ESPI

European Space Policy Institute

ESPI Yearbook 2020

Space policies, issues and trends

Report:
Title: “ESPI Yearbook 2020 – Space policies, issues and trends”
Published: June 2021
ISSN: 2218-0931 (print) • 2076-6688 (online)

Editor and publisher:
European Space Policy Institute (ESPI)
Schwarzenbergplatz 6 • 1030 Vienna • Austria
Phone: +43 1 718 11 18 -0
E-Mail: office@espi.or.at
Website: www.espi.or.at

Design: copylot.at

Cover page picture credit: Shutterstock

Table of Content

Foreword

Dear members and readers,

I am happy and proud to introduce to you this 2020 edition of our ESPI Yearbook. This long-established annual publication has gained along the years a solid reputation of being a reliable source of information and a useful tool for monitoring the development of the European space policy in a global context.

With this new issue we tried to better meet the expectations of our readers and we paid substantial efforts to ensure a consistent overall coverage of the 2020 space activities and business.

We do not pretend establishing with this yearbook THE reference document describing and analysing the evolution of the global space sector. Some other publications have such ambition, but none of them has such a strong and permanent focus on the situation of Europe. And this is exactly the purpose we pursue with this publication, highlighting the position of Europe on the space international stage and putting forward the trends at work that deserve being considered in the further development of the European space policy.

This approach builds on the permanent "Space Sector Watch" effort that we initiated two years ago with our new ESPI Insights monthly publication structured along four major areas of interest to our members:

- Policy & Programmes, where we report on the latest developments of space public, governmental and institutional affairs,
- Industry & Innovation, where we gather prominent announcements related to space industry evolutions worldwide and technology's most promising progress,
- Economy & Business, which is based on a collection of indicators relevant to the global space economy and markets,
- Launches & Satellites, which presents some exploitations of our in-house databases related to launch site activities worldwide over the past year.

2020 has been quite remarkable regarding the development of space policy-related matters with:

- The COVID-19 pandemic and its impacts on the global space sector,
- The finalization of the EU Multiannual Financial Framework and Space Programme for the period 2021-2027 with unprecedented financial commitments and new ambitions,
- Changes in Europe's institutional space leadership,
- New developments in approaches to space and defence with a growing presence of space in the global defence agendas,
- New steps in the development of the Artemis programme, including the signature of the Artemis Accords

Regarding space industry, 2020 has also been quite dense with the advent of major initiatives that might have disruptive consequences in the medium term:

- The strong rise in interest for commercial spaceports in Europe and throughout the World
- The growing interest in reusable launcher programmes across the globe
- The lifeline provided by C-Band clearing for a bearish GEO satcom market,
- Major developments of the U.S. Human Spaceflight and Human Landing System programmes

I hope you will enjoy going through this publication as much as we did preparing it and that you will share with us the need to fill-in a gap with solid Europe-centred socio-economic indicators to support the further development of the European space policy in order to best foster effectiveness of public expenditures, business development and investment.

I would be more than happy to receive feedback on ways we could further tailor this publication to your needs.

In the meantime, I remain,

Sincerely yours,

Jean-Jacques Tortora

Director of the European Space Policy Institute

About ESPI Space Sector Watch

As part of its mission, the European Space Policy Institute (ESPI) continuously monitors international space affairs and tracks a selection of indicators in proprietary databases. The ESPI Yearbook series is part of this broader ESPI Space Sector Watch that includes complementary publications.

ESPI Yearbook

The ESPI Yearbook is an annual publication of the providing an overview of major developments and trends in space policy, industry, programmes, economy and overall worldwide space sector activity over the year.

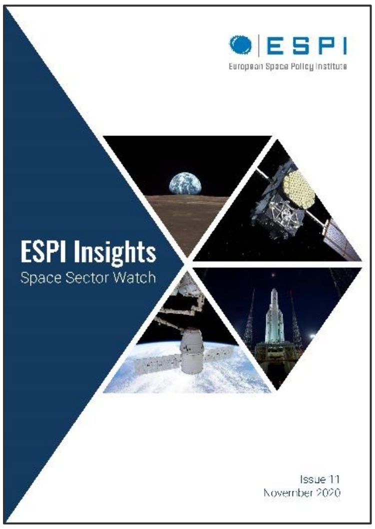
The Yearbook is organised in four complementary chapters:

- Policy & Programmes: space policy highlights and trends, major space programme developments
- Industry & Innovation: launcher and satellite industry developments, selected company infosheets
- Economy & Business: global and European space economy indicators (turnover, budgets, investment)
- Launches & Satellites: space activity statistics, mission highlights and ESPI launch log

The ESPI Yearbook does not aim to be comprehensive but rather to provide useful information, data and insights on a selection of topics expected to shape the future of the global and European space sector.

ESPI Yearbook 2020 is the 2nd edition of the new ESPI Yearbook series, available for free on ESPI website. Previous editions are available in eBook and Hardcover format on Springer website.

ESPI Insights



ESPI Insights is a monthly overview of major developments in the global space sector. The publication provides a digest of top space news and useful links to official documents, public reports, web articles or conference websites.

The ESPI Insights series was designed to be complementary to the ESPI Yearbook series and both series follow the same structure.

Sign in ESPI Newsletter to receive ESPI Insights directly in your mailbox every month. All previous editions are available for free on ESPI website.

ESPI Executive Briefs

ESPI Executive Briefs are short papers published every month that provide the views of the Institute on outstanding space policy topics.

Recent topics include for example:

- European Multi-Orbit Connectivity System (ESPI Brief 47, January 2021)
- Artemis Accords: What Implications for Europe? (ESPI Brief 46, November 2020)
- Questions raised by the COVID-19 crisis for the European space sector (ESPI Brief 41, May 2020)

All ESPI Executive Briefs are available for free on ESPI website.

COVID-19: A SPACE PERSPECTIVE ON THE GLOBAL PANDEMIC

For a more comprehensive review of the implications of the COVID-19 crisis in Europe including economic impact indicators, see ESPI Special Report – COVID-19 and the European space sector.

Space delivers: space solutions in response to the crisis

At the virtual G20 conference held in October 2020, UNOOSA Director Simonetta Di Pippo remarked that "the current pandemic is a crisis unlike any we have ever seen. It has taught us that decisive action matters. It has also shown that when called upon, the space sector can deliver."[1]

Space systems have already repeatedly demonstrated that they provide unique solutions, essential to better understand, monitor and respond to a variety of crises. The COVID-19 crisis showed again that they can also be quickly put to good use in the case of unexpected critical situations. In 2020, space solutions proved to be valuable at all stages of the management of the crisis, from monitoring and assessment of the situation to enabling responses and accelerating recovery, but also to supporting epidemiological research efforts and intelligence about the situation.

- Satellite imagery enabled direct observation of the multiple effects of the crisis across large areas, actively supporting an informed monitoring and assessment of its impact, helping to plan operations on the ground and to gather information for a multitude of applications.
- Satellite navigation was also used to actively detect and track a variety of situations such as traffic jams at borders, allowing for a better management of these issues through information dispatch and coordination of countermeasures.
- Satellite communications, which are essential to ensure ubiquitous connectivity for all, played an even more important role whilst telecommunication infrastructures were facing a quick and massive increase of bandwidth demand.

Copernicus EMS

Overall, the "big picture" delivered from space allowed to visualise the lockdown of cities and to monitor the effects on the environment and on economic activities, enabled decision-making, and gave transparency to the implementation of containment measures.

Various public institutions as well as private companies sought to further leverage space capabilities to respond to the COVID-19 crisis and launched various initiatives to stimulate the development of new space applications.

- Earth Observing Dashboard: ESA, NASA and JAXA initiated a joint project to create the Earth Observing (EO) Dashboard, combining expertise to provide a more global coverage, through an additional set of 146 indicators not found in other dashboards. Informing on the impacts of the crisis on commodities market, ship and air traffic, pollution, planting and harvesting, nightlight emissions: the amount of data provided by space assets is critical to prepare targeted and effective recoveries.

[1] United Nations, "Space sector works to keep societies and economies on track during COVID-19", (October 2020): https://news.un.org/en/story/2020/10/1074872

- NASA COVID-19 dashboards: it features data collected by EO satellites, instruments aboard the ISS and sensitive ground-based networks. Several categories of change are searchable on the global maps, including economic and environmental factors.[2]
- COVID-19 dashboard for Agriculture: NASA Harvest, a consortium including NASA Earth Applied Sciences' and the University of Maryland, released a dashboard to help quantify the pandemic's impact on agricultural production and food security around the world.[3]
- RACE dashboard: ESA and the European Commission launched the Rapid Action on COVID-19 and EO (RACE) dashboard, providing key information on the impact of the crisis at environmental, economic and social levels, through 178 different indicators.
- Galileo Green Lane: the GSA (now EUSPA) and the European Commission launched Galileo Green Lane, aimed at supporting road traffic management to facilitate mobility and the transit of goods, easing the situation at European borders.
- Thailand COVID-19 iMAP Dashboard: The Geo-Informatics and Space Technology Development Agency (GISTDA), in Thailand, used space applications to combat COVID-19, in particular to enable policymakers to utilise COVID-19 related data.[4]

Galileo Green Lane

Additionally:

- The Nigerian Space Agency launched a TeleMedicine facility to support COVID-19 testing in Nigeria.
- The South African National Space Agency (SANSA) has collaborated with representatives of the local Earth observation industry to identify how the agency could partner with industry on existing Earth observation products and to offer support/funding to fast track further development of products into usable support tools by the government in its effort to contain COVID-19.
- Israel's Ministry of Health developed an application (Hamagen) to monitor the COVID-19 pandemic and allow the identification of positive patients and people who came in contact with them using user's GPS coordinates on the device.
- The Government of Bulgaria developed an application (ViruSafe) that aims to help fight COVID-19 by offering each user regular information about their symptoms and monitoring the pandemic with a map showing where and how many infected users are present in Bulgaria at a certain point in time.
- The Norwegian Government developed an application (Smittestopp) that will help the health authorities to limit the transmission of coronavirus. Anonymised data about movement patterns in society from the app are used to develop effective infection control measures.

Finally, valuable contributions have come from national space agencies, which launched several initiatives to fund innovative projects to fight COVID-19. Together with ESA, ASI and UKSA launched two separate initiatives, respectively of €10M and £2.6M, for the development of space applications for healthcare and education. On this front, the attention of space actors devoted to COVID-19 has not yet come to an end, with new projects involving more and more private actors and innovative solutions.[5]

---

[2] NASA, Available at: https://earthdata.nasa.gov/COVID19/
[3] NASA, "NASA HARVEST COVID-19 Dashboard COVID-19", Available at: https://harvestportal.org/dashboard/
[4] United Nations Economic and Social Commission for Asia and the Pacific, Lockdown Measure Impacts and COVID-19, (January 2021)
[5] Some examples of recent contracts and initiatives by European space actors: ESA and e-Geos, ESA and Leaf Space, Telespazio and e-Geos, Telespazio and UNIDO, DLR, CNES and its ongoing Observatory of Space Economy.

A year to recover from impacts of the crisis in the space sector

Credit: Freepik

The outbreak and worldwide spread of the COVID-19 crisis left a permanent mark on the year 2020. Started as a public health crisis, a global economic and financial turmoil followed with unprecedented consequences. Through successive contamination waves that still continue in 2021, the COVID-19 crisis has affected policy, economy and society at global and regional levels and impacted most economic and industrial sectors with dreadful consequences on GDP and employment rates.

The space sector was not spared the negative impacts of the pandemic. As other sectors, the space industry has been affected by the crisis and directly suffered the consequences of lockdown measures adopted by governments throughout the World. Across the sector, the activity of space agencies, system manufacturers, launch service providers, satellite operators as well as service companies was disrupted in multiple ways:

- Labour and operations were affected by social distancing measures (e.g., recourse to teleworking), industrial and launch site shutdowns as well as disruptions in the global supply chain.
- Business was impacted by payment delays, orders cancellation and additional costs to implement protection measures that led to a productivity loss.

Examples of reported impacts on public space programmes

Although countries around the globe adopted different sets of measures to respond to the crisis, disruptions were recorded in most countries, affecting several programmes, and leading to various delays. Examples of such reported schedule delays include:

- The James Webb Space Telescope (JWST): A schedule risk assessment in July 2020 prompted managers to add a 7-month delay to the programme, moving the launch readiness date from March 31st to October 31st, 2021.
- The NASA-ISRO Synthetic Aperture Radar (NISAR): ISRO's delivery of its radar to JPL was delayed from August 2020 to February 2021 based on a revised schedule. In addition, NISAR officials have anticipated a 7-month launch readiness date delay from June 2022 to January 2023.
- The Orion Multi-Purpose Crew Vehicle: Impact on the delivery of the second European Service Module is at least 3 months, while Lockheed component supplier delays are likely multiple months.
- The Space Launch System (SLS): 3-month schedule delay for Artemis I. The planned launch is November 2021. In addition, delays will be experienced in critical activities including the Core Stage Green Run testing, software development and integrated testing, qualification testing, and numerous Artemis II and III production activities.[6]
- The ExoMars Rosalind Franklin rover mission: ESA and Roscosmos decided to postpone the launch of the second ExoMars mission to study the Red Planet between August and October 2022.[7]
- Ariane 6 rocket will not launch until the second quarter of 2021 at the earliest, and Vega C is planned to flight for the end of the first quarter in 2021 due to multiple factors, including the pandemic and the anomaly that occurred during the Vega mission in 2020.

[6] NASA, "NASA's Lunar Exploration Program Overview", (September 2020): https://www.nasa.gov/sites/default/files/atoms/files/artemis_plan-20200921.pdf
[7] ESA, "ExoMars to take off for the Red Planet in 2022", (March 2020): https://www.esa.int/Newsroom/Press_Releases/ExoMars_to_take_off_for_the_Red_Planet_in_2022

COVID-19 site and facilities shutdowns occurred in several countries, including European countries, the United States, China, Russia and India (including space agencies and most of the industrial players). Various ESA and NASA facilities were reportedly shutdown. In China as well, some activities were temporarily interrupted, especially those of the Wuhan National Space Industry Base, close to the epicentre of the pandemic's outbreak and home to several launch systems-related activities.

Regarding launch sites, spacefaring nations around the world behaved differently. Based on the NASA Coronavirus Response framework,[8] activities were suspended in March 2020 at NASA´s Michoud Assembly Facility in New Orleans, Louisiana and Stennis Space Center in Hancock County, Mississippi. The Kennedy Space Center in Florida and the Johnson Space Center in Houston operated with all non-essential personnel working from home in Spring 2021. Cape Canaveral Space Force Station, Florida, United States, closed launch viewing site to guests and a public viewing location outside the base gates for several months. The Guiana Space Centre also suspended activities for two months and only resumed operations on May 11th, 2020. Baikonur Cosmodrome, Kazakhstan has operated normally over the past several months.[9] India avoided rocket launches for most of 2020 to cope with new industry requirements, among other effects, and the fist launch of the country occurred in November 2020.

NASA Office of Inspector General released a report on March 31st, 2021, outlining that COVID-caused facility closures, mandatory remote working and disruptions to the materials supply chain had cost NASA almost $3 billion since March 2021. Additional cost impacts are also expected to materialise in subsequent U.S. fiscal years.[10]

Public measures to ensure business continuity

As compared to other industrial sectors, space is probably structurally more resilient thanks to long-term contracts and backlogs that partially mitigate the impact of temporary disruptions. The central role played by public programmes, at least in the upstream segment, also provides some important guarantees through a stable, predictable and sizeable demand. This resilience was further enhanced by the set of measures taken by public institutions to ensure business continuity.

In Europe, which was hit hard by the pandemic, public customers (ESA, EU and its agencies, national space agencies) quickly reacted to the situation and adopted a series of mitigation measures to ensure business continuity by maintaining payment despite programme delays. For example, ESA put forward a detailed plan to streamline and facilitate the procurement approval and the tendering processes, and make partial advanced payments applicable from prime contractors up to sub-contractors and industrial partners. Comparable measures were taken by other European agencies who reportedly received hundreds of requests from industrial suppliers regarding payment plan suspensions and other contractual adjustments to take into account difficulties faced by the companies, from Large Scale Integrators (LSI) to Small and Medium Enterprises (SME). These reactive measures were complemented later on by European and national recovery plans supporting directly or indirectly the space sector.

To help repair the economic and social damage caused by the coronavirus pandemic, the EU agreed on the NextGenerationEU, a €750 billion temporary recovery instrument to help repair the immediate economic and social damage brought about by the coronavirus pandemic. Among it, the Council adopted in February 2021 the regulation establishing the Recovery and Resilience Facility (€672.5 billion), which is the heart of the EU's extraordinary recovery effort.[11] Among the main Eurozone countries, Italy and Spain will be the major beneficiaries of the European funds.

---

[8] NASA, "NASA Response Framework", (May 2020) : https://nasapeople.nasa.gov/coronavirus/nasa_response_framework.pdf
[9] Xihuanet, "Kazakhstan's Baikonur city extends COVID-19 quarantine", (September 2020)
[10] NASA Office of Inspector General, Final Memorandum COVID-19 Impacts on NASA's Major Programs and Projects
[11] European Commission, Recovery Plan Europe

- Italy will finalise and release its national "Recovery and Resilience Plan" in early 2021. The Ministry of Economic Development aims to allocate €12.5 billion for the overall aerospace and defence industry and €1 billion specifically for the space economy.[12]
- France "Relaunch Plan" allocated €500M to the space sector including €365M from the European Recovery plan.

The UK released the Space Sector COVID Support Plan to support the space sector to recover from COVID-19.[13]

In the United States, the Rescue Plan will build on the two massive relief packages approved by the Congress in 2020. The first is a "two-step plan" (the Jobs Plan), which was announced in March 2021 and aims to revitalise a flagging economy and speed up the nation's response to the coronavirus pandemic.[14]

These public measures will likely prevent major financial consequences for public space programmes, at least in the short-term. Industrial delays that cannot be recovered will put pressure on contractors and the longer-term and economic consequences (e.g., fixed costs during activity shutdown) will have to be absorbed at some point either by suppliers or customers.

The situation is different in commercial markets, on which the space sector increasingly depends for its growth. Beyond the impact of the COVID-19 crisis on productivity, revenues and costs, the space sector was also affected by the wider consequences of the crisis for the global economy. Challenges with investment, reduction in sales and manufacturing delays have led several companies to file for bankruptcy. Among them are OneWeb, Intelsat, Speedcast International and Sky & Space Global. Also, Aerial & Maritime (A&M) had to shut down.

Thankfully, the crisis did not entirely hamper major achievements in the space sector in 2020. As operations resumed to some extent from East to West, space programmes and businesses progressed toward important milestones.

