Version 1.0
2 November 2021

EURODEFENSE
Space Observatory

Recent evolutions – SmallSats and the Space Economy

The purpose of this document is to highlight important trends which have been discerned by specialty reports and research from the space industry and academia since the previous Eurodefense Space Observatory material was distributed. This material is informative and meant to underscore the rapid development of the space sector and Europe's changing position in it.

The most important trend has been the substantial rise in the number of space assets, growing from an estimated 2,062 to 4,084 in just two years [1] [2], as seen in Table 1.

Table 1. The evolution of the inventory of space assets from 2019 to 2021, according to the Union of Concerned Scientists' Open Source Satellite Database

Satellite Quick Facts ***(30.04.2021 compared to 31.03.2019)***			
Total number of operating satellites: 4,084/2,062			
United States: 2,505/901	Russia: 168/153	China: 431/299	Other: 980/709
LEO: 3,328/1,338	MEO: 139/125	Elliptical: 57/45	GEO: 560/554
Total number of US satellites: 2,505/901			
Civil: 32/38	Commercial: 2,091/523	Government: 166/164	Military: 216/176

The vast majority of these new systems are small satellite systems, under 600 kg, and belong to just two major constellations, Starlink and Oneweb, which are dedicated to communications, as seen in Figure 1. We can say that they distort the overall industry analysis, but, nevertheless, the greatest growth in satellite systems is in this segment and the US leads it by far.

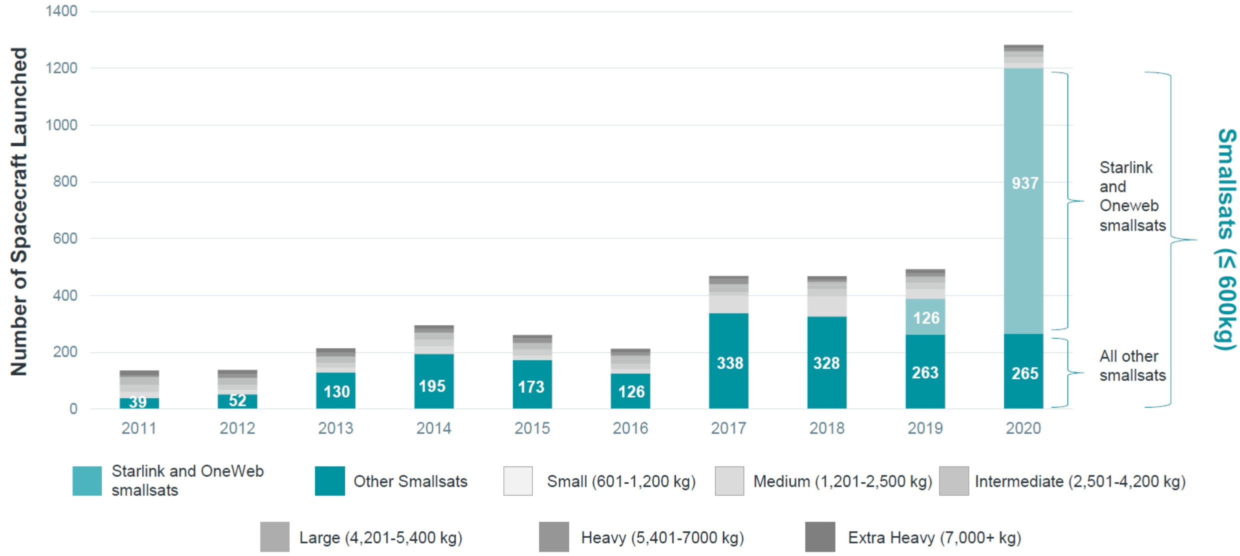


Figure 1. Smallsats launched between 2011 and 2020 [3]

The previous Space Observatory document detailed the transfromations that have led to this trend, but it can be summarized as follows:

- Advances in miniaturization, thereby increasing the capability of satellites while decreasing mass;
- Advances in standardization of satellite architectures to lower costs;
- Advances in cost of launching systems, either through cheaper launches or the possibility of bundling systems;
- Advances in demand for space services, especially in communications, remote sensing, technology demonstration and so on (figure 3);
- The accessibility, including through venture capital, of funding for new space companies.

