for example already done for Operation Bellerophon in mid 2016 [7, 8]. The goal is to ensure that the integration of more spaceflight by using airspace does not disproportionately affect the performance of the existing European ATM network.

3.4 Space Access and Spaceports in Europe

While the guidance of the European Commission or the Governments of the States are not pressing into the commercialisation too much yet, some key parameters have been identified already and are being discussed:

Local space access. Opposite to the US, there is not yet an existing framework of Government or private Spaceports in Central Europe. The only really space access for Europe is through the Guiana Space Centre in Kourou. Smaller sounding rockets can be launched in Esrange in Kiruna, Sweden and from the Andøya Space Center, Norway. These launch areas have their own benefits, but they are not easily and fast accessible. Hence there is a development in Europe to establish more local spaceports.

Sovereignty: More local and fast space access increases the sovereignty of Europe and their States, which is in the current political situation one important factor.

Touristic Flights: Of course touristic flights require local access for the travellers which want to have their space experience local to their home town.

CubeSat based research: There is an increasing number of CubeSat manufacturers and users in Europe: Companies, Universities, and Research Centers are developing CubeSats and missions for the fraction of costs than of „conventional" satellites. These companies cannot effort to launch their systems from spaceports fare away from Europe.

Biosciene: Bioscience is developing fast in Europe. Also here are Small and Medium Sized Companies (SME), Universities and Research Centers to mention. There is an increasing need for science under microgravity. This also requires a very fast access from the lab to the experiment in space and vice versa. Shipping of living cell cultures all over the world is a hassle for the researches which limits the use of interesting cells in a lot of cases [9, 10].

From the academic perspective New Space creates faster and cheaper access to space and enables the design of experiments on small satellites (or other types of platforms) that can be created by universities themselves. This can be done cheaper, faster, and with own and local resources.

From the areas above it can clearly be seen, that spaceports are hubs for economic and scientific development. So the **added value** remains for the local economy. The development in new space access opportunities is not only seen from the available technologies or investments. The benefits here are to stimulate the local industries, to enhance also the science and research by providing fast and easy local space access. Finally getting highly skilled jobs created in the areas in the center of Europe is the major goal. There is no strategic top-down development of New Space and Spaceports in Europe, but European States are investing, as can be seen from the following examples[*]:

4. United Kingdom

4.1 Law and regulation

The UK is quite far advanced in the implementation of new spaces laws. The UK implemented the Space Industry Act 2018. This act introduces a quite complete set of rules for space activities from and for the UK as for Licensing, Range Control, Individuals take part in spaceflight activities, Safety, Security, Liability etc.[12]. There is the power to make regulations to limit the amount of liability of an operator for injury or damage to third parties which is deemed necessary for the industry to develop. Goal of the Law is to let the industry develop in the UK allowing launches also from the UK.

4.2 Spaceports

Planned spaceports are Sutherland in Scotland, Glasgow Preswick Airport, and Newquay in Cornwall, Smaller rockets can be used to launch small satellites into polar orbits from the locations. This includes vertical launches as well as horizontal launches.

5. France

5.1 Law and regulation

The French Space Operation Act (SOA) was introduced 2008.. It is focussed on the case of French Guiana Space Center (GSC).

5.2 Spaceports

Guiana Space Center (GSC) is the Spaceport for France and for ESA. National Spaceports in France are not in sight.

6. Italy

6.1 Law and regulation

A new space law is under discussion. By the Ministry of Transportation Decree (July 2017), access to space is seen to foster Space Economy in Italy. The

[*] The following discussion is presenting examples. It is not the goal to give a comprehensive overview for all European States and a full listing of their activities.

Italian Civil Aviation Authority (Enac) was given charge to develop regulatory framework for suborbital transportation as well as for 3rd parties & occupants safety and Spaceport selection criteria & procedures[13].

6.2 Spaceports

Agreements have been signed between Italian Stakeholders and Virgin Galactic for SpaceShipTwo and LauncherOne, respectively. Taranto Grottaglie Airport in the South of Italy is designated Spaceport andd was opened in May 2019.