Looking back at 2020 from the perspective of the space domain, available indicators show that the resilience of the sector has limits. Ultimately, the COVID-19 crisis will lead to a net deficit for the space sector related to productivity loss, reduced turnover and increased costs that should not be underestimated. The sector may also continue to suffer in the longer-term from other impacts such as deteriorated markets or reduced financing capacities among others. In the long term, the magnitude of business impacts and their ripple effects will depend on multiple factors related to the crisis, to the governmental response and to the wider socio-economic shock. Although the final outcome of the crisis is difficult to anticipate, it is essential to already take stock of the impact suffered by the space sector so far and to take into consideration that it will be weakened by the crisis.

[12] Presidenza dei consigli dei Ministri, "Piano nazionale di ripresa e resilienza", (May 2021): http://www.politicheeuropee.gov.it/it/comunicazione/approfondimenti/pnrr-approfondimento/
[13] Government of the United Kingdom, "COVID-19 support plan: space sector recovery ", (February 2021): https://www.gov.uk/government/publications/covid-19-support-plan-space-sector-recovery
[14] Available at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

1 Policy & Programmes

1.1 Space Policy highlights and trends

1.1.1 European Union sets new ambitions for space

The European Union approved its space programme for the Multiannual Financial Framework 2021-2027, which will be marked by a larger overall budget, the introduction of new activities and ambitions and a more prominent place given to security-related activities.

After more than 2 years of trilateral interinstitutional negotiations at EU level (European Commission, European Parliament, Council of the European Union), the Council and the Parliament, the two legislative bodies of the EU, finalised two essential processes:

- The overall negotiations of the 2021-2027 Multiannual Financial Framework, which defines the budget of the EU for the next 7 years including for the EU space programme
- The Regulation establishing the space programme of the Union and the European Union Agency for the Space Programme

As a result of these developments, the European Union will:

- Create a single space programme grouping together the existing flagship programmes Galileo / EGNOS and Copernicus and two new programme components GOVSATCOM (governmental satellite communications) and SSA (Space Situational Awareness)
- Allocate €14.9 billion (current prices) to the pursuit of objectives associated with the various components:
  - Galileo/EGNOS: €9.01 billion
  - Copernicus: €5.42 billion
  - GOVSATCOM/SSA: €440 million

The EU GNSS Agency, which was mainly responsible for Galileo / EGNOS until now, will be transformed into the EU Agency for the Space Programme in 2021, enlarging its responsibilities to other components of the EU Space Programme.

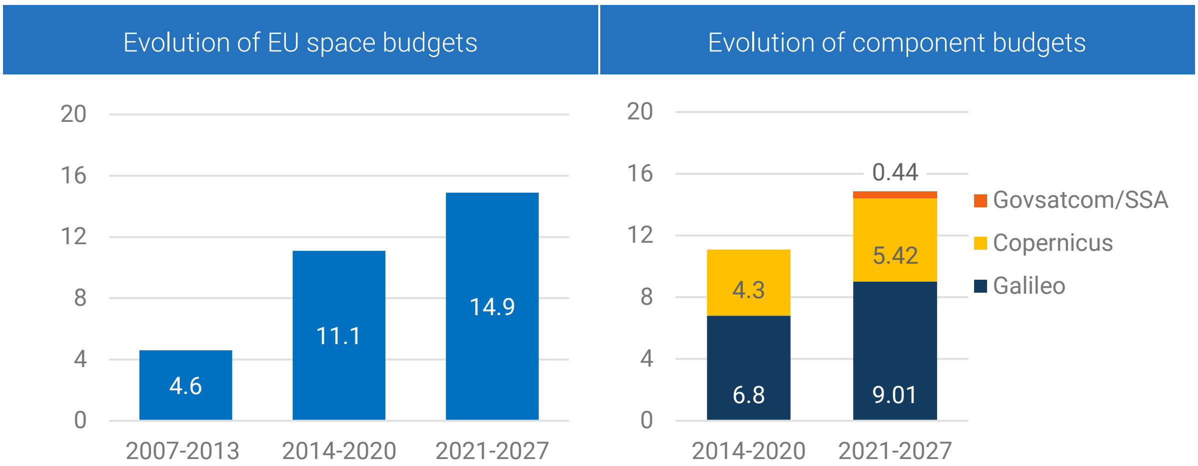


Figure 2: EU space budget keeps growing (figures in € billions, current prices)

Galileo / EGNOS and Copernicus: programmes continue and eye next evolutions

The new MFF 2021-2027 ensures the continuity of flagship programmes Galileo/EGNOS and Copernicus. Major milestones were reached during the MFF 2014-2020: Galileo and Copernicus progressed through the deployment phase of their space components (22 Galileo FOC satellites and Sentinels 1A & 1B, 2A & 2B, 3A & 3B, 5P and 6) and gradually increased user uptake. In 2016, after declaring Early Operational Capability (EOC), Galileo started offering Initial Services, ramping up toward Full Operational Capacity (FOC) in 2021. Copernicus initiated the provision of the remaining of its 6 thematic services (atmosphere, marine, climate change, and security services in addition to land and emergency management services launched in 2012) and continue to provide data under full, free and open data policy principle.

Galileo satellites ready for launch

The increased budgets for Galileo/EGNOS and Copernicus for the new MFF 2021-2027 will provide resources for continuity in operations and infrastructure, enhancement of capabilities, further development of services and a deeper integration of satellite navigation and Earth Observation data in other policy areas and economic sectors. Procurement of 6 new Copernicus missions and 12 Galileo 2nd generation satellites have been conducted in 2020 and early 2021.

SSA and GOVSATCOM: new programme lines towards stronger EU engagement in security and defence matters

While both Galileo and Copernicus offer security applications, the integration of Space Situational Awareness and GOVSATCOM as components of the EU Space Programme (although with smaller budgets) underlines the growing importance of the security and defence dimension of EU engagement in space. SSA and GOVSATCOM will build on activities initiated during the MFF 2014-2020. The next MFF gives both lines of action greater political significance and a long-term vision:

Space Situational Awareness (SSA)	GOVSATCOM
With the objective of monitoring and preventing space hazards, the SSA component will build upon the work by several member states in the 2015-established EU Space Surveillance and Tracking (EUSST) Support Framework and expand the cooperative framework to include new domains and more EU member states. Beyond SST, the SSA component will also include an early-stage EU engagement in space weather and near-Earth objects.	The GOVSATCOM initiative is addressing the need for a secure, guaranteed, and autonomous governmental satellite communications capability for the EU and its Member States. Until 2025, GOVSATCOM will primarily rely on existing capacity, pooling and sharing national assets. Some of the early programme developments (until and throughout 2020) have included major involvement of the European Defence Agency.

Timeline of the negotiation and adoption of the Regulation on the EU Space Programme 2021-2027

The negotiation of the new Regulation establishing the EU Space Programme for the 2021-2027 and EUSPA comprised of a series of institutional and interinstitutional negotiations:

- In June 2018, the European Commission released its original proposal.[15] An opinion on the proposal was released by the European Economic and Social Committee the In October 2018,[16] and by the Committee of the regions in December 2018.[17]
- In December 2018, the European Parliament adopted its version during the plenary proposing several amendments[18] and the Romanian Presidency of the Council of the European was granted a negotiating mandate in the same month.[19]
- In January 2019, the Council reached the first interinstitutional Agreement on a majority of the text (leaving aside mostly budgetary and Brexit provisions). It started negotiation with the European Parliament in the First Trilogue on January 15th, 2019, and subsequently reached a partial interinstitutional agreement in the second Trilogue, on February 26th/ 27th, 2019.[20]
- Following the suggestion by the European Parliament for certain amendments, and the consequential presentation of the updated partial agreement in March 2019,[21] the Romanian Presidency reached a comprehensive Common Understanding with the representatives of the European Parliament on a partial draft in the plenary on April 17th, 2019.[22]
- In November 2020, the European Council agreed on the full text.[23] It received the mandate to negotiate with the European Parliament on November 5th, 2020.
- After a third Trilogue meeting, on December 15th, Council and Parliament negotiators reached a provisional political agreement on the proposed regulation.
- The compromise text was approved by Council's Permanent Representatives Committee on December 18th, 2020.[24]
- In April 2021, the Council and European Parliament formally adopted the regulation. The EU Space Programme entered into force retroactively on 1 January 2021.

[15] European Commission, "Proposal for a Regulation of the European Parliament and of the Council ", (June 2018): https://eur-lex.europa.eu/resource.html?uri=cellar:33f7d93e-6af6-11e8-9483-01aa75ed71a1.0003.03/DOC_1&format=PDF
[16] European Parliament, "Official Journal of the European Union C 62/51", (February 2019): https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018AE2993&from=EN
[17] European Parliament, Opinion of the Committee of the regions on 'The space programme of the European Union and the European Union Agency for the Space Programme' (December 2018): https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52018AR3640
[18] European Parliament, "Establishing the space programme of the Union and European Union Agency for the Space Programme ***I", (November 2019): https://www.europarl.europa.eu/doceo/document/TA-8-2018-0520_EN.html
[19] European Parliament, Interinstitutional File: 2018/0236(COD) 15490/18, (December 2018)
[20] European Parliament, "LEGISLATIVE TRAIN 12.2020", (December 2020) : https://www.europarl.europa.eu/legislative-train/api/stages/report/current/theme/new-boost-for-jobs-growth-and-investment/file/mff-eu-space-programme
[21] European Council, "EU shapes its future space policy programme", (March 2019) : https://www.consilium.europa.eu/en/press/press-releases/2019/03/13/eu-shapes-its-future-space-policy-programme/
[22] European Parliament, "Interinstitutional File: 2018/0236(COD) 7481/19 COR 1", (April 2019): https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_7481_2019_COR_1&from=EN
[23] European Parliament, "Interinstitutional File: 2018/0236(COD) 12594/20", (November 2020): https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_12594_2020_INIT&from=EN
[24] European Council, "Interinstitutional File: 2018/0236(COD) 14200/20", (December 2020): https://www.consilium.europa.eu/media/47672/st14200-en20.pdf

Timeline of the negotiation and adoption of the EU space budget

The final figure of the 2021-2027 EU space budget is somewhat lower compared to what the European Commission had initially proposed in June 2018. The impact of Brexit and of the COVID-19 crisis contributed to this reduction. The initial proposal of €14.2 billion and the 2020 approval of €13.2 billion in constant prices correspond respectively to €16 and €14.9 billion in current prices.[25]

The figure below illustrates the budgetary evolution in both constant and current prices.

Figure 1: Evolution of the EU Space Programme budget 2021-2027 (Source: adapted EP data[26])

While the final revised budget remains lower than the original proposal, the overall space envelope still represents a €3.8 billion increase compared to the previous MFF 2014-2020 (€11.1 billion, current). This highlights a 36% increase of the space envelope compared to the previous MFF. The share of the space

[25] European Commission, "Space policy and activities beyond 2020: the new EU space programme at a glance", (June 2018)
[26] European Parliament, "Visualising the proposed European Union 2021 2027 multiannual financial framework and the recovery instrument (Next Generation EU)", (November 2020)

budget in proportion to the entire MFF envelope has also increased: the revised 2020 space budget represents 1.2% of the total MFF while space represented only 1% of the total MFF budget for 2014-2020.

Other EU financial instruments for space and new European Commission's space initiatives

The EU Space Programme and its related budgetary allocation do not encompass all EU activities in the space sector. Other EU programmes and funds support strategic objectives such as technology non-dependence, innovation, security and defence or, more recently, support to private space investment. The support to space initiatives is incorporated most notably in the three instruments:

- Horizon Europe will follow Horizon 2020 as the new EU Framework Programme for Research & Innovation. The overall financial envelope for Horizon Europe has been set to €95.5 billion (current prices). Its support to space technologies and applications, primarily within the Cluster 4 "Digital, Industry and Space", is thematically linked to the EU Space programme (development of Copernicus and Galileo services, SSA and GOVSATCOM-related activities…) and to other strategic innovation areas (reusable launchers, European technology non-dependence, space science…).
- The European Defence Fund (EDF) will contribute to the implementation of growing EU's ambition in security and defence The EDF formally launches in 2021 with a €7 billion budget over 7 years.[27] It is, above else, an industrial programme, providing funding for both early-stage research and late-stage capability development and acquisition. The EDF will likely build upon space-themed projects supported by its precursor, the European defence industrial development programme (EDIDP) and would provide co-funding opportunities for Permanent Structured Cooperation (PESCO) projects, some of which focus on space defence capabilities as well.

► *More about EDIDP and PESCO space-related projects in section 1.1.3*

- The InvestEU programme will be the Union's chief investment instrument aimed to foster innovation and facilitate access to funding. InvestEU will aim to mobilise more than €400 billion through EU budgetary guarantee of around €26 billion.[28] It will bring under a single roof various concurrent investment tools, including the European Fund for Strategic Investments (EFSI) and the InnovFin Equity programme. EU commissioner Thierry Breton has also signalled plans to establish €1 billion European Space Fund, to help EU start-ups and SMEs to raise investment.[29]

► *More about the EU support to private investment in 2020 in section 1.1.5*

Throughout 2020, the European Commission unveiled several additional initiatives in the space domain.

Commissioner Thierry Breton and industrial stakeholders have expressed their interest in moving forward with the development of a "new integrated, secure and autonomous space connectivity system". A consortium of European companies (gathering major actors for a unique bid) was awarded a €7.1million contract in December 2020 to execute the first study.[30] This initiative will build on the GOVSATCOM component of the EU Space Programme and include the development of a new multi-orbit connectivity system to complement GOVSATCOM preliminary services. It would also promote innovative quantum cryptography technologies in relation with the Quantum Communication Infrastructure initiative.

[27] Science Magazine, "Europe hopes new R&D fund will boost meager defense capabilities and create opportunities for science", (December 2020)
[28] Europost, "EU negotiators strike a deal on InvestEU Fund", (December 2020)
[29] European Commission, "Enhancing Europe's Space Power" (December 2020): https://ec.europa.eu/commission/commissioners/2019-2024/breton/blog/enhancing-europes-space-power_en
[30] ESPI, "About a new European multi-orbit connectivity system (ESPI Briefs 47)" (February 2021): https://espi.or.at/news/espi-brief-47-about-a-new-european-multi-orbit-connectivity-system

Thierry Breton expressed on multiple occasions also additional Commission areas of focus, such as Space Traffic Management, autonomous access to space with new generation of launchers (including reusable vehicles) or innovative support to space entrepreneurship.[31]

Concerning Space Traffic Management, two projects[32,33] under the Horizon 2020 programme were formed in 2020, gathering large consortia of European industry, institutional and academic stakeholders with the objective to investigates the way forward for Europe in the increasingly important sphere of STM. With regards to space entrepreneurship, the CASSINI initiative was launched under the management of DG DEFIS. Intended to increase the number and improve the market penetration of space- start-ups, it consolidates existing initiatives as well as envisages new ones, covering the entire entrepreneurial cycle.[34]

10th EU-ESA Space Council

On November 20th, the 10th EU-ESA Space Council took place for the 2nd year in a row, under the German Presidency of the EU Council and the Portuguese and French co-chairs of the ESA Council. The meeting built upon the EU Council conclusions focused on establishing key principles for the European positioning into the global space economy.[35] The EU Council, under the German presidency, set European objectives to enhance of competitiveness, foster European security, resilience and autonomy in space, as well as recovery from the COVID-19 crisis.

Although a joint declaration after the 10th EU-ESA Space Council has not been published, EU and ESA representatives outlined some significant key messages in the press conference: [36]

- Europe must maintain its role as leading space power in a fast-changing environment, retaining that this role is built on large collective effort and through a solid budget, capable to assure the support and expansion of Copernicus and Galileo.
- To remain a global space power, Europe has to engage with new challenges, such as building an STM framework, and launching new flagship project, namely a European constellation for communications, and combine the institutional nature with commercial feasibility and success.
- Strengthen the access to market, leveraging the strong contributions that could come from start-ups, as well as the attraction of private investments; enhancing the coordination of public and private funding schemes; and fostering new markets uptake of downstream products in non-space sectors.
- Consolidate autonomy in the access to space, a field where the European representatives have multiple visions that could eventually contribute to achieve different goals (e.g. reinforcement of the Guyana Space Centre, democratisation of access to space, new launcher portfolio…).

---

[31] Thierry Breton, "Enhancing Europe's Space Power", (December 2020): https://linkedin.com/pulse/enhancing-europes-space-power-thierry-breton/
[32] European Commission, "Space Traffic Management for Xxi Century Space Operations", (January 2021): https://cordis.europa.eu/project/id/101004319
[33] European Commission, "European Ways Forward for Space Traffic Management", (January 2021): https://cordis.europa.eu/project/id/101004208
[34] European Commission, "Cassini", (March 2021): https://ec.europa.eu/defence-industry-space/eu-space-policy/space-research-and-innovation/cassini_en
[35] European Council, "Key principles for the global space economy: EU Council adopts conclusions", (November 2020): https://www.consilium.europa eu/en/press/press-releases/2020/11/11/key-principles-for-the-global-space-economy-eu-council-adopts-conclusions/
[36] European Council, Video conference of space ministers, 20 November 2020: https://www.consilium.europa.eu/en/media-galleries/compet/2020-11-20-compet/?slide=0

About the involvement of the United Kingdom in the EU Space Programme after Brexit

The UK's departure from the EU, effective January 1, 2021, impacts UK involvement in the components of the EU Space Programme, to which the UK already participated. According to the post-Brexit "EU-UK Trade and Cooperation Agreement" reached late December 2020:[37]

- The UK no longer participates in Galileo and EGNOS programmes. The UK will not have access to the encrypted Galileo Public Regulated Service and cannot play any part in the development of Galileo or EGNOS. UK entities will, however, be able to use the 'open' signal to develop products and services for consumers and can use the open PNT services provided by Galileo and EGNOS. EU subsidiaries of UK businesses are eligible to bid for future work on the EU GNSS programmes.
- The UK's participation in the Copernicus programme will continue, pending a further agreement to be worked out in 2021. As Copernicus is not fully funded solely by the EU and the UK remains an ESA Member State, under all circumstances, the UK will continue to participate in the Copernicus Space Component (CSC-4) of the Copernicus programme through ESA.
- While UK users can continue to access EU Space Surveillance and Tracking services, the UK is no longer eligible to participate in the EU SST programme, contribute to providing operational services or take part in the scientific and technical groups that make up the programme.

UK memberships in EUMETSAT and ECMWF remain unaffected by Brexit.