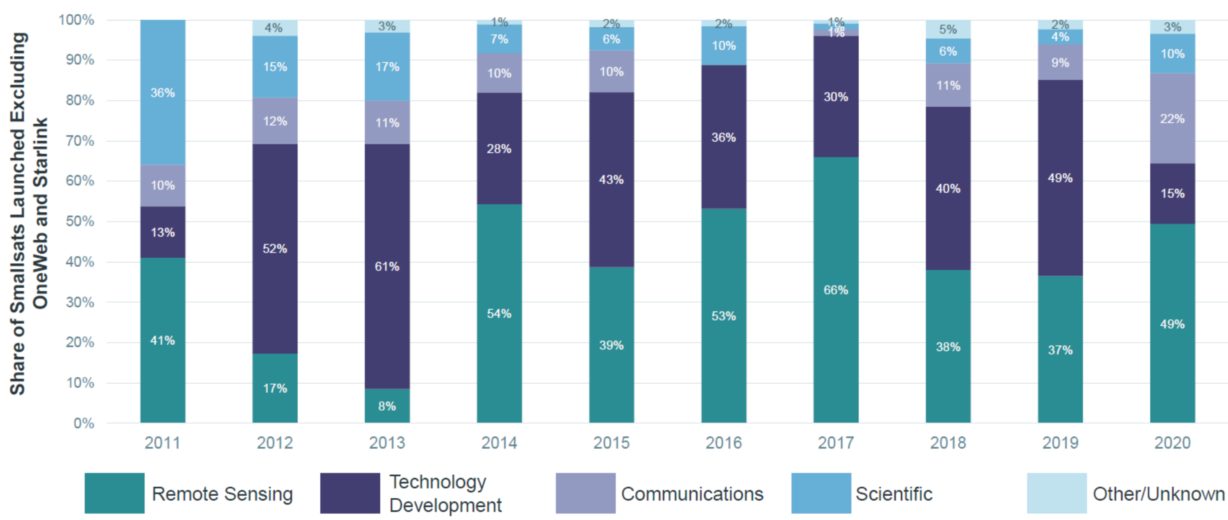


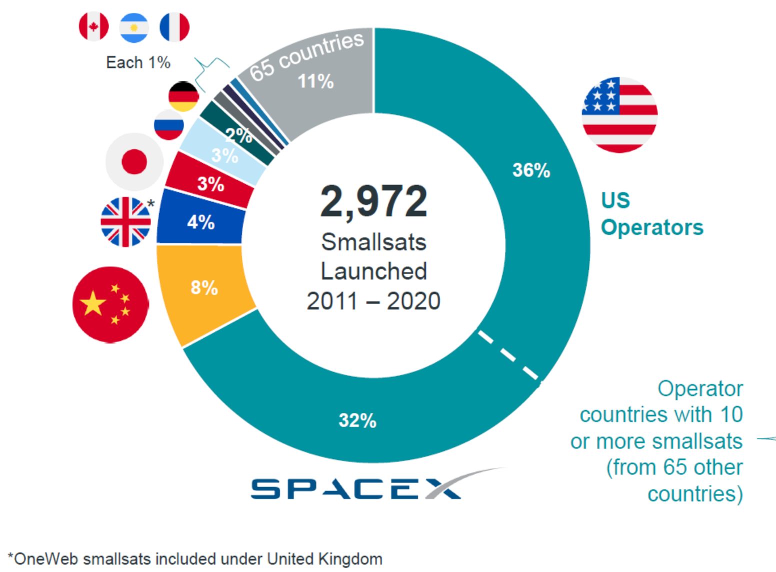
Figure 2. The role of new smallsat missions, excluding Starlink and Oneweb (communications) [3]

This is a competition that Europe is undoubtedly losing and, along with it, it is losing the competition for:

- Breadth of space industry;

- The development of private space industry, including through a vibrant start-up sector;
- Resilience through redundant capacity based on large number of smallsat services provider systems;
- The military applications of smallsats, which are as yet underexplored.

Figure 3 highlights the low European levels of involvement in this dynamic technological domain.



Operator Country	# of Smallsats
USA	2,027 (955 Starlink)
China	224
UK	129
Japan	82
Russia	83
Germany	49
Canada	29
Argentina	23
France	21
India	18
Australia	17
South Korea	17
Italy	16
Singapore	14
Spain	13
Israel	12
Finland	10

Figure 3. Smallsats launched between 2011 and 2020, by operator country (Starlink in US and Oneweb included in UK)[3]

The situation is even more dire when we compare government owned smallsat launches, since government are an important consumer of space services and buyer of first resort for the national aerospace industry (Figure 4).