7. Germany

7.1 Law and regulation

A new space law is under development and a draft is planned to be published by the Government in 2020. During the preparation for the law, proposals have been made to integrate regulations for vertical and horizontal launch of vehicles from Spaceports in Germany. In the process of discussion are involved the Federal Ministry of Transport and Digital Infrastructure, the Federal Ministry of Economic Affairs and Energy, as well as the DLR Space Administration.

7.2 Spaceports

In Germany as well as in all other mentioned states, the fast, cheap and local access to Spaceports is regarded as a key element to boost local economy and science. Currently the dual-use (military-civil) of military airports is discussed and implemented at different locations. The airports of Rostock-Laage and Nordholz, both located in the North of Germany close to the Sea are military airfields (Airforce and Navy) and by special agreements also used for commercial passenger flights. In addition to the use for civil aviation, commercial space transportation activities are being discussed. This could lead to the establishment of a network of Spaceports in the North of Germany. The location close to the sea allows very reasonable operations for air launches, where a carrier aircraft lifts-off from the airport and releases the rocket over the sea for example a polar orbit. Also touristic space flights seem to be possible from these locations. Furthermore, new launch vehicles currently in development can perform aircraft-like take-off and landing from airfields in Germany (see Fig.3) [14]. Also in this case a coastal location would be advantageous since it simplifies the fulfilment of noise and safety regulations. Together with the rocket test range and MRO facility Trauen/Faßberg this yields to a network for Spaceport operations in Germany, Fig. 4, 5.[15].

8. Discussion

Special focus must be set on different business cases for spaceport operations. This includes also the geographical logistics of industries and research organizations with needs for flying hardware in space or to conduct space experiments. Logistics and accessibility to a spaceport are necessary for a discussion of the different business models which analyse the spaceport operations as well as the benefits of local access to space.

Fig. 3. Horizontal take-off launch vehicle Aurora currently in development at German company "POLARIS Raumflugzeuge"

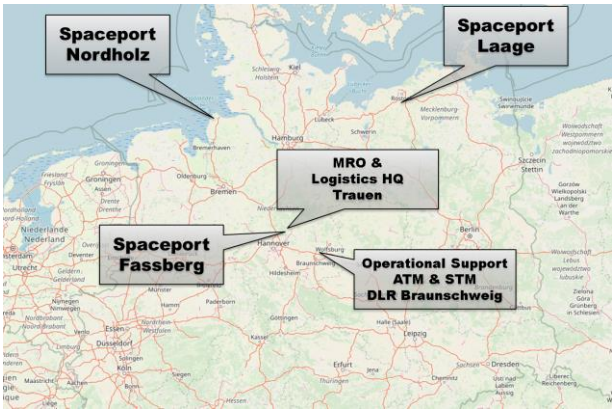

Fig. 4. Possible Spaceport and MRO network in the North of Germany. (Map fromOpenStreetMap, Open Database License (ODbL))

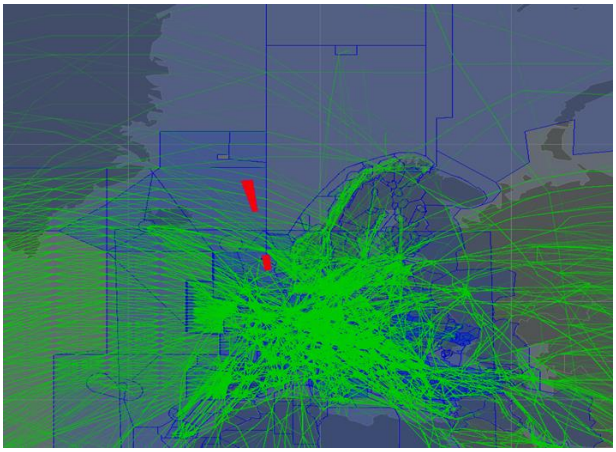

Fig. 5. Air Launch areas (in red) over the North Sea for missions started at a Spaceport in the North of Germany. The other air traffic is shown in green [15].