[37] Government of the United Kingdom, UK involvement in the EU Space Programme, (December 2020): https://www.gov.uk/guidance/uk-involvement-in-the-eu-space-programme

1.1.2 Changes in European institutional space leadership

On December 17th, ESA Member States endorsed the appointment of Josef Aschbacher as the next ESA Director-General (DG)[38], after he was nominated by ESA Member States on November 26th. Dr Aschbacher, who is an Austrian national, served as Director of Earth Observation Programmes (D/EOP) and Head of ESRIN since 2016. He will commence his new role from July 2021, succeeding Jan Wörner.[39] Mr. Wörner was elected ESA DG in December 2014 and extended for additional two years in 2018.

Figure 1: Timeline of ESA Director-Generals (Credits: ESA)

Roles and responsibilities of ESA Director-General

ESA DG is one of the two organs of ESA, the other being the Council. Whilst the ESA Council is the representative body of the Member States, the DG is the CEO of the Agency and its legal representative. DG's responsibilities include taking "all measures necessary for the management of the Agency, the execution of its programmes, the implementation of its policy and the fulfilment of its purpose, in accordance with the directives issued by the Council" (article 2, ESA Convention). The DG should execute his or her responsibilities in an efficient and industry-supportive manner.

The process of ESA DG election

In February 2020, Jan Wörner announced he would step down from his position in July 2021. ESA released the vacancy notice for the DG position in June 2020,[40] followed by a five-month recruitment

[38] ESA, "N° 32–2020: ESA Council appoints Josef Aschbacher as next ESA Director General", (December 2020): https://www.esa.int/Newsroom/Press_Releases/ESA_Council_appoints_Josef_Aschbacher_as_next_ESA_Director_General
[39] ESA, "ESA group nominates Josef Aschbacher as next ESA Director-General; ratification vote set for Dec. 16-17", (November 2020): https://www.spaceintelreport.com/esa-group-nominates-josef-aschbacher-as-next-esa-director-general-ratification-vote-set-for-dec-16-17/
[40] ESA, "Vacancy for the post of ESA Director General" (June 2020): https://www.esa.int/About_Us/Careers_at_ESA/Vacancy_for_the_post_of_ESA_Director_General

process, managed by a committee led by Anna Rathsman of Sweden, chairman of ESA's Council and DG of Rymdstyrelsen, the Swedish National Space Agency. ESA DG must be nominated by 2/3 of all ESA Member States. The ESA DG is appointed by the Council, with each Member State, voting with one vote.

While there was no public information regarding the total number of candidates, some media reported that shortlisted applicants included Simonetta Di Pippo (Director of UNOOSA), Pedro Duque (Spanish minister of science, innovation and universities and former astronaut), Roberto Battiston (former head of ASI), Jean-Yves Le Gal (president of CNES) or Christian Hauglie-Hanssen (Director General of Norwegian Space Agency).

The three finalists, Hauglie-Hanssen from Norway, Duque from Spain, and Aschbacher from Austria were communicated to ESA Member States on November 24th. Josef Aschbacher received the majority support in an ESA-internal vote. Subsequently, the selection was ratified by the ESA Council in a second meeting on December 17th (also requiring a two-thirds majority).

In the press conference in after he was confirmed, Josef Aschbaher outlined his three priorities for ESA under his mandate as Director-General:[41]

- better defining ESA's relationship with the European Union,
- commercialisation and better promoting the growth of the European space industry, and
- efficiency of ESA itself, minimizing the cost of agency operations.

Other changes in institutional space leadership in Europe

In addition to the selection of the new ESA DG, important leadership changes took place also in other European institutional bodies dealing with space activities

- The EU GNSS Agency Administrative Board elected Rodrigo da Costa as the new Executive Director of the Agency for the next 5 years.[42]
- The Council of EUMETSAT appointed Philip Evans as a new Director-General. He will succeed Alain Ratier, in a mandate that will start on January 1st, 2021 for a five-year term.[43]
- François Arbault was appointed as the new Deputy Director-General for Defence, Industry and Space (DG DEFIS), replacing Pierre Delsaux, who moved to DG for Health and Food Safety (SANTE).[44]
- Ekaterini Kavvada was appointed as the new Director for Development and Innovation in DG DEFIS.[45]

In addition, two European trade associations dealing with space appointed in 2020 new presidents:

- Alessandro Profumo of Leonardo was appointed as President of the Aerospace and Defence Industries Association of Europe (ASD).[46]
- Eurospace appointed André-Hubert Roussel of ArianeGroup as President[47]

[41] Space News, "New ESA director general sees EU relations and commercialization as priorities", (December 2020)
[42] "European GNSS Agency, "New Executive Director of the European GNSS Agency takes up office", (October 2020): https://www.gsa.europa.eu/newsroom/news/new-executive-director-european-gnss-agency-takes-office
[43] Eumetsat, "EUMETSAT Council appoints Philip Evans as next Director-General", (November 2020): https://www.eumetsat.int/eumetsat-council-appoints-philip-evans-next-director-general
[44] "Keep track of developments in the European institutions and public affairs with our Movers and Shakers column" (November 2020): https://www.theparliamentmagazine.eu/news/article/movers-and-shakers-27-november-2020
[45] Ibid.
[46] AeroSpace and Defence Industries Association of Europe, "Alessandro Profumo elected new President of ASD", (September 2020)
[47] Eurospace, "André-Hubert Roussel appointed president of eurospace", (June 2020)

ESPI interview with Jan Wörner, ESA Director-General from July 2015 to February 2021

You have reached the end of your 6-year term as Director General of the European Space Agency. Among the many activities that you have managed over this period of time, what would you like to be reminded as your greatest achievements?

I would not highlight one specific mission among the wide range of space activities conducted by ESA during my time. Space missions usually develop in a timeframe that exceeds the mandate of a Director General. Major missions are fundamentally the outcome of a collective effort and the merit belongs to all those who contribute.

During my time in the office, I paid my best efforts to provide ESA with a particular and recognisable narrative. This is actually more difficult that it seems at first glance. I do not believe for instance that an agency like ESA should communicate only on its missions. It needs an overarching story to tell, that I tried to elaborate through a number of concepts that I put forward, like the United Space in Europe in order to reflect the plurality of European stakeholders interacting with us.

When you talk about NASA, people immediately think about landing on the Moon or the ISS. It is not that straightforward for ESA yet. Our 4 programmatic pillars – Science & Exploration, Safety & Security, Applications and Enabling & Support – serve this purpose and are equally important in this respect. But ESA's destinations are also part of this narrative. What I mean here is Society since space positively fosters knowledge and communication, I mean Economy since ESA contributes to building up a stronger European industry, and I mean Environment because our activities advance both the climate change efforts as well as sustainability on Earth or in orbit.

And would you have any regrets, objectives that you didn't have the means to fulfil or things that you would retrospectively have preferred to do differently?

First on a personal note, my biggest shortcoming certainly is my lack of diplomacy. I usually make a point of saying what I believe is right and it is my conviction that this is the right thing to do for a Director General. Actually, I am neither a professional diplomat nor a politician and many might concur on this.

Second, I was probably too naïve. I do not fundamentally believe in the need for stringent rules and regulations to frame each and every of our activities. However, when they exist I abide to them and I would expect others to act similarly. As far as ESA is concerned, our Convention is an international treaty remarkably well conceived, but I am quite upset when some of its provisions, in particular related to European space policy, are not followed. This is also the case for optional programmes, in which by default each member State should be automatically involved unless it specifically denies. Currently, it is implemented the other way around.

Speaking about the ESA Convention, you stressed its outstanding relevance in many respects. However, a lot of things have changed in both European and global space sectors since its inception in the 1970s. Is it still appropriate in the current setup or do think it should be revisited anytime soon?

The basic text of the Convention, most notably in its first parts, is a masterpiece of law. There are some more questionable parts, e.g., the integration of national activities into ESA, that will probably never fully materialise. This might be used to make the case for at least a partial revision. Overall, I do not believe we should open this pandora box. Beyond the necessary convergence of delegations, which is a challenge in itself, this would also imply to get back to 22 national parliaments to ratify it again. I do not think it is realistic, and even worth the hassle to make just what I consider as slight adjustments. Even worse, there are outstanding parts in the ESA Convention that could get lost in the process… The beauty of the Convention lies in the strict focus on the fundamentals. Let's not take the risk to spoil this with unnecessary details.

Another example is the geo-return principle, which is extremely important. It is regularly challenged as being against fair competition. I disagree with this. As a matter of fact, geo-return not only allows but it stimulates competition. Through the geo-return principle, all ESA member states have the possibility to build-up national space technological and industrial skills and become part of bigger space missions, thus improving competitiveness of their industries. Without the geo-return rules, ESA would actually have less member States and more monopolistic structures, which is in fact contrary to open and fair competition. ESA is thus fostering competitiveness and improves these aspects also from the EU standpoint.

Last but not least, one of jewels enshrined in the Convention is ESA's Space Science programme in itself. It would most likely not come again if we revisit the Convention. Thanks to its mandatory nature, it is driven by scientists, not by politicians and benefits of a protective fence around it. I would like to see space exploration as well, to be controlled by people genuinely involved in the extension of our knowledge of the solar system.

What are your prospects regarding medium-term ambitions of ESA Member States in space exploration?

I would say - and this might also apply to some other ESA programmes - that a major driving factor is most often industrial policy. I think it would be smart for the Agency to find a way to bring more expert voices to national ESA Council delegations in addition to financial, legal and political arguments. This certainly is one of the suggestions I would like to make for the future.

During your time in the office, would you say that the Agency has benefited of a form of competition between Member States concerning subscriptions to programmes?

It is true that there have been some oversubscription issues occasionally when two Member States were bickering for leadership. Interestingly, the Convention actually provides recommendations on how to handle such situation, stating that Member States' contributions should be commensurate to their GNPs. I ambitioned and achieved to reach a balanced approach in such cases, and it remains an outstanding task to be handled on a case-by-case basis by the Director General.

As the global space sector continues to transform, what do you think will be the consequences for Europe and how should ESA anticipate these?

When I joined the DLR back in 2007, I produced a slide showing the evolution of the respective contributions of public and private actors or commercial entities to various space activities. There was already a significant shift at that time and this trend has just been steadily continuing. However, I am convinced that activities such as basics of science and exploration as well as all security-related efforts will remain mostly conducted by public actors. The rest will gradually move towards commercial rationales. This will obviously impact agencies in general and ESA in particular. For ESA, there are 5 different key positions that the Agency must be able to accommodate in the framework of such shift:

1) To continue to assume the traditional responsibilities of a Space agency as in the past,
2) To remain a capable and reliable partner of industry (PPPs) as we currently are in several domains,
3) To behave as a competent and responsible customer for all service-oriented procurements such as ADRIOS,
4) To enable the growth of the private sector and space capabilities in particular in smaller countries,
5) To act as a broker – combining different actors with different competences together.

At the moment, Europe is doing very well in space and for much less money than some other actors. What we lack is a greater acceptance of failure and in this respect, we could be get some inspiration from recent developments in particular in the United States.

Is there any concluding message you would like to convey?

Space is an important instrument to bridge earthly crises and ESA has the potential to play an important role for European spirit. ESA is an instrument for a positive change to help us behave European in a global world of competition and cooperation.

1.1.3 Space defence and security agendas unfolding new governance and capabilities

Following major developments in 2019 in the space defence domain, year 2020 continued this trend and confirmed the growing security dimension of space activities.

In its previous iteration, the ESPI Yearbook put a particular spotlight on space defence, underlining that 2019 was a landmark year in the space defence domain confirming a change of paradigm in the approach of various spacefaring nations and intergovernmental organisations. This change of paradigm includes:

- adaptation of doctrines to address space as an operational war faring domain alongside land, air and sea
- reorganisation of armed forces to better address and integrate the space domain
- growing development of counterspace capabilities to damage, disrupt or destroy space systems
- new approach to innovation through improved and more efficient R&D and acquisition mechanisms

Developments in the space-defence conundrum in 2020 confirmed these trends and included primarily governance reorganisations and advancements achieved in capabilities build-up.

USA: Progress on multiple fronts

A new U.S. Defense Space Strategy (DSS)[48] was unveiled on June 17th as an update of the National Security Space Strategy from 2011. The U.S. DSS aims to address an increasingly competitive and threatening space environment and improve the DoD "spacepower capacity to ensure space superiority". The new U.S. DSS is a new step in the reorganisation of the U.S. military approach to space called by the Trump administration, which culminated in 2019 with the creation of the U.S. Space Force (USSF), the U.S. Space Command (USSPACECOM) and the Space Development Agency (SDA). The new DSS identifies:

Three high-level objectives	Four lines of effort (LOEs) to achieve the desired objectives
1. Maintain space superiority 2. Provide space support to national, joint and combined operations 3. Ensure space stability	1. Build a comprehensive military advantage in space 2. Integrate military spacepower into national, joint and combined operations 3. Shape the strategic environment 4. Cooperate with allies, partners, industry, and other U.S. Government departments and agencies

Table 1: Priorities of the new U.S. Defense Space Strategy

Overall, the U.S. DSS largely draws on the 2011 National Security Space Strategy even though priorities have been reorganised and that two elements stand out: the U.S. DSS is more assertive and puts a more prominent emphasis on operations in space.

In the close domain of space security, the White House also released Space Policy Directive 5 (SPD-5) on September 4th, which lays down the foundation of a consolidated U.S. approach to cybersecurity in space by establishing principles and guidelines.[49] SPD-5 establishes five core principles to safeguard space assets and critical infrastructure, ensuring cybersecurity best practices are followed for the full satellite life cycle, from design to mission operation. Ultimately, SPD-5 brings the issue of Cybersecurity higher in the U.S. space policy agenda, underlining that it is poised to become a central issue for the sector.

[48] U.S Department of Defense, "Defense Space Strategy Summary", (June 2020) https://media.defense.gov/2020/Jun/17/2002317391/-1/-1/1/2020_DEFENSE_SPACE_STRATEGY_SUMMARY.PDF
[49] White House, "Space Policy Directive 5", (September 2020): https://www.whitehouse.gov/wp-content/uploads/2020/09/2020SPD5.mem_.pdf

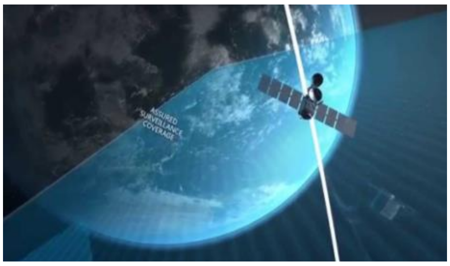
In the newly established U.S. Space Force, various processes moved ahead. On July 10th, the U.S. Space Force released its first doctrine, the Space Capstone Publication (SCP), called "Spacepower" [50] which establishes spacepower as a vital element for U.S. prosperity and security, and a distinct form of military power. The new doctrine points out that the success of the Space Force depends on its ability to coordinate strategy and operations with other U.S. military services and international allies. It identifies three "Cornerstone Responsibilities of Military Space Forces":

U.S. Space Force seal (Credit: U.S. Space Force)

- preserve freedom of action
- enable join lethality and effectiveness and
- provide independent options

The document is divided in five sections describing the key competencies of the Space Force: space security, combat power projection, space mobility and logistics, information mobility, and space domain awareness.

Another major topic for the U.S. Space Force in 2020 was the preparation of a reform of acquisition of space systems. Being part of the larger Congressional push to speed up technological innovation in the U.S. national security community, the space acquisition reform moved without a major milestone in 2020. The FY 2021 National Defense Authorisation Act directed the Department of the Air Force to report back by May 15th, 2021with recommendations specifically tailored for acquisition of space systems.[51] In September, the Space Force made its first foreign deployment, stationing a squadron of 20 space operators in Qatar. Analysts stated its mission is likely to focus on Iran's as missile programme and counterspace capabilities.[52]



U.S. Space Fence surveillance capability is based on generating narrow fan-shaped beams that detect objects passing through (Credit: Lockheed Martin)

With regards to new capabilities, the U.S. Space Force formally declared the initial operational capability and operational acceptance of the Space Fence radar system on March 27th.[53] The system is located on the Marshall Islands in the Pacific Ocean and was developed by Lockheed Martin for around USD 1.5 billion reportedly. The U.S. Space Fence provides significantly improved space surveillance capabilities. Once fully operational, it should dramatically increase the amount of catalogued anthropogenic space objects in the U.S. catalogue.

The Space Development Agency (SDA) also progressed on the development of new capabilities. It began with the implementation of the National Defense Space Architecture (NDSA) initiative by procuring first batches of satellites for the multi-layered "resilient military sensing and data transport capability" in Low Earth Orbit.[54] SDA plans to launch the first 28 satellites (Tranche 0 constellation of "transport" and "tracking" satellites) in 2022.[55]

---

[50] United States Space Force, "Space Power. Doctrine for Space Forces", (June 2020) https://www.spaceforce.mil/Portals/1/Space Capstone Publication_10 Aug 2020.pdf
[51] SpaceNews, "On National Security | Space acquisition reform awaits Biden's Pentagon team", (December 2020)
[52] Middle East Monitor, "US Space Force makes first foreign deployment to Qatar", (September 2020)
[53] United States Space Force, "USSF announces initial operational capability and operational acceptance of Space Fence", (March 2020)
[54] GOVCONWIRE, "SDA Issues Launch Services Solicitation for Space Defense Architecture Program", (October 2020)
[55] Ibid.

Japan: New Space Defence Unit in the Air Self-Defense Force

The year 2020 has marked a significant acceleration in the process of "normalization" of Japan´s strategic posture in space. Within the 2020 Basic Space Plan, officially enacted on 30 June 2020, the government of Japan defined three major security-related objectives, namely, to:

- strengthen the utilization of space to support Japan's national security: The Basic Space Plan calls for effectively enhancing and using various space-based assets and functions, including information gathering, surveillance, early warning, military communications and security-relevant navigation, positioning and timing services for a variety of defense purposes.
- promote a stable and sustainable use of outer space: Within the 2020 Basic Space Plan, this specific objective gain even more prominence as compared to the other national interests.
- ensure superiority in space: The Basic Space Plan 2020 specifies the objective to "ensure superiority in use of space at all stages from peacetime to armed contingencies". The document also outlines that to achieve this objective the Self Defence Forces will "work to strengthen its mission assurance capability and capability to disrupt opponent's command, control, communications and information".

These objectives were further reiterated in the annual defense white paper, which emphasised the need to continue acquiring offensive and defensive capabilities involving the space domain.