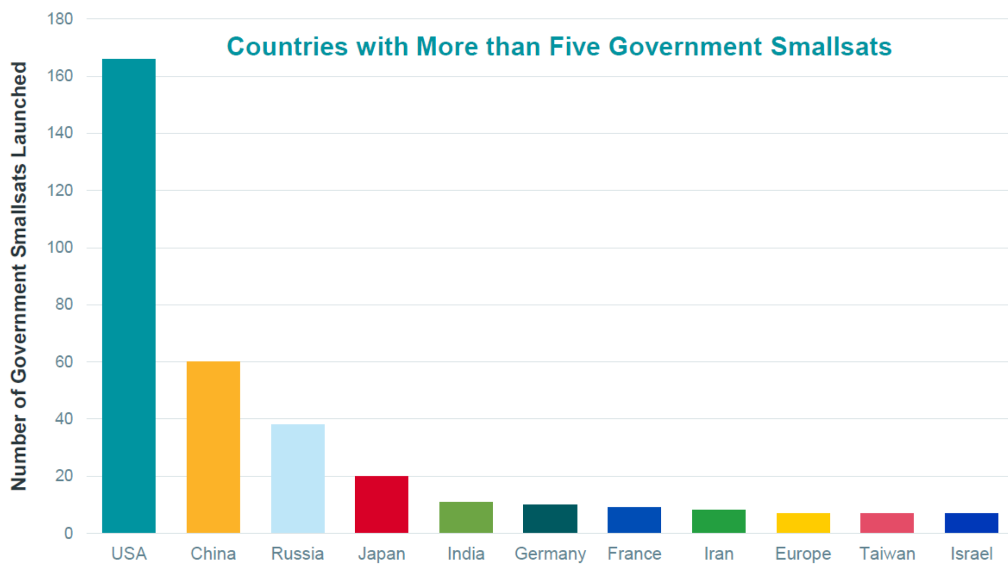


Figure 4. Government smallsat launches between 2011 and 2020 [3]

Only France, Germany and the EU itself make it into the top 10. Countries with five or fewer smallsat include: Canada, **Norway**, Vietnam, **United Kingdom**, South Korea, Algeria, UAE, **Italy**, North Korea, Ecuador, **Poland**, the Philippines, Ethiopia, Turkey, Indonesia, Australia, Egypt, Nigeria, **Spain**, Ukraine, Belarus, Colombia, Malaysia, Kazakhstan, Brazil, Thailand, Mexico, Pakistan, Peru, **Belgium**, **Sweden**, Rwanda, Chile.

210 universities or academic institutions launched smallsats between 2011 and 2020, but only the Technical University of Berlin is among the 11 institutions which have launched more than 5 smallsats, with 14, in second place after the Kyushu Institute of Technology in Japan with 16. The lower lifespan of smallsat missions means that a low number of launches indicates limited capability or interest to maintain a permanent presence in space on the part of the operator [3].

Europe is also subsequently losing the market for launching these systems, which is, in itself, a growing lucrative domain for microlauncher companies supporting a high tech and innovative aerospace sector. Only France is consistently in the top six launchers of these satellites, and its presence varies (Figure 5).

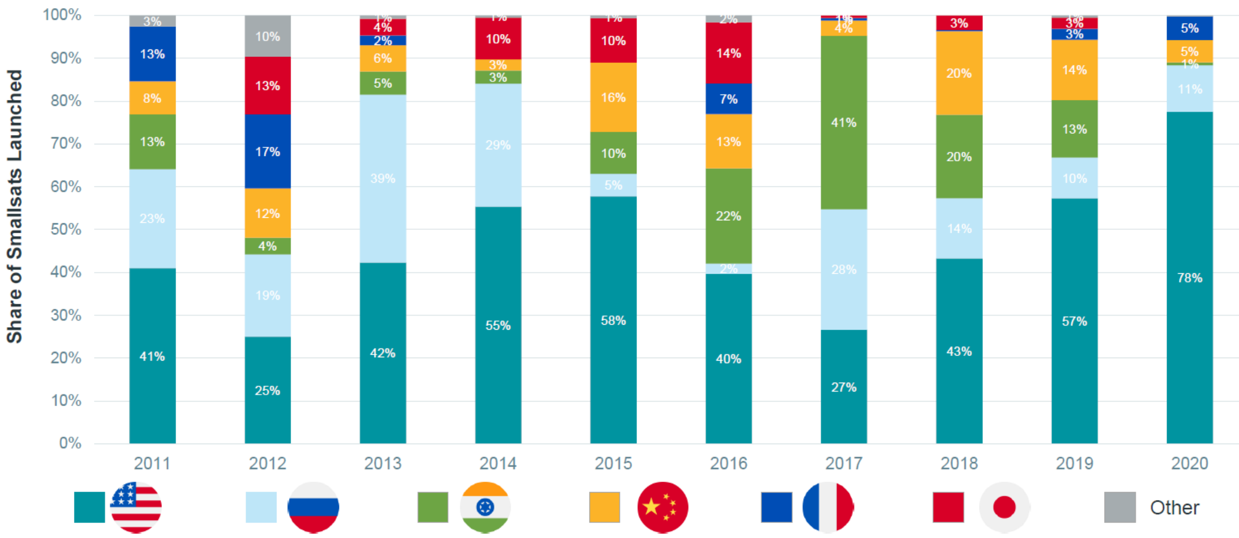


Figure 5. Launches of smallsats between 2011 and 2020 by launcher country [3]