The results show that for specific innovative payloads i.e. bioscience or responsive information access, local spaceports will emerge the business activities in local European countries. Also constraints will slow down innovation. An example is the missing European space law. including missing standardization of rules for licensing launches. This yields to fragmentation and business uncertainty, preventing investments. The cases, compared taking the different innovation and investment cultures in the European states and the USA into are different.

9. Conclusions

A European Space Law should be implemented by the European Commission. This should address the following topics - including licensing, certification and liability - which are not yet dealed with in all European States yet:

- The launch of payload and astronauts into space from European ground by commercial and Government users.
- The launch and landing of space vehicles on Spaceports in Europe.
- The licensing of the operations of Spaceports on European ground.
  - for international space flight traffic to and from Europe,
  - for suborbital or orbital "hypersonic" point to point air traffic,
  - for commercial passenger transport to and from Europe.

Acknowledgements

Special thanks to Claudia Koch, John Sloan (FAA), and Dragos Tonea (Eurocontrol) for reviewing parts of the paper.

References

[1] D. Paikowsky, What Is New Space? The ChangingEcosystem of Global Space Activity, 67th International Astronautical Congress, Guadalajara, Mexico, September 26–30, 2016.

[2] ICAO Working Paper, Concept of sub-orbital flights, Council 175th Session, C-WP/12436 (2005)

[3] J. Sloan, International Update and Preview of US Position on ICAO and Space, International Commercial Space Transportation Roundtable, Arlington, Virginia, 2019.

[4] F. Morlang, Frank, Future space traffic integration by AFUAS SWIMming. 38th AIAA/IEEE Digital Avionics Systems Conference (DASC), 08.-12. Sep. 2019, San Diego.

[5] H. Krag, Interaction of Air and Space Traffic – A Space Perspective, Integrating Air and Space Traffic Management, An European perspective on a global challenge, International Colloquium, German Aerospace Center (DLR), Braunschweig, August 30-31, 2018.

[6] J.-L. Ammeloot, J.-B.Marciacq, Accommodating Sub-orbital and Orbital Aircraft (SOA) flights in the EU, Briefings to the ICAO Air Navigation Commission (ANC) and ICAO Council , 21st of October 2013, Montreal.

[7] D. Tonea, Commercial Space Operations and the European Network, Integrating Air and Space Traffic Management, An European perspective on a global challenge, International Colloquium, German Aerospace Center (DLR), Braunschweig, August 30-31, 2018.

[8] D. Tonea, European Higher Airspace Operations, European Higher Airspace Operations Symposium Brussels, 2 April 2019.

[9] C. Koch, F. Kohn, Johann Bauer, Preparing normal tissue cells for Space flight experiments, Preparative Biochemistry & Biotechnology, 2015; 14(2):208-2013.

[10] C. Ulbrich, M. Wehland, J.Pietsch, G. Aleshcheva, P. Wise, J. v. Loon, N. Magnusson, M. Infanger, J. Grosse, C. Eilles, A. Sundaresan, D. Grimm, The impact of simulated and real microgravity on bone cells and mesenchymal stem cells, Biomed Res Int. 2014; 2014:928507.

[11] ICAO Assembly 40th Session, Report on Commercial Space Transport (CST). September 2019. A40-WP/15.

[12] Space Industry Act 2018, http://www.legislation.gov.uk/ukpga/2018/5/contents/enacted, (accessed 2019-10-15).

[13] G. Di Antonio, Suborbital Transportation Development in Italy, Integrating Air and Space Traffic Management, An European perspective on a global challenge, International Colloquium, German Aerospace Center (DLR), Braunschweig, August 30-31, 2018.

[14] Polaris Raumflugzeuge, https://www.polaris-raumflugzeuge.de/ (accessed 2019-10-20).

[15] S. Kaltenhaeuser, T. Luchkova, N. Klay, R. B. R. Ang, Assessment of the Impact of Air Launch Operations on Air Traffic in Europe; 5th Annual Space Traffic Management Conference, UT Austin, Texas, 26.-27. February 2019.