In order to meet the superiority objective and be able to deter threats, a reorganisation of military space activities has been nonetheless implemented. Specifically, on May 18th, Japan officially launched the Space Operations Squadron[56], which operates as part of Japan's Air Self-Defense Force. Located at Tokyo's Fuchu Air Base and with an initial staff of twenty officers, the Squadron will be responsible for SSA operations to protect Japanese satellites and monitor space debris and will cooperate in this domain with JAXA, the U.S. Space Command and the U.S. Department of Defense. The unit should be fully operational in 2023 with approx. 100 members.[57]

Russia: Suspicious orbital activity and missile tests under international spotlight

Out of 17 Russian space launches in 2020, 5 missions carried military payloads, including two navigation satellites of the Glonass constellation, a military communications satellite Meridian-M and an early warning spacecraft Kupol.[58]

While no breakthrough organisational or policy developments in the Russian military space were reported in 2020, western observers, namely the U.S. and UK armed forces but also some international exports, pointed out to three different Russian actions as probable non-destructive tests of anti-satellite capabilities. On July 15th the U.S. Space Surveillance Network of radar and telescopes tracked the deployment of a secondary payload into orbit from the Russian Cosmos 2543 satellite.[59] The object was unusually deployed near another Russian satellite at a high relative speed. The manoeuvre has been classified by the U.S. Space Command as a non-destructive anti-satellite test. According to the U.S. Space Command, in April and December Russia also tested twice a Direct-Ascent ASAT system from Plesetsk.[60,61] The missiles did not hit any objects in Low Earth Orbit.

[56] The Japan Times, "Japan's new space squadron takes a giant leap forward", (June 2020)
[57] East Asia Forum, "Japan's space defence policy charts its own course", (January 2021): https://www.eastasiaforum.org/2021/01/18/japans-space-defence-policy-charts-its-own-course/
[58] ESPI Launch Database
[59] U.S Space Command, "Russia tests direct-ascent anti-satellite missile", (April 2020) https://www.spacecom.mil/MEDIA/NEWS-ARTICLES/Article/2151611/russia-tests-direct-ascent-anti-satellite-missile/
[60] SpaceWatch.Global, "Russia Tests PL-19 Nudol Direct-Ascent ASAT System", (April 2020)
[61] U.S Space Command, "Russia tests direct-ascent anti-satellite missile", (December 2020) https://www.spacecom.mil/News/Article-Display/Article/2448334/russia-tests-direct-ascent-anti-satellite-missile/

Growing European Union involvement in security and defence and synergies with space

In June, more than €70 million were provided to four new space-related initiatives in a European Defence Fund (EDF) precursor; the European Defence Industrial Development programme (EDIDP):[62]

- GEODE (Galileo for EU Defence) to develop Galileo PRS receiver capabilities
- PEONEER (Persistent EO for for actioNable intElligence survEillance and Reconnaissance) to develop a software platform for automated interpretation of satellite and other sources data,
- OPTISSE (Very high-resolution OPTIcal payload for Small Satellites for defencE applications) to develop multiple EO small satellites payload,
- ESC2 (European Strategic Command and Control System) to develop an interoperable C2 system,

Earlier, in April, new EDIDP calls for proposals on SSA and early warning capabilities were issued:[63]

- SSAEW-SC2-2020 – Advanced Space Command and Control (SC2) capability to process and exploit SSA data generated from sensors and catalogues to provide a complete space picture,
- SSAEW-SSAS-2020 – Enhanced SSA sensors for accurate identification and characterization of existing Geostationary Earth Orbit (GEO) and Low Earth Orbit (LEO) public and private assets,
- SSAEW-EW-2020 – Early warning against ballistic missile threats through initial detection and tracking of ballistic missiles before handing over to ground based radars.

From the “Space for Security” standpoint, another EDIDP call, titled “MSC-MFC-2020” aims to develop multifunctional capabilities, including space-based surveillance, to enhance the maritime awareness[64]

Permanent Structured Cooperation (PESCO) and Preparatory Action on Defence Research (PADR), frameworks have also been recently used for space capabilities development. This includes PESCO projects focusing on development of EU military PNT capabilities (“EURAS”), military space awareness (“EU-SSA-N”) and space early warning and interception (“TWISTER”). The PADRis supporting R&D projects for quantum secure communication and navigation, through the Quantaquest project and a defence positioning system in GNSS denied areas through the Optimise project.[65]

In October, the European Commission has also launched the H2020 7Shield project (Safety and Security Standards of Space Systems, ground Segments and Satellite data assets) or the development of services and technologies protecting the ground segment (maximum EU contributions €6.9M).[66]

In February 2021, the European Commission presented its Action Plan on Synergies between civil, defence and space industries[67] with three headline objectives: to enhance the complementarity between relevant EU programmes and instruments (‘synergies’), to promote that EU funding for space and defence-related R&D benefits European citizens (‘spin-offs’) and to facilitate the use of civil research and innovation in European defence projects (‘spin-ins’). As part of the Action plan, the European Commission has launched three flagship projects on space traffic management, space-based global secure communications system and EU drone technologies. The publication of the Action plan follows the

---

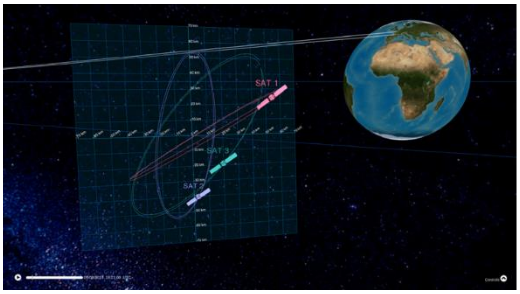
[62] European Commission, “European Defence Industry - results of the calls”, (June 2020): https://ec.europa.eu/info/publications/european-defence-industry-results-calls_cs
[63] European Commission, “European Defence Industrial Development Programme (EDIDP) 2020 calls for proposals, conditions for the calls and annexe”, (May 2020): https://ec.europa.eu/research/participants/data/ref/other_eu_prog/edidp/wp-call/edidp_call-texts-2020_en.pdf
[64] Ibid.
[65] European Parliament, “The European space sector as an enabler of EU strategic autonomy”, (December 2020): https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/653620/EXPO_IDA(2020)653620_EN.pdf
[66] European Commission, Project desription (October 2020): https://cordis.europa.eu/project/id/883284
[67] European Commission, “Action plan on synergies between civil,defence and space industries”, (February 2021): https://ec.europa.eu/info/sites/default/files/action_plan_on_synergies_en_1.pdf

rapprochement between defence and space under the umbrella of the new Directorate General for Defence Industry and Space (DG DEFIS), which was officially formed on January 1st 2020.

France: New French Air and Space Force

On September 11th 2020, the French Armée de l'Air was renamed into Armée de l'Air & de l'Espace.[68] The name change is part of a broader reorganisation of the French armed forces, which elevates the role of space in national security matters. It follows the establishment of the French Space Command in September 2019, which is expected to reach full operational capability in 2025.

In 2020, the French Space Command expanded its sources of SSA information by subscribing to WeTrack™, a global network of radio-frequency (RF) sensors designed, owned and operated by Safran Data Systems.[69]



Safran's WeTrack service (Credit: Safran)

A parliamentary report issued in October also revealed progress in developing and using ground- and space-based systems to detect and disable foreign satellites conducting proximity operations with France's military space assets.[70]

This is a direct reaction to the suspicious operations conducted by the Russian Luch (Olymp-K) spacecraft in close vicinity of the French-Italian Athena-Fidus satellite that French Defence Minister, Florence Parly, had publicly denounced in 2018.[71] A demonstrator in development for this "patrolling" mission named Yoda will consist of two nanosatellites, each weighing 10-20kg, which will operate in geostationary orbit. The programme benefits from a significant CNES involvement and its expertise in the ANGELS nanosatellite initiative.[72]

In March 2021, the 2019-created French Space Command launched its first military space exercise, called ASTERX. with the objective assess to France's current capacity to protect its space assets and to monitor an increasingly militarized space. The US Space Force and the German Space Situational Awareness Centre participated to the ASTERX exercise.[73]

Germany: Inauguration of GESTRA space radar and a new Space Operations Center

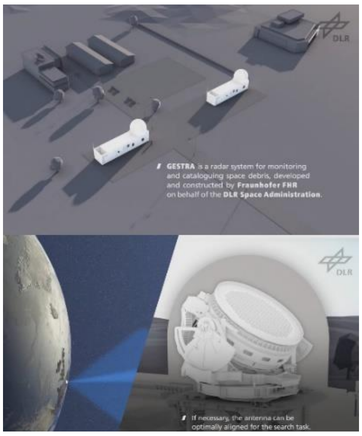
On October 13th, the German Experimental Space Surveillance and Tracking Radar (GESTRA) began operations.[74] It is Germany's first space radar system. It is designed to be transportable, and the data collected will be sent to the German Space Situational Awareness Centre (GSSAC), which is jointly operated by the DLR Space Administration and the German Air Force. At the European level, GESTRA will be involved in the EU SST Support Framework.

On September 21st, the Defence Minister Annegret Kramp-Karrenbauer opened the Air and Space Operations Centre (ASOC).[75] Operated by the Air Force, the facility is expected to be operational by spring

[68] Ministère des Armées, "Armée de l'Air et de l'Espace, Le logo", (September 2020) https://www.defense.gouv.fr/air/dossiers/armee-de-l-air-et-de-l-espace/le-logo
[69] Jack Richardson, "French Space Command to Use Safran Systems. European Security and Defense", (November 2020)
[70] Space Intel Report, "French Officials Describe Plans To Detect, Track And Deter 'Intruders' In Geostationary Orbit", (November 2020)
[71] BBC News, Russia 'tried to spy on France in space' - French minister, (September 2018) https://www.bbc.com/news/world-europe-45448261
[72] Assemblée Nationale, "Avis n°3465 fait au nom de la Comission de la Défense Nationale et des Forces Armées sur le projet de loi de finance pour 2021. Tome VI. Défense. Préparation et emploi des forces: Air.", Jean-Jacques Ferrara (October 2020) http://www.assemblee-nationale.fr/dyn/15/rapports/cion_def/l15b3465-tvi_rapport-avis
[73] "France conducted first military drills in space", (March 2021): https://phys.org/news/2021-03-france-military-drills-space.html
[74] Deutsches Zentrum für Luft- und Raumfahrt, "Im-proved safety in Space – GES-TRA space radar ready to be-gin op-er-a-tions", (October 2020) https://www.dlr.de/content/en/articles/news/2020/04/20201013_space-radar-gestra-begin-operation.html
[75] General Anzeiger, "The Bundeswehr gazes into space from the Lower Rhine", (September 2020)

2022. The ASOC will provide early warning of objects entering the atmosphere, including space debris, consolidating on existing capabilities in the SST and SSA domains. ASOC, which is a part of the German air force facilities serving NATO, will initially have 50 experts, growing to 150 by 2031.[76]

In September, Germany purchased U.S. jam-resistant GPS equipment, becoming the first nation to buy the upgraded and jam-resistant GPS user equipment under the U.S. Foreign Military Sales program.[77] The M-Code receivers can now be bought by 58 nations around the world, following the approval of the secretary of the U.S. Air Force and the office of the Secretary of Defence, to enable greater interoperability in defence equipment of allied nations.



GESTRA radar (Credit: DLR)

United Kingdom: New RAF Space Command announced for 2021 and new military/commercial SSA partnership

The United Kingdom will set up a Space Command to lead on UK space operations, space workforce generation in terms of training and growth, and space capability in delivering space equipment programmes.[78] The new Space Command plans were part of Prime Minister Boris Johnson's November announcement on the biggest investment in defence since the Cold War (£16 billion over 4 years, which equates to about a 10% annual increase in the defence budget).

Earlier in September it was also announced[79] that UKspace, the trade association of the British space industry, would be partnering with the RAF to develop a new Commercial Integration Cell at the UK Space Operations Centre which will enable enhanced coordination of military and commercial space operations.

Iran: Military satellite launch revealing the existence of IRGC Space Command

On April 22nd, Iran successfully placed the 6U military Earth observation satellite Noor-1 into 425km sun-synchronous orbit, using previously unknown satellite launch vehicle the Iran's Islamic Revolutionary Guard Corps (IRGC) calls Qased. It was also reported that Noor-1 launched from a base that had never been used for satellite launches in Iran, in the Shahroud area in Northern Iran.[80] The launch followed a series of earlier launch failures, including February 2020 attempt to launch Zafar-1 satellite that marked the fourth straight Iranian launch failing to place a satellite into orbit since 2017.[81] Media interviews following the launch included the appearance of IGRC's Space Command commander. Until this appearance the existence of Iran's Space Command was unknown, at least in open sources.[82]

Australia: AUD 7 billion investment in space defence capabilities over the next decade

The 2020 Defence Strategic Update and 2020 Force Structure Plan released in July revealed a AUD 270 billion investment over the next 10 years to upgrade the capability and potency of the Australian Defense Force (ADF). AUD 7 billion, representing 3% of the total investment package, will be used to fund capability development in the space domain, marking a record level of funding to ensure that Australia establishes and maintains a sovereign space capability.[83] The Australian Defence Minister stated space is increasingly critical to the ADF's warfighting effectiveness, in particular real-time communications,

[76] Deutsche Welle, "German military launches space junk tracking system", (September 2020)
[77] GeospatialWorld, "Germany becomes first country to purchase jam-resistant GPS receivers from the U.S.", (November 2020)
[78] Gareth Jennings, "UK to launch new Space Command", (November 2020): https://www.janes.com/defence-news/news-detail/uk-to-launch-new-space-command
[79] UK Space, "UK space and RAF to establish Commercial Integration Cell for greater military and commercial space collaboration", (July 2020): https://www.ukspace.org/ukspace-raf-establish-cic-for-greater-military-and-commercial-space-collaboration/
[80] ibid
[81] Spaceflight Now, "Iran fails in satellite launch attempt", (February 2020)
[82] SpaceWatch.Global, "Iran Unveils Military Space Command, New Details on Satellite Launch", (April 2020)
[83] SpaceConnect, "Australian space capabilities a major winner in Defence Strategy Update", (July 2020)

situational awareness and rapid information delivery.[84] According to the new plan, the ADF will be working with the U.S. and the Australian Space Agency to improve its satellite communications, space domain awareness, precision navigation and timing and intelligence, surveillance and reconnaissance capabilities. This plan will also see new satellites and establishment of ground control bases.[85]

International developments and other space defence news

- New space developments in NATO: In February during the NATO Defence Ministers Meeting, representatives from France, Italy, the United Kingdom, and the United States signed an MoU that will provide NATO with military satellite communication capabilities for 15 years.[86] The service follows the previous NATO SATCOM Post-2000 project (in place from 2005 to 2019) and is based on a previous authorisation achieved in May 2019 for €1Billion, to ensure the acquisition of services. On October 22nd, NATO announced the building of a new space operations centre at the Ramstein Air Base in Germany[87], which will form part of NATO air force high command and serve as a coordination centre for space observations and awareness. It will gather information about possible threats to satellites and could develop further into a command centre. It was also announced NATO will set up in Toulouse, France a new centre of excellence devoted to military space.[88]
- France and Germany in the CspO – In February, France and Germany formally joined the United States, the United Kingdom, Canada, Australia, and New Zealand in the multilateral Combined Space Operations Initiative.[89,90] CspO's mission is to coordinate the efforts made by each participating nation in space defence. It also seeks to enhance space capabilities, and to facilitate the joint space operations carried out by the participating nations.[91]
- U.S.-Russian diplomatic talks – On July 27th, the United States and Russia conducted the first formal Space Security Exchange meeting since 2013.[92] Taking place in Vienna, the aim of the talks was to incentivize responsible behaviour in outer space.
- USA and Japan commit to strengthen space defence ties. On August 26th, Japanese and U.S. representatives met at the seventh meeting of the Japan-U.S. Comprehensive Dialogue on Space. Both delegations agreed to expand bilateral space defence cooperation, mentioning future collaborative SSA endeavours or enhanced cooperation between the U.S. Space Command and Space Force and the Japan Air Self-Defense Force's Space Operations Squadron.

---

[84] Ibid.
[85] InnovationAus, "Space, the new Defence spending frontier. Denham Sadler", (July 2020)
[86] NATO, "NATO begins using enhanced satellite services", (February 2020)
https://www.nato.int/cps/en/natohq/news_173310.htm?selectedLocale=en
[87] Deutsche Welle, "NATO plans new space center in Ramstein, Germany" (October 2020)
[88] DefenseNews, "Ramstein Air Base to host new NATO space center", (October 2020)
https://www.defensenews.com/global/europe/2020/10/20/ramstein-air-base-to-host-new-nato-space-center/
[89] SpaceConnect, Germany signs up for multinational Combined Space Operations Initiative. (February 2020) https://www.spaceconnectonline.com.au/operations/4116-germany-signs-up-for-multinational-combined-space-operations-initiative
[90]Gouvernment.fr, "France fully embraces the Combined Space Operations (CSpO) initiative", (February 2020)
https://www.gouvernement.fr/en/france-fully-embraces-the-combined-space-operations-cspo-initiative
[91] Ibid.
[92] U.S Department of State, "Meeting of U.S. – Russia Expert Groups on Trilateral Arms Control and for the Space Security Exchange", , (July 2020) : https://www.state.gov/meeting-of-u-s-russia-expert-groups-on-trilateral-arms-control-and-for-the-space-security-exchange/

- South Korea's first military communications satellite. On July 20th, SpaceX launched the Anasis-II geostationary satellite, the first dedicated military communications satellite of South Korea. The satellite is part of an offset deal for the acquisition of F-35s by South Korea[93]. Manufactured by Airbus using the Eurostar E3000 platform, Anasis-II replaces the ageing Anasis-I satellite, also known as the Mugunghwa-5, used for both civilian and military purposes. This launch made South Korea the 10th country in the world to operate a satellite solely for military purposes.[94]

Artist rendering of the Anasis-II satellite (Credit: Airbus)

- Estonian government and Defence Industry Association sign cooperation agreement: The agreement[95] aims to improve cooperation between the government and the private sector to promote the Estonian space industry, particularly in areas such as cybersecurity.
- Continuous build-up of counterspace capabilities. Two reports published independently by the Centre for Strategic and International Studies (CSIS) and the Secure World Foundation (SWF) underscored the continuous proliferation of counterspace capabilities, with the United States, Russia and China seemingly operating the most advanced sets of assets. According to the SWF, evidence shows significant R&D of a broad range of kinetic and non-kinetic counterspace capabilities in multiple countries.[96] However, only non-kinetic capabilities are actively being used in current military operations. In addition, according to CSIS, in the last year, more states have been considering the development of offensive and defensive counterspace capabilities to protect space systems from attacks.[97]