This is especially important since, even though smallsats can be launched in higher numbers by normal launchers, as a group, nevertheless in 2020 smallsats accounted for the majority of launches for the first time, with 68 out of 114 launches featuring smallsats. 25 of those launches were with micro (<500 kg to LEO) and small (500-2,200 kg to LEO) launch category vehicles [3].

Preliminary analysis shows that, in the first 6 months of 2021, more smallsats were launched than in the entirety of 2020.

Given its performance when it comes to launches, it should come as no surprise that Europe has also been falling behind in terms of launch sites (Figure 6). Several are under development, including in the UK, Italy and Romania, but government interest in supporting them is limited and the market they can tap, without a well developed regional launch industry for smallsats, is uncertain.

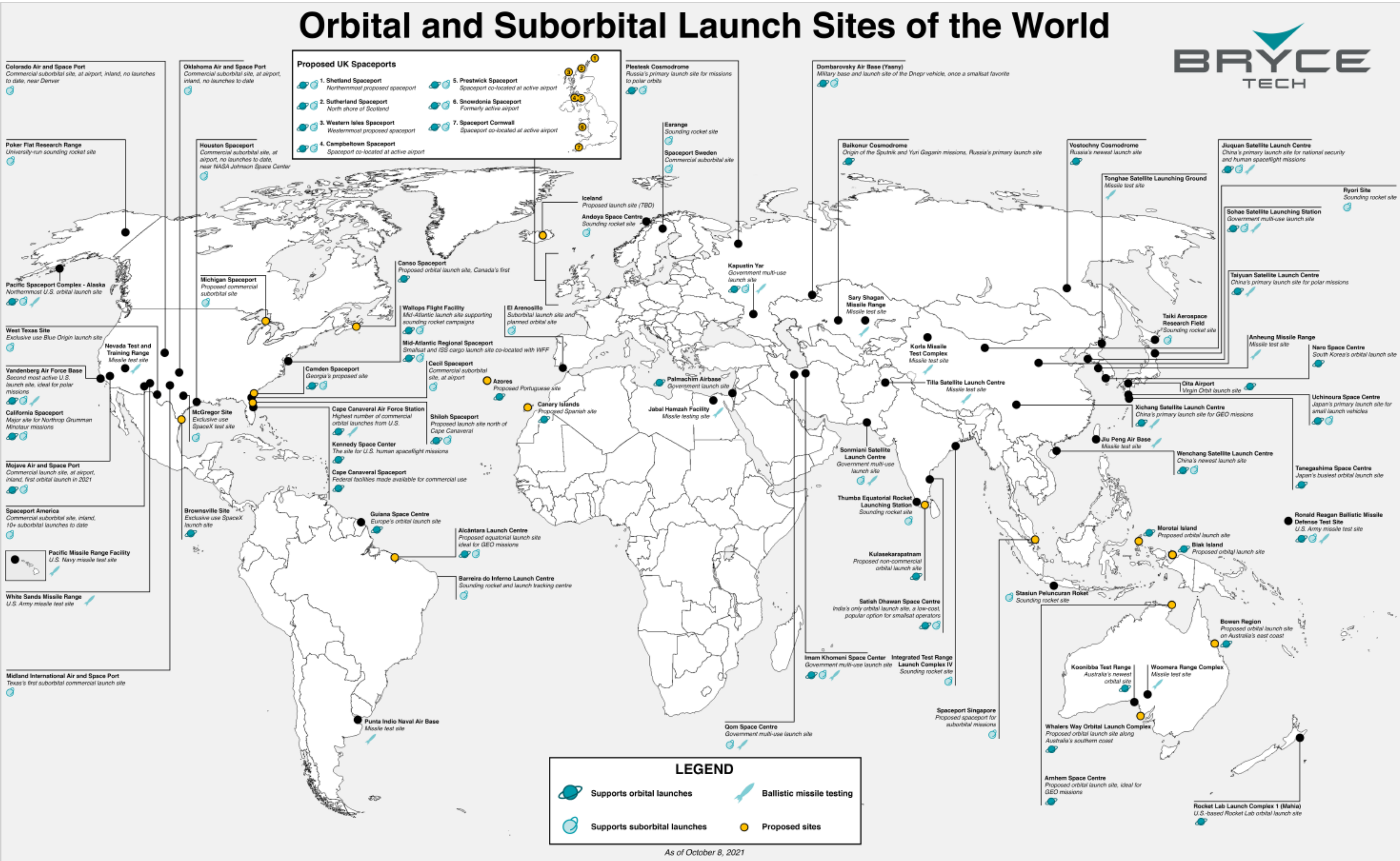


Figure 6. Map of active launch sites around the world (incomplete) [4]

At the same time, Europe is falling behind in the underlying financial capacity to support the development of an innovative and competitive space sector. While there is governmental acknowledgement of the resources that must be invested into space, and the new focus is visible at EU and ESA levels, the major funding for start-up companies in space comes mostly from venture capital, as can be seen in Figure 7.

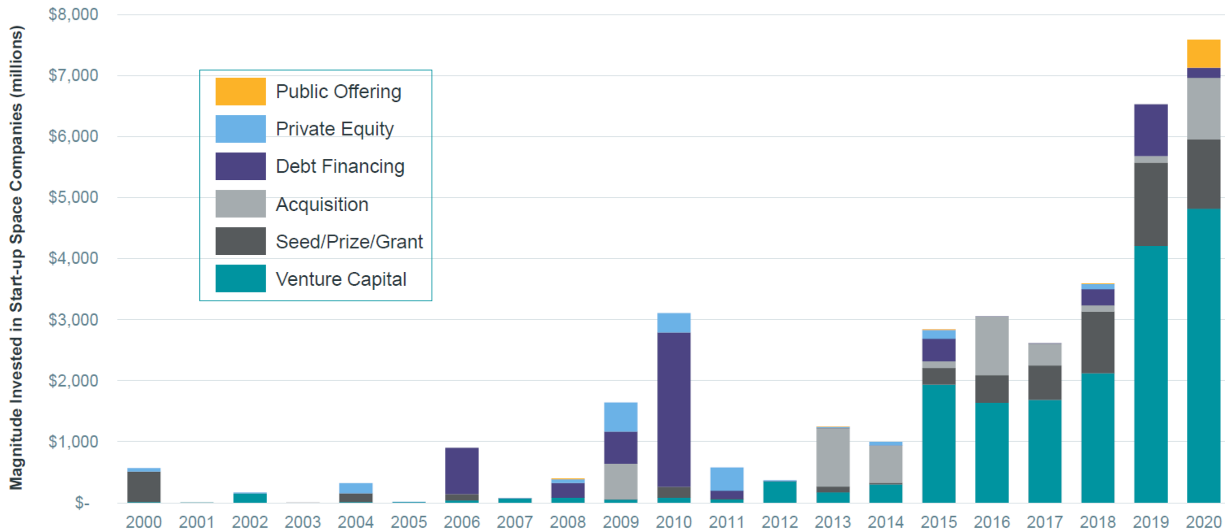


Figure 7. Sources of funding for start-up space companies globally 2000-2020 [5]

Figure 8 provides a global view. Of the 1,212 unique start-up investors identified by Bryce Tech in the 2000-2020 period, almost half (544) were from the United States, followed by China with 136, Japan with 107, the UK with 103 and India with 37. The notable absence of other European countries shows that there was a lost start that was only partially recovered by 2020 [5].

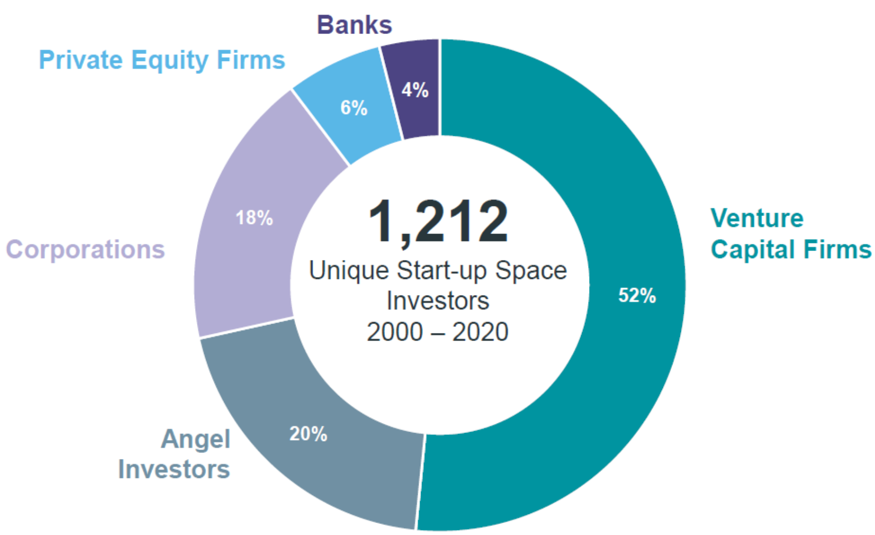


Figure 8. Sources of funding for all start-up space companies 2000-2020 [5]