---

[93] NASA Spaceflight, "SpaceX Launches ANASIS-II Military Communications Satellite for South Korea", (July 2020) https://www.nasaspaceflight.com/2020/07/spacex-launch-anasis-satellite-korea/
[94] Korea Joongang Daily, "Korea's military gets its own satellite in space" (July 2020): https://koreajoongangdaily.joins.com/2020/07/21/national/defense/satellite-AnasisII-DAPA/20200721184300416.html
[95] Majandus Ja Kommunikatsionni Ministeerium, "MKM ja Eesti Kaitsetööstuse Liit allkirjastasid koostööleppe kosmosetööstuse arendamiseks", (September 2020) https://mkm.ee/et/uudised/mkm-ja-eesti-kaitsetoostuse-liit-allkirjastasid-koostooleppe-kosmosetoostuse-arendamiseks
[96] Secure World Foundation, "Global Counterspace Capabilities: an Open Source Assessment", (April 2020) https://swfound.org/counterspace/
[97] Todd Harrison et al. CSIS, "Space Threat Assessment 2020", (March 2020) https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/200330_SpaceThreatAssessment20_WEB_FINAL1.pdf?6sNra8FsZ1LbdVj3xY867tUVu0RNHw9V

1.1.4 Artemis Accords: The U.S. sets conditions for international cooperation

In 2020, nine countries signed the Artemis Accords, a 7-page set of principles that countries willing to participate in the U.S. Artemis programme accept to adhere by.[98] The Accords present a broad vision on "principles for cooperation in the civil exploration and use of the Moon, Mars, comets and asteroids", envisioned as an "operationalisation" of the 1967 Outer Space Treaty.[99]

NASA announced the initiative in May 2020. While Australia, Canada, Italy, Japan, Luxembourg, the United Kingdom and the United Arab Emirates reached an agreement with the US on October 13th, most of the international community has not taken a formal position on this initiative in 2020. In November, Ukraine became the 9th signatory country,[100] while Brazil signed a joint statement of intent in December. Some critical views on the Accords have already emerged, including in Europe.[101]

The signatory nations agreed in the Artemis Accords on following principles:

1. Peaceful purposes: agreeing on a peaceful vision to not only bolster space exploration but also to enhance peaceful relationships between nations.
2. Transparency: recognising partner nations will be expected to uphold this principle by publicly describing their own policies and plans in a transparent manner.
3. Interoperability: calling for the U.S. and partner nations to utilize existing international standards and develop new standards when necessary.
4. Emergency assistance: reinforcing each partner's commitment to the 1968 Rescue Agreement.
5. Registration of space objects: reinforcing the critical nature of registration of space objects and urging adherence to the 1976 Registration Convention.
6. Release of scientific data: committing to the timely and open sharing of scientific data.
7. Preserving heritage: committing to the preservation of outer space heritage with historic value.
8. Space resources: expressing the crucial role space resource extraction and utilization in enabling safe and sustainable operations and committing the partners to conduct such activities in compliance with the Outer Space Treaty.
9. Deconfliction of activities: stressing out the need to avoid harmful interference and establishing the principle of safety zones.
10. Orbital debris and spacecraft disposal: presenting the commitment of the partners to plan for the mitigation of orbital debris.

Most of the principles agreed on by the signatories seem to enjoy a wide consensus, in line with the prevailing understanding of core space law instruments. However, principles on space resources and deconfliction of activities turned out to be contentious, presenting a legal interpretation of international space treaties that is not universally shared.

Virtual Signing Ceremony of the Artemis Accords on October 13th 2020 (Credit: NASA TV)

[98] NASA, "The Artemis Accords", (October 2020): https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf
[99] The Space Review, "The Artemis Accords take shape", (October2020)
[100] U.S Embassy in Ukraine, "Ukraine becomes the 9th country to sign the Artemis Accords", (November 2020) https://ua.usembassy.gov/ukraine-becomes-the-9th-country-to-sign-the-artemis-accords/
[101] #SpaceWatchGL Interviews – Kai-Uwe Schrogl: "We must not overrate the Artemis Accords". SpaceWatch.Global (November 2020), https://spacewatch.global/2020/11/spacewatchgl-interviews-kai-uwe-schrogl-we-must-not-overrate-the-artemis-accords/

Since the virtual signing of the Artemis Accords in October, many aspects of the Accords have been subject to debates among experts and officials of the international space community. ESPI published a Brief on implications of the Accords for Europe underlining that:[102]

- While the Accords are, title-wise, associated with the Artemis programme, principles therein reach beyond Artemis-related lunar presence (their scope applies to Moon, Mars, comets and asteroids).
- While a non-signature of the Accords does not prevent other countries from exploring space, it is reasonable to expect that NASA will request the signature if a country wants to join U.S. missions.
- Although multilateral by nature, the Artemis Accords were not debated in traditional multilateral space. The Accords were principally developed through U.S. bilateral channels.
- The Artemis Accords represent a political commitment of participating countries and do not have a legally binding nature under international law.

The U.S. administration presented the Accords as a preamble to following bilateral agreements between the U.S. and signatory countries (government-to-government, agency-to-agency or others).[103] Prior to the virtual signing ceremony, NASA already signed several joint statements of intent with Artemis Accords partners: with the Japanese Government[104] (July 2020), with the Italian Government[105] followed by NASA-ASI Joint Statement[106] (both September 2020), and with the Australian Space Agency[107] (September 2020). In December, a similar statement of intent was signed with Brazil, which has not yet signed the Accords but expressed interest to do so soon.[108] Additionally, the UK Space Agency and the Luxembourg Space Agency already signed lunar-related joint statements of intent with NASA in 2019.[109,110]

Broader international involvement unclear

As of December 2020, neither China, Russia, and India have signed the Artemis Accords nor have formally issued a public position on the matter. Some criticism from Russia emerged on the Lunar Gateway, a part of the broader Artemis Programme but without explicit mention of the Accords. Russia is now unlikely to participate in the Lunar Gateway but called for standardization of interfaces so Russian spacecraft can dock as well.[111] With regards to the Lunar Gateway, in October NASA signed an MoU with ESA[112], delineating the European contribution to the Gateway and approving two additional European Service Modules (ESMs) for NASA's Orion spacecraft.[113] This marks continuation of an established NASA-ESA cooperation on lunar missions.

---

[102] ESPI, "ESPI Briefs" No. 46, November 2020, available at: https://espi.or.at/news/espi-brief-46-artemis-accords-what-implications-for-europe
[103] NASA, "The Artemis Accords", (October 2020): https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf
[104] SpaceNews, "NASA signs agreement with Japan on lunar exploration", (July 2020)
[105] NASA, NASA Administrator Signs Declaration of Intent with Italy on Artemis Cooperation. (September 2020) https://www.nasa.gov/feature/nasa-administrator-signs-declaration-of-intent-with-italy-on-artemis-cooperation/
[106] NASA, "NASA and Italian Space Agency Sign Joint Statement", (October 2020): https://www.nasa.gov/image-feature/nasa-and-italian-space-agency-sign-joint-statement
[107] NASA, "Australian Government Commits to Join NASA in Lunar Exploration and Beyond", (September 2019) https://www.nasa.gov/press-release/australian-government-commits-to-join-nasa-in-lunar-exploration-and-beyond/
[108] NASA, "NASA Administrator Signs Statement of Intent with Brazil on Artemis Cooperation" (December 2020): https://www.nasa.gov/feature/nasa-administrator-signs-statement-of-intent-with-brazil-on-artemis-cooperation
[109] Gov.uk, "On 50th anniversary of Apollo 11 launch, UK and NASA state intent to work on future Moon missions", (July 2019) https://www.gov.uk/government/news/on-50th-anniversary-of-apollo-11-launch-uk-and-nasa-state-intent-to-work-on-future-moon-missions
[110] NASA, "Joint Statement Signing Between NASA and the Luxembourg Space Agency", (October 2019) https://www.nasa.gov/image-feature/joint-statement-signing-between-nasa-and-the-luxembourg-space-agency
[111] Space Policy Online, "Rogozin Wants Iss Extension, Gateway Too U.S.-Centric", (October 2020)
[112] ESA, "Positive signs for Europe as ESA goes forward to the Moon", (October 2020) https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Positive_signs_for_Europe_as_ESA_goes_forward_to_the_Moon
[113] ESA, "Shared vision and goals for the future of Europe in space", (October 2016): esa.int/About_Us/Corporate_news/Shared_vision_and_goals_for_the_future_of_Europe_in_space

For what concerns the European involvement in the Artemis Accords, while three of EU/ESA Member States have signed the Accords (Italy, Luxembourg, the UK), it seems that others had diverging views. The Accords have important implications for European stakeholders. Among others, the Artemis Accords underscored the current lack of a joint European space diplomatic posture.[114]

Besides, the eleven European states participating on the IGA (Belgium, Denmark, France, Germany, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom) have reactivated the European International Space Station Intergovernmental Agreement Coordination Committee (CC) to assess the necessity of an intergovernmental agreement as the basis for extending the ISS partnership to Lunar Gateway cooperation and Moon exploration and the potential role of the IGA therein.

Institutional positions on space resources taking shape

In-situ space resources extraction and utilisation has been a highly debated topic in the space community over the past. The Artemis Accords seem to play a major role in the overall U.S. policy to foster ISRU for commercial purposes. It has its legal anchoring in the 2015 Space Competitiveness Act, which was followed, shortly after, by a new law establishing comparable principles in Luxembourg. In February 2020, a new UAE space law entered into force, which also aims to allow private ownership of space resources.[115] By joining the Artemis Accords, at least six additional countries have expressed a likeminded approach. The Accords, however, do not go legalise the commercial viability of ISRU and remain limited to acknowledging the lawfulness of such activities. On the other hand, a German government official argued that the Accords are "unacceptable in some respects, in particular when it comes to private property rights".[116]

In April, the U.S , the White House issued an "Executive Order on Encouraging International Support for the Recovery and Use of Space Resources"[117], reaffirming a long-term U.S. rejection of the 1979 Moon Agreement and the notion of outer space as a Global Commons.[118] NASA also agreed to buy lunar samples collected by 4 companies for a token sum primarily to set a precedent for space resource rights on the Moon.[119] In Europe, Luxembourg partnered with ESA in November to create a "European Space Resources Innovation Centre (ESRIC).[120] At ESA level, the Agency has stepped up its efforts in the space resources domain and published ESA Space Resources Strategy already in May 2019.[121]

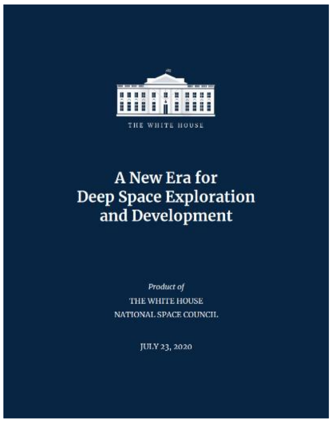
[114] ESPI, "Artemis Accords: What implications for Europe? ESPI Brief 46", (November 2020) https://espi.or.at/news/espi-brief-46-artemis-accords-what-implications-for-europe
[115] The National News, "UAE looks to regulate asteroid mining as it aims to lure private space sector", (November 2019)
[116] #SpaceWatchGL Interviews – Kai-Uwe Schrogl: "Europe has to stand united" SpaceWatch.Global (October 2020) https://spacewatch.global/2020/10/spacewatchgl-interviews-kai-uwe-schrogl-europe-has-to-stand-united/
[117] White House, "Executive Order on Encouraging International Support for the Recovery and Use of Space Resources", (April 2020) https://www.whitehouse.gov/presidential-actions/executive-order-encouraging-international-support-recovery-use-space-resources/
[118] ESPI, "U.S. Executive Order on space resources utilisation. ESPI Brief 40 (April 2020)", https://espi.or.at/news/espi-executive-brief-40-u-s-executive-order-on-space-resources-utilisation
[119] NASA, "NASA Selects Companies to Collect Lunar Resources for Artemis Demonstrations", (December 2020) https://www.nasa.gov/press-release/nasa-selects-companies-to-collect-lunar-resources-for-artemis-demonstrations
[120] The Government of the grand Duchy of Luxembourg, "Luxembourg teams up with ESA to create a unique 'European Space Resources Innovation Centre' to be established in the Grand Duchy" , (November 2020) https://gouvernement.lu/en/actualites/toutes_actualites/communiques/2020/11-novembre/18-luxembourg-spaceresources.html
[121] ESA, "ESA Space resources Strategy", (May 2019): https://sci.esa.int/documents/34161/35992/1567260390250-ESA_Space_Resources_Strategy.pdf

Additional domestic policy developments in the United States concerning the Artemis programme

In 2019, U.S. Vice President announced a new Artemis goal – landing astronauts at the lunar South Pole by 2024, instead of 2028.[122] To accommodate this accelerated plan, NASA announced in March that the Lunar Gateway, deemed until then as an essential component of getting astronauts on the Moon by 2024, would no longer be a prerequisite for this goal.[123] In November, a report by NASA's Office of the Inspector General found that the initial elements of Lunar Gateway are facing major cost overruns and delays.[124]

In April, NASA selected Blue Origin, Dynetics and SpaceX to design and develop human landing systems (HLS) for the Artemis programmme, awarding contracts of total value close to $1 billion.[125] In October all three firms completed important development milestones – Certification Baseline Reviews (CBR).[126]

In the second half of 2020, three major Artemis-related policy documents were published in the U.S.:



On July 23rd, A New Era for Deep Space Exploration and Development[127] was issued by the White House and the National Space Council. The document outlines the rationale and purpose for U.S: human space exploration plans through Artemis and beyond and addresses the commercialization of Low Earth Orbit, returning to the Moon and extending human presence to Mars. The five primary roles of the U.S. government in this effort should be:

1. the promotion of a secure and predictable space environment
2. the support to the commercial activity and industry in space
3. the support of R&D of new space technologies; with commercial and international partners
4. the creation of infrastructure needed for space exploration and
5. the support of advanced U.S. space research

On September 21st, NASA released the Artemis plan,[128] an updated comprehensive plan for Artemis missions. The document confirms the plan to send astronauts to the lunar South Pole in 2024 and, specifies the funding requirements of nearly $28 billion through 2025. The funding would cover the Artemis "Phase I", which includes the Artemis I-III missions together with HLS for approx. $16.2 billion, as well as the SLS, Orion and the Exploration Systems Development (ESD) mission. The planned schedule for first 3 Artemis missions is:

Artemis I:	uncrewed mission around the Moon in 2021
Artemis II:	crewed moon flyby in 2023
Artemis III:	crewed lunar landing in 2024

[122] Space Policy Online, "Pence: Americans Will Land At Moon's South Pole By 2024", (March 2019)
[123] Space Policy Online, "Gateway No Longer Mandatory For 2024 Moon Landing", (March 2020)
[124] Space Today, "Lunar Gateway facing cost and schedule delays", (November 2020)
[125]. NASA, "NASA Selects Blue Origin, Dynetics, SpaceX for Artemis Human Landers", (April 2020) https://www.nasa.gov/feature/nasa-selects-blue-origin-dynetics-spacex-for-artemis-human-landers/
[126] NASA, "NASA, Human Lunar Lander Companies Complete Key Artemis Milestone", (October 2020) https://www.nasa.gov/feature/nasa-human-lunar-lander-companies-complete-key-artemis-milestone
[127] The White House National Space Council, "A New Era for Deep Space Exploration and Development", (July 2020) https://www.whitehouse.gov/wp-content/uploads/2020/07/A-New-Era-for-Space-Exploration-and-Development-07-23-2020.pdf
[128] . NASA, "NASA's Lunar Exploration Program Overview. Artemis Plan", (September 2020) https://www.nasa.gov/sites/default/files/atoms/files/artemis_plan-20200921.pdf

Memorandum on the National Strategy for Space Nuclear Power and Propulsion (Space Policy Directive-6)

INFRASTRUCTURE & TECHNOLOGY

Issued on: December 16, 2020

The penultimate of Trump administration SPDs, issued on December 16th, tackles the use of space nuclear power and propulsion (SNPP) systems in deep space operations.[129] The U.S. views SNPP systems (e.g., radioisotope power systems and fission reactors) as fundamentally enabling technologies of U.S. space exploration plans, in particular for environments not suited for other fuel options. The SPD-6 sets principles and a supporting roadmap to demonstrate that the U.S. is committed to using SNPP systems safely, effectively and responsibly.

In December, the FY 2021 omnibus spending bill appropriated $23.27 billion to NASA, which was $642 million more than what it received in 2020 but nearly $2 billion less than requested. While the SLS, Orion and Exploration Ground Systems all received funding at or above the administration's request, the bill provided just about one-quarter of the administration's request of $3.3 billion for the Human Landing System (HLS), raising concerns that it will make NASA's 2024 lunar landing goal even more challenging.[130]

[129] White House, "Memorandum on the National Strategy for Space Nuclear Power and Propulsion (Space Policy Directive-6)", (December 2020): https://www.whitehouse.gov/presidential-actions/memorandum-national-strategy-space-nuclear-power-propulsion-space-policy-directive-6/
[130] SpaceNews, "NASA receives $23.271 billion in fiscal year 2021 omnibus spending bill", (December 2020)

1.1.5 Governments accelerate their support to investment in the space sector

Public actors have been recently stepping up their support to the growth of private investment in the space economy. In 2020, there were numerous institutional actions around the world with the goal to foster and facilitate private space investment. These measures took the shape of:

- Direct investment by public actors (e.g., investment bank) in private space companies
- Public funding towards venture or equity funds, which then re-invest into the space sector
- Governmental initiatives to enable or facilitate private investment (regulatory measures, tax policy instruments…)

European governments and institutions have emerged as top supporters of investment in the space sector. This trend has been initiated already in 2018 and 2019 through several developments:

- In 2018 CNES, in partnership with ESA, launched a space investment fund CosmiCapital, managed by Karista. The fund will invest in space industry businesses and applications, for which it plans to raise €100M.In November 2020, Karista announced the fund will be deployed in 2021.[131]
- Also in 2018, ESA and the European Investment Bank (EIB, shareholders are 27 EU Member States) signed a Joint Statement. The Statement echoed shared ESA-EIB objectives to foster investments in space sector and to facilitate and increase available financing and access to it.[132]
- In 2019, EIB and the EU GNSS Agency in Prague signed an agreement to cooperate on supporting investment in the European space-based service economy.[133]

Europe's first announced space venture fund CosmiCapital targets early-stage ventures and is planned to be deployed in 2021 (Credit: Karista)

In 2020 European and national public institutions continued to develop financial instruments to foster entrepreneurship and accelerate investment into space start-ups.

European Union space investment mechanisms

With New Space increasingly high in its space agenda, the EU is now openly and actively seeking to support entrepreneurship and investment in the European space sector and introduced new instruments for this purpose. Several new major European initiatives to boost investments, mobilise additional funds and support entrepreneurship and private investment were introduced in 2020:

- The European Commission announced €300 million in investments for the space sector following the joint investment by the European Commission and the EIF in Orbital Ventures and the Primo Space venture capital fund. The announcement is part of the initiatives put in place by the Commission and the EIF in the framework of the €100 million InnovFin space equity pilot. It constitutes the first ever space equity pilot officially backed by the EU.