In 2020, there were 342 investors who made 140 deals to invest in 124 start-up space companies. 211 of them were first time investors into space, signaling the attraction of the field and its maturity. 36% or 123 of these investors were American, 48 Chinese, 31 British, 21 Japanese and 17 French. However, US start-up companies accounted for 63% of total investment received in 2020, which points to another important discrepancy, which is also registered in other technological domains [5].

Europe can recover some of the lost head start because the growth in the space start-up domain is significantly frontloaded. Excluding debt financing and acquisitions, 26 billion dollars were invested in start-up space companies in total between 2000 and 2020. 22 billion dollars, or 84% of that investment, has taken place since 2015. So, in reality, the sector has picked up speed, with evolutions in favor of the incumbent player like the US, but offering also an opportunity for Europe, if it can manage to encourage the private funding of space start-ups.

This is a worthwhile endeavor not just for strategic reasons, though these are central to Eurodefense perspectives and interests. Without a thriving, innovative and sustainable space industry, made possible by a full spectrum of financing types and actors, the EU cannot remain competitive in space, ultimately affecting strategic space autonomy. Its security will also suffer, because its space services consumption is growing significantly and this consumption, in the absence of strategic space autonomy, will be provisioned, assured and, consequently, controlled and governed by others.

At the same time, the global space economy is growing much faster than the global economy. As seen in Figure 9, the global space economy has reached 371 billion dollars in 2020, and is slated to reach 1.5-2 trillion dollars by 2030, at the most optimistic, and 2 trillion dollars by 2040 at its most pessimistic, according to estimates reported by the OECD [6].

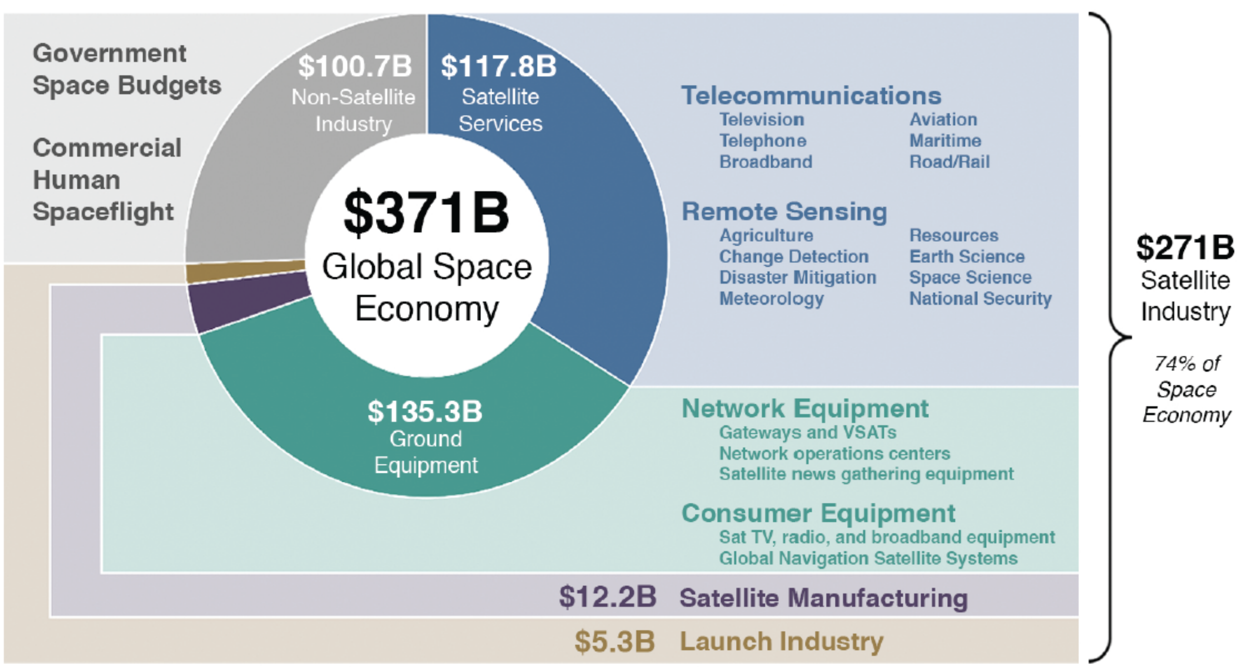


Figure 9. The level of the space economy [7]