---

[131] Cosmicapital, Karista publishes an article on the NewSpace in Private Equity Magazine, (November 2020)
[132] ESA, "Joint Statement of the European Space Agency and the European Investment", (July 2018) : Bank https://www.esa.int/About_Us/Corporate_news/Joint_Statement_of_the_European_Space_Agency_and_the_European_Investment_Bank
[133] GSA, "EIB sign agreement on investment in space", (July 2019) https://www.gsa.europa.eu/newsroom/news/gsa-eib-sign-agreement-investment-space

- The European Commission has also awarded €238 million in investments in highly innovative start-ups and SMEs through the European Innovation Council (EIC) Equity Fund.[134] The EIC Fund is an innovative instrument part of the EIC accelerator, through which the Commission aims to make direct equity as well as quasi-equity investments. The Dutch start-up Hiber benefited from this mechanism as it closed a €26 million round in 2021 in a new funding round led by the European Innovation Council.
- At the 13th European Space Conference, European Commissioner Thierry Breton announced the creation of the Competitive Space Start-ups for Innovation initiative (CASSINI), which is projected to result in the establishment of a €1 billion European Space Fund building on the success of the InnovFin space equity pilot. The fund will be put in place by the European Commission and the EIB Group and will "cover actions on the whole innovation cycle, from business idea to industrialisation".[135]

Credit: European Commission

- The European Commission has driven efforts to simplify funding mechanisms in the EU and created the InvestEU Fund with the aim of "bringing all EU investment instruments under one roof".[136] The Fund will thus offer a single budgetary guarantee scheme involving 14 European financial instruments. Space is part of the areas eligible for financing and investment operations, in particular for activities that are in line with the Space Strategy for".[137]

European Space Agency

ESA long played a major role and been a driving force in the growth of the European start-up ecosystem by supporting entrepreneurship and investment through various support mechanisms ranging from business incubation centres to different funding instruments and programmes.

- In 2020, ESA awarded the first contracts under its Boost! Commercial Space Transportation Services and Support Programme (to Isar Aerospace, HyImpulse, Rocket Factory Augsburg, Orbex, Skyrora). The programme was adopted during the Space19+ ESA Ministerial Council to support "commercially successful, privately funded initiatives for new space transport services".[138] It has a €54.5 million budget running from 2020 to 2022, with seven countries having committed to it on a voluntary basis.
- In 2020, ESA also took major steps to explore new approaches to procurement with the aim of increasing the involvement of private actors and new companies. ESA adopted a service-oriented approach designed to demonstrate the commercial viability of In-Orbit Services (€86 million contract to the Swiss start-up ClearSpace).

National initiatives in Europe

In addition to the new initiatives undertaken by the EU and ESA, the year 2020 has also been marked by new national efforts in support of space investment.

- Germany has been particularly active in 2020, with the DLR notably sponsoring a competition for micro launchers aiming to support the development of new launch solutions in Europe. Isar

[134] European Commission, "Commission awards more than €278 million to 75 start-ups and SMEs set to shape the future" (December 2019) https://ec.europa.eu/info/news/commission-awards-more-eu278-million-75-start-ups-and-smes-set-shape-future-2019-dec-05_en
[135] European Commission, "Speech by Commissioner Thierry Breton at the 13th European Space Conference" (January 2020) https://ec.europa.eu/commission/commissioners/2019-2024/breton/announcements/speech-commissioner-thierry-breton-13th-european-space-conference_en
[136] European Union, "InvestEU", (December 2020) https://europa.eu/investeu/about-investeu_en
[137] Ibid.
[138] European Space Agency, "ESA boost to new commercial space transportation services" (June 2019) https://www.esa.int/Enabling_Support/Space_Transportation/ESA_boost_to_new_commercial_space_transportation_services

Aerospace won the second phase of the competition[139] and is expected to receive an €11 million award from the agency as well as a letter of recommendation for ESA to advance in the agency's Commercial Space Transportation Services and Support Programme. The German government participated indirectly in start-up funding rounds through support to venture capital funds. High-Tech Gründerfonds for instance led the seed funding round closed by German start-up DcubeD in 2021.[140]

- France continued to sustain its efforts to foster the emergence of space start-ups in 2020. This was notably carried out through its participation in several significant investment rounds in French space companies. France participated in the funding €100 million investment in Kinéis through CNES, CLS Groupe and Bpifrance.[141] The round was the largest European investment for a space start-up in 2020 In addition to Kinéis, France also backed the funding of Preligens (formerly Exocube) through a €20 million investment led by the French public investment bank Bpifrance.[142]
- The United-Kingdom also remained one of the most active players in the development of a national New Space ecosystem by participating in a number of high-profile deals in 2020. Notably, the UK Space Agency led the €33 million investment in the satellite terminal manufacturing start-up Isotropic Systems, and backed Lumi Space with a grant in the framework of a collaboration with the Ministry of Defence[143] to develop a debris-tracking technology. The UK government also played a prominent role in the emergence of OneWeb from Chapter 11 bankruptcy as it provided 50% of the initial $1billion investment necessary to co-acquire the company with Bharti Global.
- Italy remained active in 2020 following the creation of the Primo Space venture capital fund, which launched in July with a first closing worth approx. €58 million. The fund is supported by the Italian Space Agency and is backed by the new EU InnovFin Space Equity Pilot (ISEP). Primo Space has already contributed to the Italian space venture ecosystem by leading the €5 million Series A funding round in Leaf Space and the €2 million funding round in Aiko Space.[144]
- Spain continued its participation in the development of the first Spanish renewable launcher through a €405.000 investment made by the Centre for the Development of Industrial Technology (CDTI) in the private company PLD Space, as the start-up continues the production of its Miura micro launcher.

Growing public support to private space investment in the rest of the world

Beyond Europe, signs of an accelerating governmental support to private space investment emerged in India, UAE, the U.S, Japan and China.

- The Indian space sector has joined the ongoing trend of relaxed foreign direct investment (FDI) regulation in the country. Among other priorities, the new draft Indian space communications policy aims to encourage and facilitate FDI in Indian space businesses.[145] In 2020 the Indian Government also announced the formulation of a new Space-Based Remote Sensing Policy, which is designed to attract investments and unleash the involvement of the private sector. Additionally, the Indian government announced a wave of reforms that include establishing the Indian National Space

[139] Deutsches Zentrum für Luft und Raumfahrt, "DLR-Mikrolauncher-Wettbewerb" (March 2020) https://www.dlr.de/content/de/artikel/news/2020/03/20200714_dlr-mikrolauncher-wettbewerb-drei-teams-sind-eine-Runde-weiter.html)

[140] "Deployable Cubed GmbH, Boost for "New Space made in Germany" through investment by HTGF and ILV in Munich-based Start-up DCUBED", (January 2020) https://dcubed.space/2021/01/07/boost-for-new-space-made-in-germany-through-investment-by-htgf-and-ilv-in-munich-based-start-up-dcubed/

[141] Kinéis, "Kinéis raises 100 million euros and finances its constellation of nanosatellites dedicated to the Internet of Things (IoT)" (February 2020) https://www.kineis.com/en/kineis-raises-100-million-euros-and-finances-its-constellation-of-nanosatellites-dedicated-to-the-internet-of-things-iot/

[142] Preligens (November 2020): https://www.preligens.com/post/announcement-series-a-name-change

[143] United Kingdom Government, "Government backs UK companies tackling dangerous space junk! (September 2020) https://www.gov.uk/government/news/government-backs-uk-companies-tackling-dangerous-space-junk

[144] Primo Space, "Primo Space & Whysol Investments lead a €5m Series A round in Leaf Space" (June 2020) https://primomigliosgr.it/en/post/primo-space-and-whysol-lead-eur5m-series-a-round-in-leaf-space

[145] Reed Smith, "India takes steps to facilitate foreign direct investment in the space sector", (October 2020) https://www.reedsmith.com/en/perspectives/2020/10/india-takes-steps-to-facilitate-foreign-direct-investment

Promotion and Authorisation Centre (IN-SPACe), an "autonomous nodal agency under the Department of Space" that will provide the necessary support for the private space industry to conduct activities. On its side, ISRO announced a new program for space startups called Space Enterprise Encouragement and Development (SEED) with the objective to further encourage private space investment and open ISRO's facilities for use by private players (for development, testing…), which was previously not allowed.[146]

- In the UAE, the new national space law, in force since February 2020, seeks to open the doors for investment in the UAE space sector due to its legislative and regulatory environment that should provide foreign investors with assurance ahead of starting their business in the UAE.[147] The UAE national legislation allows for the exploitation of space resources as well.
- In the USA, the federal government stepped up its efforts to mitigate the COVID-19 impact on private space due to drastic decrease in the availability of private capital. U.S. civil and military agencies put in place various tools (postponement of milestones, immediate invoicing, accelerated payments) to make sure companies can survive the turbulent period until private capital flows return to normal.[148]
- In Japan, the government enacted a new Basic Plan on Space Policy on 30 June 2020, which promotes a significant overhaul of national space activities, including a stronger support to commercial space. Several government organisations traditionally involved in providing direct funding to innovative ventures are increasingly including New Space companies in their portfolios, the most notable being the Ministry of Economy, Trade and Industry 's Innovation Network Corporation of Japan (INCJ) as well as the Ministry of Finance's Development Bank of Japan (DBJ).[149] Several prefectures too have started to more actively support commercial space initiatives. In particular, Fukui Prefecture has been branding itself as a new space hub with testing facilities, the development of prefectural satellite and the creation of education programs in local universities. Top companies like All-Nippon Airlines and Shimizu Corporation have also started to invest significantly in space ventures and devote important resources to internal space-related projects.
- In China, analysts noted that 2020 was an exceptional year for space investment, with some funding rounds benefitting from investments by state-backed firms or funds.[150] With nearly equal investment from government and private sources, Chinese commercial space companies have raised a total of at least $1.85 billion since 2014, when the government opened portions of China's space sector to private capital.[151] In addition, local governments increasingly support space companies, signing multiple deals in particular with the launch sector in 2020.[152] A new Chinese policy issued in April that adds satellite internet to the list of "new infrastructures" is also expected to lead to both bigger public investment and better private capital prospects for Chinese firms.[153] In few months, it was already observed that this new policy quickly triggered a flurry of private investment.[154]

---

146 Hindustan Times, "Private firms to get access to ISRO's facilities, space exploration opportunities", (May 2020) https://www.hindustantimes.com/india-news/private-firms-to-get-access-to-isro-s-facilities-space-exploration-opportunities/story-5vQriboni9O33WeiUsO8GI.html
147 Arabian business, "New UAE Space Law 'to open doors to foreign investment", (February 2020)
148 CNBC, Michael Sheetz, "The US government is helping get cash to private space companies, replacing frozen venture capital", (April 2020): https://www.cnbc.com/2020/04/24/us-government-getting-cash-to-private-space-companies-replacing-venture-capital.html
149 See 2.4.
150 SpaceNews, "Remote sensing satellite firm completes huge funding round as Chinese space sector activity accelerates", (December 2020)
151 Geospatial World, "Private investment fuels china commercial space sector growth, alongside state-backed investment", (May 2020): https://www.geospatialworld.net/news/private-investment-fuels-china-commercial-space-sector-growth-alongside-state-backed-investment/
152 Ibid.
153 SpaceNews, "China's commercial satellite sector sees boost from 'new infrastructure' policy", (May 2020):
154 Geospatial World, Private investment fuels china commercial space sector growth, alongside state-backed investment (May 2020): https://www.geospatialworld.net/news/private-investment-fuels-china-commercial-space-sector-growth-alongside-state-backed-investment/

1.1.6 Other outstanding Space Policy developments

New space policies in Japan, United States and India

Japan: Cabinet Office releasing the new Basic Plan on Space Policy

On June 30th, 2020, the Cabinet Office released a new version of the Basic Plan on Space Policy[155] to guide Japan´s space activities over the next decade. The Basic Plan is structured around 4 parts:

The first part reflects on the context and the environment in which the space policy functions, pointing out changes in the outer space power balance, the growing importance of space security, the exacerbating safety and sustainability risks, the rise of private space activities, the rapid advances in Science and Technology and the growth of worldwide space activities.

ESPI Report 74 "Securing Japan" investigates the evolution of Japan's

The second part outlines the targets of the new policy -to strengthen the comprehensive foundations of Japan's space activities including industrial, scientific and technological bases and to contribute to a wide range of national interests":

- ensure space security,
- strengthen disaster countermeasures, national security and contribute to addressing global issues,
- create new knowledge through space science and exploration,
- realise space-driven economic growth and innovation,

The third part states "Japan's basic stance for fostering space policy" which includes guidelines on the prioritizations of certain aspects of the space policy as well as on the implementation and concomitant budget allocations. The 2020 Plan puts a particular spotlight on:

- an output-driven space policy based on different user requirements (including security ones)
- a space policy providing investment predictability through long-term planning
- a space policy making efficient and effective use of various resources (incl. financial and human)
- a space policy oriented towards cooperation with allies and trustworthy nations

Lastly, the fourth part of the Basic Plan includes "Japan's concrete approach to space policy", outlining specific programmatic measures Japan plans to employ to reach its objectives in space.

USA: New National Space Policy and additional Space Policy Directives and Executive Orders

On December 9th, before the end of the Trump administration, the U.S. Government released a new National Space Policy,[156] and the Memorandum on the National Space Policy.[157] Almost a year in the works, the new U.S. space policy does not bring substantial changes to the space policy of Obama administration, which it supersedes. The document highlights the main principles to conduct space activities, including "shared interest of all nations to act responsibly in space to ensure the safety, stability, security, and long-term sustainability of space activities". The new space policy stresses the necessity to strengthen the U.S. leadership in the space sector, intensify the commercial space sector, increase international cooperation, continue science and exploration activities, and reinforce national security.

[155] Cabinet office of Japan, "Outline of the Basic Plan on Space Policy (Provisional Translation)", (June 2020): https://www8.cao.go.jp/space/english/basicplan/2020/abstract_0825.pdf
[156] White House, "National Space Policy of the United States Of America", (December 2020): https://www.whitehouse.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf
[157] White House, "Memorandum on The National Space Policy", (December 2020): https://www.whitehouse.gov/presidential-actions/memorandum-national-space-policy/

Overall, throughout its 4-year mandate, the Trump administration dealt with space policy predominantly by issuing Space Policy Directives and Executive Orders, including four in 2020:

Jun 17	Executive Order 13803: Reviving the National Space Council (amended by Executive Order 13906 in Feb 20)	Executive Orders
Dec 17	Space Policy Directive 1: Reinvigorating America's Human Space Exploration Program	Space Policy Directives
Mar 18	National Space Strategy	Other policy instruments
May 18	Space Policy Directive 2: Streamlining Regulations on Commercial Use of Space	Space Policy Directives
Jun 18	Space Policy Directive 2: National Space Traffic Management Policy	Space Policy Directives
Feb 19	Space Policy Directive 4: Establishment of the U.S. Space Force	Space Policy Directives
Feb 20	Executive Order 13905: Strengthening National Resilience through Responsible Use of PNT Services	Executive Orders
Apr 20	Executive Order 13914: Encouraging International Support for the Recovery and Use of Space Resources	Executive Orders
Jun 20	Defense Space Strategy	Other policy instruments
Jul 20	A New Era for Deep Space Exploration and Development (National Space Council Report)	Other policy instruments
Sep 20	Space Policy Directive 5: Cybersecurity Principles for Space Systems	Space Policy Directives
Dec 20	Space Policy Directive 6: National Strategy for Space Nuclear Power and Propulsion	Space Policy Directives
Dec 20	National Space Policy (incl. the Memorandum on the National Space Policy)	Other policy instruments
Dec 20	National Strategy for Planetary Protection	Other policy instruments
Jan 21	Executive Order 13972: Promoting Small Modular Reactors for National Defense and Space Exploration	Executive Orders
Jan 21	Space Policy Directive 7: The United States Space-Based Positioning, Navigation, and Timing Policy	Space Policy Directives
Jan 21	National Orbital Debris Research and Development Plan (National Science and Technology Council Report)	Other policy instruments

Space Policy Directives   Executive Orders   Other policy instruments

Table 2: Major U.S. space policy instruments released by White House, National Space Council or Department of Defense during the Trump administration

India: Two new policies by India's Department of Space expected to enter into force in 2021

- On October 15th, the Department of Space released for comments the draft Space Based Communication Policy of India and its draft implementing document. To meet "the growing demands on satcom requirements, promotion of space-based communication activities by industry, advancements in the relevant indigenous technologies and protection of country's space assets[158] In particular, it is meant to facilitate the relations between ISRO and the private sector.[159]
- On November 20th, a draft Space-based Remote Sensing Policy of India and its implementing document were published for a public consultation by the Department of State.[160] The new draft policy aims to enhance participation of Indian industry in space-based remote sensing and facilitate data access, in order to promote commercialisation of space technology and develop space-based remote sensing systems that will meet country's socioeconomic and other needs.

[158] ISRO, "Spacecom Policy - 2020 and Spacecom NGP-20202, (October 2020): https://www.isro.gov.in/sites/default/files/draft_spacecom_policy_2020.pdf
[159] VARINDIA, "SpaceCom Policy, opens new gates for Indian space companies", (October 2020): https://varindia.com/news/spacecom-policy-opens-new-gates-for-indian-space-companies
[160] ISRO, "SpaceRS Policy-2020 and SpaceRS NGP-2020", (November 2020) https://www.isro.gov.in/sites/default/files/spacers_policy_ngp_2020_draft.pdf

Final steps of U.S. regulatory reform of private space enterprise

Space Policy Directives 2 (streamlining commercial space regulations) and 3 (National Space Traffic Management Policy) published in 2018 triggered a large-scale regulatory reform of private space activities in the United States. Even though SPD-3 implementation has been rather slow, major milestones have been achieved in the regulatory arena, culminating with several updated regulations released in 2020.

November 2019 Update of the 2001-published U.S. Government Orbital Debris Mitigation Standard Practices (ODMSP)[161]	The updated ODMSP retain most of the original objectives but bring new quantitative limits on debris-producing events and widen the scope to cover for more recent types of activities, such as cubesats, large LEO constellations or satellite servicing. The revised ODMSP kept in practice the widely debated 25-year-old rule for end-of-life deorbiting, leading some analysts to assess them as rather underwhelming.[162]
April 2020 Update of the 2004 FCC orbital debris mitigation rules[163]	The modernised FCC space debris rules introduce new safety disclosure requirements for applicants seeking licenses and U.S. market access. The development of new rules explored also more specific debris mitigation rules, which, however, were deferred for further study.
May 2020 Revised commercial remote sensing regulations (by the DoC)[164]	The purpose of the new regulation was to ensure the competitiveness of U.S. companies on the global markets by eliminating most restrictions on how licensed remote sensing systems may be operated. Additionally, if the proposed systems offer no better capabilities than what's available on the market, they would be subject to bare minimum of conditions.[165]
August 2020 Streamlined licensing procedures for small satellites (by the FCC)[166]	The new licensing rules are intended to encourage the innovation in the small satellite sector by introducing easier, faster, and cheaper regulatory process[167] for small satellite missions (lower mass, shorter mission time, lower debris risk and less intensive spectrum use).
October 2020 Streamlined commercial space launch and re-entry licensing process (by the FAA)[168]	The new streamlined FAA rules replaced prescriptive requirements with performance-based criteria, seeking to better handle the growing number of launches. The new rule requires a single license for all types of commercial space flight launch and re-entry operations, and increases flexibility for launch and re-entry vehicle operators.

Table 3: Updated U.S. commercial space regulations

[161] NASA, "U.S. Government Orbital Debris Mitigation Standard Practices", (November 2019) https://orbitaldebris.jsc.nasa.gov/library/usg_orbital_debris_mitigation_standard_practices_november_2019.pdf
[162] SpaceNews, "U.S. government updates orbital debris mitigation guidelines", (December 2019): https://spacenews.com/u-s-government-updates-orbital-debris-mitigation-guidelines/
[163] FCC, "FCC Updates Orbital Debris Mitigation Rules for the New Space Age", (April 2020): https://www.fcc.gov/document/fcc-updates-orbital-debris-mitigation-rules-new-space-age-0
[164] Department of Commerce, NOAA, "Licensing of Private Remote Sensing Space Systems", (May 2020): https://s3.amazonaws.com/public-inspection.federalregister.gov/2020-10703.pdf
[165] SpaceNews, "Commerce Department releases streamlined commercial remote sensing regulations", (May 2020): https://spacenews.com/commerce-department-releases-streamlined-commercial-remote-sensing-regulations/
[166] Federal Register, "Streamlining Licensing Procedures for Small Satellites", (July 2020): https://www.federalregister.gov/documents/2020/07/20/2020-12013/streamlining-licensing-procedures-for-small-satellites
[167] Geospatial World, "New FCC rules make small satellite licensing easier, faster, and cheaper", (August 2020): https://www.geospatialworld.net/blogs/new-fcc-rules-make-small-satellite-licensing-easier-faster-and-cheaper/
[168] Federal Aviation Administration, "Fact Sheet – Streamlined Launch and Reentry Licensing Requirements (SLR2) Rule", (October 2020) : https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=25400

Mixed progress on the space safety and sustainability front

While 2018 and 2019 were marked with landmark policy developments in the space safety and sustainability domain,[169] 2020 has not witnessed comparable policy or programmatic breakthroughs. Indeed, 2019 confirmed the growing importance of this topic in space policy and diplomacy agendas: for example, the United Nations adopted the Guidelines for the Long-term Sustainability of Outer Space Activities (LTS guidelines) and the European External Action Service (EEAS) introduced the 3SOS initiative. Space safety and sustainability issues are increasingly addressed in mainstream media, as evidenced by coverage of multiple high-risk conjunctions in Earth's orbits in 2020.[170,171] However, progress in these areas seems to have somewhat slowed down.

In February, at the 57th session of Scientific and Technical Subcommittee (STSC) of UNOCPUOS, Member States were not able to elect the bureau of the newly established working group on the long-term sustainability of outer space activities,[172] slowing down progress on the LTS agenda, in particular on the implementation of approved UN LTS guidelines.

At the UN General Assembly, where Nations vote every year on several space-related resolutions, the United Kingdom sponsored a new UN resolution encouraging responsible behaviour in space. The UN Disarmament and International Security (DISEC) space committee adopted the draft on "Reducing space threats through norms, rules and principles of responsible behaviours" in October. The Resolution passed by vote of 164 in favour to 12 against, with 6 abstentions on December 7th.[173]

Overall, developments on the space safety and sustainability front in 2020 concerned mainly announcements and new partnerships (international, public-private):

- The newly inaugurated space radars in the USA (Space Fence[174]) and in Germany (GESTRA[175]) are expected to increase space surveillance capabilities of the U.S. and Europe.
- In the U.S., the SPD-3 implementation reached a significant milestone. After a couple of unsuccessful policy efforts in past two years[176], the U.S. Department of Commerce, envisioned in the SPD-3 to gradually take over civil SSA/STM roles, was provided $10 million for the Office of Space Commerce in the FY 2021 omnibus spending bill approved by the Congress in December. The bill merges the office with the Commercial Remote Sensing Regulatory Affairs (CRSRA) office within NOAA, and directs the office to use the funding for an STM pilot program.[177]
- In Russia, Roscosmos, announced a build-up of SSA capabilities with the plan to launch by 2027 the first satellite part of the "Milky Way" project. The project aims to monitor space debris and improve the detection capabilities of a planned network of 65 ground optical telescopes (currently 36)[178]

---

[169] "Numerous SSA sharing agreements with the U.S., expansion of the EU SSST Consortium, release of the U.S. STM policy, approval of debris removal missions, agreement on UN LTS Guidelines, various industry initiatives codifying best practises…"
[170] BBC, "Two satellites in close shave over US city of Pittsburgh", (January 2020): https://www.bbc.com/news/world-us-canada-51299638
[171] Washington Post, "A rocket booster and a dead satellite avoided a collision Thursday, illustrating the 'ticking time bomb' of space debris", (October 2020): https://www.washingtonpost.com/technology/2020/10/15/space-collision-might-happen-thursday/
[172] UNCOPUOS, "Report of the Scientific and Technical Subcommittee on its fifty-seventh session, held in Vienna from 3 to 14 February 2020", (June 2020) https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=A/AC.105/1224
[173] "Disarmament blog: space resolution adopted", (December 2020): https://blogs.fcdo.gov.uk/aidanliddle/2020/12/10/disarmament-blog-space-resolution-adopted/
[174] U.S Space Force, "USSF announces initial operational capability and operational acceptance of Space Fence", (March 2020) https://www.spaceforce.mil/News/Article/2129325/ussf-announces-initial-operational-capability-and-operational-acceptance-of-spa/
[175] DLR, "Im-proved safe-ty in Space – GES-TRA space radar ready to begin operations",(October 2020) https://www.dlr.de/content/en/articles/news/2020/04/20201013_space-radar-gestra-begin-operation.html
[176] SpaceNews, "Space traffic management idling in first gear", (November 2020): https://spacenews.com/space-traffic-management-idling-in-first-gear/
[177] SpaceNews, "Omnibus spending bill funds Commerce Department space traffic management work", (December 2020) https://spacenews.com/omnibus-spending-bill-funds-commerce-department-space-traffic-management-work/
[178] TASS, "Russia to launch first satellite to monitor space junk in 2027",(May 2020): https://tass.com/science/1161437

- In Japan, JAXA initiated CRD2, a project aimed at developing space debris removal, and contracted Astroscale for project's Phase 1.[179] JAXA also launched a demonstration of a J-SPARC initiative aimed at commercializing space debris prevention device, in partnership with ALE Co.[180]
- In India, ISRO inaugurated a new SSA Control Centre as part of the Network for space object Tracking and Analysis (NETRA). It will serve as a hub of all SSA activities in India. In addition to orbit determination, correlation and catalogue generation activities, dedicated labs will be set up at the centre for debris mitigation and remediation, compliance verification of UN/IADC guidelines and various R&D activities.[181] In addition, a joint statement issued after the third India-U.S. 2+2 strategic dialogue in October included a provision that the U.S. and India will start exchanging SSA data.[182]

Inauguration ceremony of ISRO's new SSA Control Centre (Credit: ISRO)

- The UAE Space Agency signed an agreement with UNOOSA to foster collaboration in space sustainability and to establish a UNOOSA office in the Emirates.[183]
- In the UK, the UK Space Agency has awarded over £1 million in funding to seven projects which will develop new sensor technology or artificial intelligence to monitor hazardous debris in space.[184]
- ESA has been developing Radio Frequency (RF) tags to improve the efficiency of close proximity operations and ADR[185] and supported a study investigating semi-controlled re-entry that is safer than uncontrolled re-entry but cheaper than fully controlled re-entry[186] In October, ESA published its annual Space Environment Report[187] underscoring both positive and negative trends in the recent period:[188]

While not all satellites comply with space debris mitigation guidelines, more and more space actors are attempting to adhere by the rules.	The number of debris objects, their combined mass and the total area they take up has been steadily increasing since the beginning of the space age, 2019 and 202 included. Collisions between debris and working satellites are predicted to overtake explosions as the dominant source of debris
More rockets (Incl. Rocket bodies such as upper stages) are being safely disposed of.	On average, over the last two decades, 12 accidental fragmentations have occurred in space every year – and this trend is unfortunately increasing
Around 88% of small payloads launched into LEO naturally adhere to debris mitigation guidelines due to low altitude	
Around 88% of small payloads launched into LEO naturally adhere to debris mitigation guidelines due to low altitude	

Table 4: ESA's assessment of the evolving space debris situation in Earth's orbits[189]

[179] JAXA, "JAXA concludes partnership-type contract for Phase I of its Commercial Removal of Debris Demonstration (CRD2)", (March 2020): https://global.jaxa.jp/press/2020/03/20200323-1_e.html
[180] JAXA, "Joint demonstration of J-SPARC initiated by ALE and JAXA, aimed at the commercialization of space debris prevention device", (June 2020): https://global.jaxa.jp/press/2020/06/20200605-1_e.html
[181] ISRO, "ISRO SSAControl Centre Inaugurated by Dr. K. Sivan, Chairman, ISRO/ Secretary", (December 2020): https://www.isro.gov.in/update/16-dec-2020/isro-ssacontrol-centre-inaugurated-dr-k-sivan-chairman-isro-secretary-dos
[182] "Joint Statement on the Third U.S.-India 2+2 Ministerial Dialogue", (October 2020): https://www.state.gov/joint-statement-on-the-third-u-s-india-22-ministerial-dialogue/
[183] UNOOSA, "UNOOSA and UAE Space Agency announce agreement to advance space sustainability", (June 2020) https://www.unoosa.org/oosa/en/informationfor/media/2020-unis-os-532.html
[184] Government of the United Kingdom, "Government backs UK companies tackling dangerous 'space junk'", (September 2020) https://www.gov.uk/government/news/government-backs-uk-companies-tackling-dangerous-space-junk
[185] ESA, "Radio Frequency Tags To Ensure Safe Rendezvous", (April 2020) https://blogs.esa.int/cleanspace/2020/04/15/radio-frequency-tags-to-ensure-safe-rendezvous/
[186] ESA, "Design for demise: bringing spacecraft down safely and efficiently", (May 2020) https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Design_for_demise_bringing_spacecraft_down_safely_and_efficiently
[187] ESA, "ESA's Annual Space Environment Report", (September 2020) https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf
[188] ESA, "The current state of space debris", (October 2020) https://www.esa.int/Safety_Security/Space_Debris/The_current_state_of_space_debris
[189] Ibid.

Progress in the creation of the Latin American and Caribbean Space Agency (ALCE)

Countries in the Latin American and Caribbean region envisioned the possibility to establish a unified space agency. In 2013, the Brazilian Space Agency (AEB) expressed its interest in an alliance of national space agencies (ALAS) which never materialized.[190]

In 2020, Mexico sought to boost the initiative of a regional space agency during its presidency of the Community of Latin American and Caribbean States (CELAC). In October, the project incurred its first tangible development as Argentina joined in and signed with Mexico a Declaration on the Constitution of a Regional Mechanism of Cooperation on Space Affairs, paving the way towards the establishment of the Latin American and Caribbean Space Agency (ALCE).

The Declaration was signed by the two countries' foreign ministers and since then, six other countries (Bolivia, Ecuador, El Salvador, and Paraguay, Peru and Colombia) embarked on the project.[191] Peru and Colombia were granted an observer status.[192] Brazil left CELAC in January 2020, rendering the prospect of it joining ALCE uncertain. The rationale of ALCE is to pool resources, promote technology transfer and increase regional space capacities.[193]

ALCE is expected to begin operations in 2021.[194] While the Declaration contains six basic programmatic actions, concrete plans have not yet been released as of December 2020.

In parallel to ALCE, there were also some Latin American space policy developments at national level:

- Costa Rica announced its desire to establish its own space agency. In July, the Legislative Assembly passed a bill towards the creation of the Costa Rican Space Agency.[195]
- The same month, the Uruguayan Air Force created the "Space Affairs Commission" in order to spark the foundation of a Uruguayan national space agency.[196]

Signing of the Declaration on the Constitution of Regional Mechanism of Cooperation on Space Affairs by Mexican and Argentinian foreign ministers (Credit: Mexican Government)

---

[190] MundoGEO ,"Brasil propone una alianza Latinoamericana de agencias espaciales", (November 2013) https://mundogeo.com/es/2013/11/11/brasil-propone-una-alianza-latinoamericana-de-agencias-espaciales/

[191] Gobierno de Mexico ,"México y Argentina sientan las Bases para la Constitución de la Agencia Latinoamericana y Caribeña del Espacio. ", (October 2020): https://www.gob.mx/aem/prensa/mexico-y-argentina-sientan-las-bases-para-la-constitucion-de-la-agencia-latinoamericana-y-caribena-del-espacio-254452

[192] Periferia Ciencia, "La Agencia Espacial Latinoamericana y del Caribe sumó a seis países", (November 2020): http://www.periferiaciencia.com.ar/noticia.php?n=1692)

[193] La Jordana, "Agencia Latinoamericana y Caribeña del Espacio operará en 2021", (November 2020): https://www.jornada.com.mx/ultimas/politica/2020/11/16/agencia-latinoamericana-y-caribena-del-espacio-operara-en-2021-5499.html

[194] NIUSGEEK, "La Agencia Latinoamericana y Caribeña del Espacio (ALCE) empezará sus operaciones en 2021: estos son sus objetivos", (November 2020): https://rpp.pe/ciencia/espacio/la-agencia-latinoamericana-y-caribena-del-espacio-alce-empezara-sus-operaciones-en-2021-estos-son-sus-objetivos-noticia-1305359?ref=rpp

[195] El Periodico, "Proyecto para crear Agencia Espacial Costarricense recibe visto bueno de comisión legislativa.. Allan Madriz", (July 2020): https://elperiodicocr.com/proyecto-para-crear-agencia-espacial-costarricense-recibe-visto-bueno-de-comision-legislativa/

[196] ICN, "Futura agencia espacial uruguaya intentaría conseguir capacitación de Rusia y EEUU", (August 2020): https://www.icndiario.com/2020/08/futura-agencia-espacial-uruguaya-intentaria-conseguir-capacitacion-de-rusia-y-eeuu/

New bilateral collaborations announced in 2020

More than 30 major bilateral cooperation agreements on space activities were signed in 2020, including both new partnerships and expanded collaborations between countries already working together:

January France – Egypt	CNES signed cooperation agreement with the Egyptian Space Agency covering a range of fields including Earth observation, the Space Climate Observatory initiative, space applications, the development of nanosatellites and training.
January France – China	President of CNES Jean-Yves Le Gall, signed a framework agreement with Mr. Bai Chunli (president of the Chinese Academy of Sciences), concerning research on microgravity and the Earth Observation domain, also linked to climate actions.
January Russia – Belarus	The agreement between Roscosmos and the National Academy of Sciences of Belarus provides the basis for expanding the Canopus constellation of remote sensing satellites, improving its capabilities and intensifying the cooperation on the data and services.
February Italy – Bahrain	ASI signed a Letter of Intent with the National Space Science Agency (NSSA) of the Kingdom of Bahrain to lay the foundations for further cooperation on space science and exploration as well as education opportunities in the sector.
February Italy – Australia	ASI signed a Declaration of Intent with the Australian Space Agency to implement a previous MoU (Oct. 2019) and increase cooperation for joint experiments on the ISS, giving opportunity to Australia to access the Station for scientific activities.
February Hungary – Singapore	The agreement between the Hungarian MFA and Singapore Space Technology Association covers the areas of EO and climate change, research and development, robotic space exploration, and space communication equipment.
February Luxemburg – New South Wales (AUS)	The Grand Duchy of Luxembourg and the State of New South Wales, Australia, signed a MoU on future cooperative space activities covering space science, technology, applications, exploration, policy and law.
February USA – South Africa	The NASA – SANSA study agreement explored the potential of a ground station in South Africa to support near-Earth and deep space exploration. In May, South African cabinet approved the plans for a ground station in Western Cape province, thus complementing the existing U.S. network of deep space ground stations in the US, Spain and Australia.
February France, Italy, USA, the UK	NATO Defence ministers of 4 countries signed an MoU that will provide NATO with military satellite communication capabilities for 15 years, ensuring continuation of a previous satcom service (2005-2019).
May USA – Peru	Officials of the U.S. Space Command and the Peruvian National Commission on Aerospace Research and Development signed an SSA data sharing agreement.
June Finland – USA	The Finnish Geospatial Research Institute agreed with NASA on a new cooperation in the space geodesy field.
June China – Serbia	The new MoU seeks to improve bilateral cooperation between Serbia and China in multiple domains and includes a provision for the joint development of a satellite.
June UK – USA	The UK and American governments signed the "US-UK Technology Safeguards Agreement" enabling U.S. companies to participate in space launches from the British soil.
June Latvia – ESA	On the basis of the Association Agreement between ESA and the Republic of Latvia (for a duration of seven years), Latvia became ESA Associate Member.