The space economy is, increasingly, being driven by the fast-growing fields in which Europe, with its lower private sector involvement in space compared to the US, is at a disadvantage – satellite services. The OECD notes that the world is entering a fifth stage of space development, one in which we are witnesses to "growing uses of satellite infrastructure outputs (signals, data) in mass-market products and possibly for global monitoring of treaties (land, ocean, climate), third generation of space stations, extensive mapping of solar system and beyond thanks to new telescopes and robotic missions, new space activities coming of age (e.g. new human-rated space launchers, in-orbit servicing)" [8]. The space economy expresses those developments, as it is "the full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding, managing and utilizing space. Hence, it includes all public and private actors involved in developing, providing and using space-related products and services, ranging from research and development, the manufacture and use of space infrastructure (ground stations, launch vehicles and satellites) to space-enabled applications (navigation equipment, satellite phones, meteorological services, etc.) and the scientific knowledge generated by such activities. It follows that the space economy goes well beyond the space sector itself, since it also comprises the increasingly pervasive and continually changing impacts (both quantitative and qualitative) of space-derived products, services and knowledge on economy and society" [6].

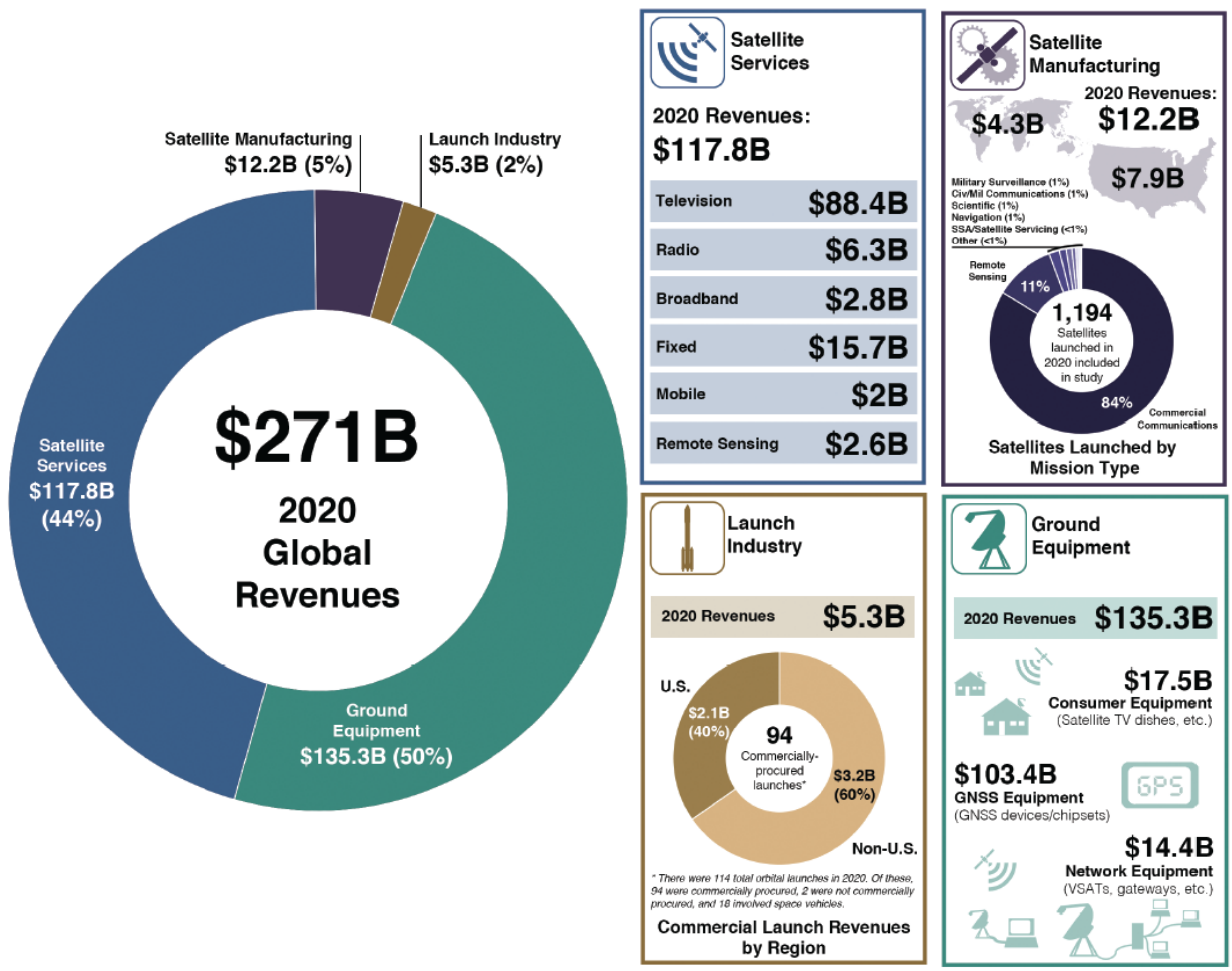


Figure 10. The satellite industry breakdown in 2020 [7]

Figure 10 provides an overview of the space industry, absent government spending on space and human spaceflight, which is equivalent to 74% of the space economy. Satellite services, increasingly driven by smallsats launched by non-traditional operators (start-up companies, universities), accounted for 44% of that figure. We should not let the low contribution of satellite manufacturing and launch industry services (5% and 2% respectively) deceive as to the vital role that these industries play in innovation and competitiveness. Of the 12.2 billion dollars in satellite manufacturing activity in 2020, the US accounts for 65%, a figure inflated by the role of SpaceX with its Starlink constellation, but this is not the only American mega-constellation on the horizon, since Facebook has also announced plans for broadband wireless communications via satellite.

Recommendations:

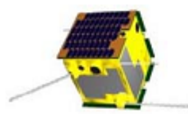
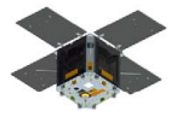
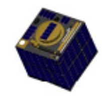
There is limited scope for European governments to encourage private appetite for investment into space, beyond the state funding of research, development and innovation.

There are three possible avenues for an initiative encouraging private funding of space start-ups as a driver of innovation:

- Encouraging the supply side of start-ups, through state and EU support of space hubs and start-up incubators focusing on space and space-related domains. It is especially important to make the creation and liquidation of start-ups as painless as possible and to provide support for intellectual property protection, patenting, licensing and branding;
- The use of prizes, both at the frontier of technical ability and for incremental capability development, to motivate the formation of teams that can then coalesce into start-ups. European countries have a tradition of prizes driving research and development, but it has been overshadowed in the space field by US-based prizes;
- Stimulating the demand side for start-up products and services through a greater focus on and encouragement of new systems architectures and the services they provide, including through and emphasis on security and resilience through redundancy, interoperability and substitutive capacity.

A model in this regard should be Japan, whose main remote sensing satellite, ALOS (4,000 kg), failed during the Fukushima disaster. Japan received its necessary space services through the International Disaster Monitoring Charter and through the Sentinel Asia Initiative, but it changed strategy afterwards, eschewing exclusive investment in complex, large-scale and expensive systems in favor multiple smaller and cheaper systems, that offered redundant capabilities. The first wave of this new approach was represented by 8 microsatellites (50-60 kg with cubesat architecture – 50x50x50 cm), which can be seen in Table 11, specifically to monitor the environment of the Fukushima and Chernobyl areas [9]. Of course, there is a role for all technological avenues and Europe must identify and invest in each of them.

Table 11. The eight microsatellites that were launched in 2014 to provide redundant monitoring of the Fukushima area

				
Satellite name	**Hodoyoshi-1**	**Hodoyoshi-2**	**Hodoyoshi-3**	**Hodoyoshi-4**
Operator	Tokyo Univ.	Tohoku Univ. Tokyo Univ.	Tokyo Univ.	
Orbit	SSO 552 km	SSO	SSO 630 km	SSO 630 km
				
Satellite name	**Uniform-1**	**Chubusat-1**	**TSUBAME**	**QSAT-EOS**
Operator	Wakayama Univ. Tokyo Univ.	Nagoya Univ. Daido Univ.	Tokyo Inst. Of Technology	Kyusyu Univ.
Orbit	SSO 630 km	SSO 529 km	SSO 541 km	SSO 536 km

Conclusions:

- The EU must focus on encouraging the development of private sources of funding, with appropriate appetite for risk, to complement state and EU investment in innovation and emerging technologies;
- The EU is far behind the US, when compared relative to size, population, GDP and overall economic sophistication;
- Strategic space autonomy cannot take place in the absence of strong private sector contribution, in financing as well as in the start-up scene;
- The EU must act at multiple levels, encouraging both European financing and European innovation, otherwise the financing gap will be covered by US entities, leading to brain and technology drains and affecting EU strategic technological autonomy, which has identified these threats from the imbalance in transatlantic potential.

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