July Australia – Japan	JAXA and the Australian Space Agency signed a Memorandum of Cooperation recognising opportunities to deepen and expand bilateral space cooperation
July USA – Portugal	Officials of the U.S. Space Command and the Portuguese National Defense Resources signed an SSA data sharing agreement.
July Hungary – France	The Hungarian MFA signed a memorandum of understanding with CNES covering a broad range of space-related activities.
July Portugal – Hungary	Portuguese and Hungarian ministers signed a MoU to strengthen the Hungarian-Portuguese cooperation in the areas of space, science and technology.
August India – Nigeria	The MoU envisages India – Nigeria collaboration in space science, planetary exploration, ground stations, development of micro and mini-satellites.
August USA – UK	The U.S. Space Force signed an agreement allowing to share the Standardized Astrodynamics Algorithm Library (SAAL) with the UK MoD.
September USA – UAE	NASA has signed a Reimbursable Space Act Agreement with UAE's Mohammed Bin Rashid Space Centre (MBRSC) to train UAE astronauts on ISS systems.
October Turkey – Kazakhstan	The Turkish Space Agency signed an MoU with Kazakhstan's space agency Kazcosmos to enable cooperation between two nations' aerospace institutions and companies.
October France – India	France and India agreed on French contribution to ISRO's mission to Venus, scheduled for 2025. Earlier in 2020, CNES and ISRO extended their cooperation on remote sensing missions and agreed to collaborate in human spaceflight.
October Italy – Japan	ASI and JAXA signed an MoC aiming to renew and extend an on-going bilateral collaboration initiated in 2010. It will include cooperation in areas such as space transportation, EO and space science
October Germany – Japan	DLR and JAXA signed a cooperation agreement on the DESTINY+ mission. In 2024 it will travel to the asteroid 3200 Phaethon, aiming to collect and analyse cosmic dust samples.
October Mexico – Argentina	Foreign Ministers of the two countries signed a declaration on the constitution of a Latin American and Caribbean Space Agency.
October NASA – ESA	NASA and ESA formalised the partnership on the Artemis Gateway outpost through a dedicated MoU aimed to delineate future European contributions through modules and two additional Orion spacecraft.
November South Africa – Brazil	SANSA and AEB executives signed an MoU to launch a joint collaboration, citing in the press release primarily support to industry-to-industry ties
November ESA – South Africa	In a video call, ESA and SANSA officials signed an MoU to extend and expand mutual ties. No further details of the MoU were disclosed.
December Turkey – Ukraine	The new agreement expects bilateral cooperation on launching technologies, satellite production, marketing and production of subsystems, and a common rocket launcher.
December USA – Canada	The Canada-U.S. Gateway Treaty specifies, among other provisions, that Canadian astronaut will be part of the Artemis II mission.
December USA – Japan	The U.S. Space Force and Japan's Office of National Space Policy signed an MoU to launch two U.S. space domain awareness payloads on Japan's QZSS in 2023 and 2024.

Table 5: New bilateral collaborations announced in 2020 (Source: ESPI database)

1.2 Major space programme developments in 2020

1.2.1 Access to space programmes

Europe: Ups and downs for main launcher programmes and growing support to new launchers and spaceports

Ariane 6 and Vega-C are the next-generation of European launchers, currently under development.

For Ariane 6, ArianeGroup is the industrial lead contractor and design authority. While the new launcher was supposed to be operational in 2020, ESA announced the postponement of Ariane 6 maiden launch to the second half of 2021, and then to the second quarter of 2022.[197] ESA also announced the Agency had secured an additional €218 million from Member States to cover a 6% increase in Ariane 6 development cost (€3.8 billion in total[198]), due to delays.

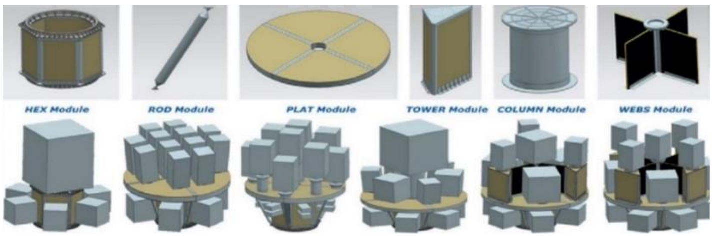
The Vega C vehicle, manufactured by Avio as prime contractor, is now expected to have its maiden launch in mid-2021, rather than late-2020 or early-2021 as previously planned. The postponement is due to delays in development activities, as well as due to the COVID-19 impacts on supply chains and the Guiana Space Centre.[199] In July UNOOSA and Avio signed an MoU to cooperate on "Access to Space 4 All". The initiative aims to provide institutions from UN Member States, in particular developing countries, with the opportunity to access space using available slots in a Vega-C launcher.[200]

Despite these delays, in October, ArianeGroup and Avio successfully tested (third and final static fire test) the P120C solid engine, which will be used on both Ariane 6 and Vega C.[201] Also, the first upper stage of Ariane 6 was fully integrated, equipped with the Vinci liquid engine.[202]

Vega-C and Ariane 6 in version 64 (Credit: ESA)

On the side of operational launchers, 2020 was again a turbulent year for Vega. In November, Vega suffered a second failure in the last three launches, losing two French and Spanish governmental satellites due to human error on the AVUM upper stage.[203] After the launch failure, French and Italian ministers in charge of space issued a joint statement underlining full institutional support to Ariane and Vega programmes.[204] The other failure, Vega's first, came in July 2019 and resulted in the loss of UAE's FalconEye 1 satellite. In January, UAE's subsequent FalconEye 2 was switched from Vega to Soyuz to minimise a probable delay due to Vega being grounded at that time.[205] This unfortunate event should not eclipse the successful Proof of Concept mission of Vega Small Spacecraft Mission Service (SSMS)[206] executed by Arianespace on September 2nd and which aims to offer routine services tailored to small satellites. The SSMS received funding from ESA and EU's H2020 programme. During this 16th Vega flight deployed to LEO 53 rideshare payloads for 21 customers.

[197] Paraboliarc, "Ariane 6 Launch Delayed to Second Quarter of 2022", (October 2020): http://www.parabolicarc.com/2020/10/29/ariane-6 launch-delayed-to-second-quarter-of-2022/
[198] European Commission, "European Commission and European Investment Bank Group join forces to boost space sector investment with €200 million of financing", (January 2020): https://ec.europa.eu/commission/presscorner/detail/en/IP_20_79
[199] SpaceNews, "Vega C debut slips to mid-2021", (September 2020): https://spacenews.com/vega-c-debut-slips-to-mid-2021/
[200] UNOOSA, "Accessing Space with VEGA-C" , (October 2020): https://www.u noosa.org/oosa/en/ourwork/psa/hsti/vegac.html
[201] ArianeGroup, "Successful final test firing of the P120C solid rocket motor for Ariane 6 and Vega-C", (October 2020): https://www.ariane.group/wp-content/uploads/2020/10/Success-of-third-P120C-test-firingENG.pdf
[202] ArianeGroup, "Successful assembly of the first upper stage of Ariane 6", (October 2020): https://www.ariane.group/de/neuigkeiten/erfolgreiche-montage-der-ersten-oberstufe-der-ariane-6/
[203] Space Flight Now, "Arianespace traces cause of Vega launch failure to 'human error'", (November 2020): https://spaceflightnow.com/2020/11/17/arianespace-traces-cause-of-vega-launch-failure-to-human-error/
[204] Movimento Cinque Stelle, "Settore dello spazio, dichiarazione congiunta Italia-Francia", (November 2020) https://m5stelle.com/settore-dello-spazio-dichiarazione-congiunta-italia-francia/
[205] SpaceNews, "UAE's Falcon Eye 2 satellite switched from Vega to Soyuz", (January 2020) https://spacenews.com/uaes-falcon-eye-2-satellite-switched-from-vega-to-soyuz/
[206] ESA, "N° 16–2020: Vega return to flight proves new rideshare service", (September 2020): https://www.esa.int/Newsroom/Press_Releases/Vega_return_to_flight_proves_new_rideshare_service



Modular parts and payload configurations of Vega's SSMS payload dispenser (Credit: ESA)

In 2020, both Ariane 6 and Vega-C garnered some additional European institutional support for future launches. In March, ESA confirmed on behalf of the European Commission the pre-order of four Ariane 6 launches to launch 3rd batch Galileo satellites from 2022 onwards.[207] In December, EUMETSAT joined the signatories of the "Joint statement on the institutional exploitation of Ariane 6 and Vega C", which was initiated by ESA in 2018 and aims to support preference for European launchers on European institutional missions.[208] The statement has been signed so far by agencies and institutions from France, Italy, Germany, Spain, Austria and Switzerland. Under this framework, Arianespace and EUMETSAT will consolidate the launch planning for Meteosat Third Generation (MTG) and Metop-SG satellites. MTG-S1 and MTG-I2 will be launched with Ariane-6 in 2023 and 2025.

Other important developments in Europe:

- Several European governments, namely Portugal, Germany, Sweden, Italy, Norway and the UK continued to provide public support to the establishment of new spaceports in their territories. These measures took primarily the form of public commitments or regulatory instruments. [209, 210, 211]
- European institutional support to small launch vehicle initiatives has also increased. German startups Hympulse, Isar Aerospace and Rocket Factory Augsburg received financial support from DLR and ESA.[212] Hympulse, received also support by the European Commission with a €2.5 million grant.[213]
- The Themis programme is based on decisions taken at ESA's last Ministerial Council Space19+, where ESA has taken the first steps towards the in-flight demonstration of this prototype reusable rocket first stage. Suborbital Themis test flights have been scheduled to 2023 and ArianeGroup, as a prime contractor, received a contract worth €33 million for the 'Themis Initial Phase'.[214]
- ESA also moved ahead towards Europe's first robotic orbital spaceplane Space Rider, signing €167 million contract with Thales Alenia Space and Avio in December. This partially reusable spaceplane will have its maiden flight in mid-to-late 2023 aboard Vega-C. Italy has long been the leading ESA Member State behind this initiative and will provide 75% of programme funding. At ESA's Space19+, eight additional ESA Member States committed their support – Belgium, Czech Republic, France, Ireland, Norway, Portugal, Romania, Spain and Switzerland.[215]

---

[207] ESA, "ESA and the European commission preorder four more Ariane 6 launches" (March 2020): https://www.arianespace.com/press-release/european-commission-preorder-ariane-6/
[208] Arianespace, "Eumetsat confirms the choice of Arianespace's European launchers for its future missions" (December 2020) https://www.arianespace.com/press-release/eumetsat-confirms-the-choice-of-arianespaces-european-launchers-for-its-future-missions/
[209] The Barent Observer, "Sweden to launch satellites from space centre inside the arctic circle", (October 2020)
[210] AeroNewsX, "Italy became the first country in Europe to approve constructions of spaceport", (October 2020): https://aeronewsx.com/italy-becomes-first-country-in-europe-to-approve-construction-of-spaceports/
[211] Get to text, "In the North Sea and in Rostock: Germany dreams of the spaceport", (September 2020): https://gettotext.com/in-the-north-sea-and-in-rostock-germany-dreams-of-the-spaceport/
[212] SpaceWatch.Global, "ESA gives first Boost to three German space start-ups", (November 2020):
[213] SpaceNews, DLR spinoff HyImpulse plans small launcher debut in 2022", (August 2020): https://spacenews.com/dlr-spinoff-hyimpulse-plans-small-launcher-debut-in-2022/
[214] ESA, "ESA plans demonstration of a reusable rocket stage", (December 2020): https://www.esa.int/Enabling_Support/Space_Transportation/ESA_plans_demonstration_of_a_reusable_rocket_stage
[215] Space Intel Report, "It took 30 years, but Europe will now have a reusable space plane for LEO missions", (December 2020): https://www.spaceintelreport.com/it-took-30-years-but-europe-will-now-have-a-reusable-space-plane-for-leo-missions/

China: Several inaugural launches and new details on future launch vehicles

In 2020, China moved ahead with several launch vehicle programmes:

- On May 5th, the heavy-lift Long March 5B rocket, a variant of the operational Long March 5, conducted its maiden flight, launching an uncrewed prototype crew spacecraft from the Wenchang Space Centre. The launch aimed to demonstrate the capability to carry space station modules to LEO and to perform a test of a new spacecraft designed for human spaceflight and deep space exploration.[216]
- On March 16th, the first launch of the new generation medium-lift Long March-7A rocket occurred as planned, but the rocket experienced an unspecified anomaly, resulting in launch failure.[217]
- On December 22nd, a medium-lift Long March 8 made its maiden flight under a long-term Chinese plans to develop reusable launcher.[218] While this particular vehicle was still expendable, a future Long March 8R variant will have a reusable first stage. In November, a senior CASC official announced that China will develop its first launch vehicle capable of vertical take-off – vertical landing by 2025.[219]

With the maiden flight of Long March 5B, China succesfully tested its most powerful rocket yet, designed to lift up to 22 tons to LEO. Even more capable launchers are in development (Credit: CGTN / Youtube)

- In September, Long March 11 has successfully launched 9 commercial EO satellites (Jilin-1 constellation) from a mobile sea-based platform in the Yellow Sea for the second time[220], confirming China's sea launch capability that was first demonstrated in 2019.
- At the 2020 China Space Conference in Fuzhou, also in September, a new Moon rocket programme was revealed. The name, as well as the first test flight date of the new launcher have not been disclosed. It is planned to be 87m long, with a three-stage central core, similarly to the ULA's Delta IV Heavy and SpaceX's Falcon Heavy.[221]
- In November, new details were disclosed on the Long March 9 super heavy launch vehicle. Planned for test launch in 2030, Long March 9 will be 93m long with a 10m -diameter core and will be capable of lifting 140 tons to LEO or 50 tons to trans lunar injection. It has long been part of long-term plans to send Chinese astronauts to the Moon and facilitate deep space exploration, however the launcher's exact role is still not clearly defined.[222]
- In September, China also launched an experimental spaceplane aboard Long March 2F, [223] culminating a multiyear effort to develop a reusable spaceplane, which bears similarities to U.S. X-37B spacecraft operated by the U.S. Space Force.

216 SpaceNews, "Long March 5B launch clears path for Chinese space station project" (May 2020)
217 SpaceNews, "Launch of China's new Long March 7A ends in failure" (March 2020)
218 Reuters, "China's new Long March 8 rocket makes maiden flight (December 2020)
219 SpaceNews, "China sets targets for smart, recoverable and reusable launch vehicles" (November 2020)
220 Xinhuanet, "China sends nine satellites into orbit by sea launch" (September 2020): http://www.xinhuanet.com/english/2020-09/15/c_139369840.htm
221 Space.com, "China is building a new rocket to fly its astronauts on the moon (October 2020)
222 SpaceNews, "China pushes ahead with super-heavy-lift Long March 9" (November 2020)
223 SpaceNews, "China carries out secretive launch of 'reusable experimental spacecraft'" (September 2020)

Russia: Second test flight of Angara-A5 and a new reusable launcher in development

Second test flight of Angara-A5, from Plesetsk in December (Credit: Russian MoD)

In December, Russia conducted the second test launch of the Angara-A5 heavy-class carrier rocket from the Plesetsk Cosmodrome.[224] The first test launch of Angara-A5 dates back to 2014. The Angara is a family of next-generation Russian launch vehicles, consisting of light, medium and heavy carrier rockets with a lifting capacity of up to 37.5 tonnes.[225] According to Roscosmos, the plan for 2021 foresees a third launch of Angara-A5 with a new Persei booster and a light Angara-1.2 launch vehicle. Roscosmos also signed a deal to deliver four Angara-A5 rockets to the Defence Ministry.[226] Purpose-wise, Angara-A5 should replace the ageing Proton launcher. In 2020, three Proton-M launch vehicles were found to have defective components, causing launch schedule delays also for the ESA-Roscosmos ExoMars mission.[227]

Both the Angara rocket family and the Vostochny spaceport in the Russian Far East persistently suffer from delays. The Vostochny spaceport has historically gone through multiple corruption scandals, which resurfaced again in 2020 with two officials arrested for their alleged involvement in bribery and embezzlement.[228] In July, the first parts of the Angara launch pad were shipped to Vostochny.[229] Roscosmos expects Angara's first launch from Vostochny in 2023, while in 2025 Angara-A5 is expected to launch a crewed spacecraft for the first time.[230] This crewed mission will use the Orel spacecraft. This crew transportation vehicle has been in development for years but new details emerged recently, anticipating the first uncrewed launch in 2023.[231]

On October 5th, Roscosmos announced the development of its first reusable launch vehicle with a methane propellant under the Amur programme. Roscosmos and the Progress Space Rocket Centre signed a contract on the conceptual design of the new launch vehicle, which will have a reusable first stage and a non-recoverable second stage. About RUB 70 billion (USD 880 million) will be invested in the design and manufacture, including estimated per-launch cost of USD 22 million Planned for maiden launch in 2026, the launcher will have a take-off mass of about 360 tonnes and will be 55m high.[232]

On top of these developments, the production of super heavy-lift Yenisei rockets (up to 70+ tons to LEO) has reportedly begun in 2020, targeting a first launch by 2028.[233] Roscosmos also announced that the development of Soyuz-5 launcher, envisioned to replace the Zenit rockets, will fully start-off in 2021 after the completion of critical design review phase. Its first launch is anticipated in mid-2020s.[234]

---

[224] AP News, "Russia test-launches Angara A5 heavy lift space rocket", (December 2020): https://apnews.com/article/russia-test-launch-angara-a5-space-8009db27b7e07f9ee41212d252763bc4
[225] TASS, "Russia's space agency may launch three Angara carrier rockets next year", (August 2020):
[226] Ibid.
[227] SpaceWatch.Global, "Quality Control Issues Delay Russian Proton-M Launches": https://spacewatch.global/2020/04/quality-control-issues-delay- russian-proton-m-launches/
[228] Parabolic Arc, "Officials Arrested in Alleged Vostochny Embezzlement, Bribery Scheme", (October 2020): http://parabolicarc.com/2020/10/26/officials-arrested-in-alleged-vostochny-embezzlement-bribery-scheme/
[229] Roscosmos, "Angara launching pad setting off to Vostochny", (June 2020): http://en.roscosmos.ru/21526/
[230] Ibid.
[231] Communal News, "'New Details Emerging on Russia's "Orel" Spacecraft", (June 2020): https://communalnews.com/new-details-emerging-on-russias-orel-spacecraft/
[232] TASS, "Russia to spend $880 mln on Amur reusable space rocket", (October 2020): https://tass.com/science/1208729
[233] Ruaviation, "Roscosmos starts manufacturing components of super-heavy Yenisei rocket", (March 2020): https://www.ruaviation.com/news/2020/3/19/14849/?h
[234] "Conceptual design of Russia's new Soyuz-5 carrier rocket to be ready by year end", (November 2017): https://tass.com/science/975015

Japan: Delayed maiden flight of H3, IHI Aerospace to develop, build and operate Epsilon S

On June 12th, JAXA announced an agreement with IHI Aerospace for the development of the Epsilon S launcher and its independent launch service business. JAXA aims at demonstrating synergy with the H3 launcher, also to reduce costs, as Epsilon S shares various components and technologies with the larger H3. Moreover, JAXA announced its first contract with NEC Corporation to launch the Vietnamese LOTUSat-1 EO satellite in 2023, which will be Epsilon S's first launch.[235] In addition, JAXA announced postponements on the H3 rocket (a successor to the H-IIA and H-IIB) due to technical problems, which were identified in the LE-9 first-stage engine. The first H3 test flight was postponed from fiscal year 2020 (ending on March 31st, 2021), to fiscal year 2021.[236]

Heavy-lift H3 is Japan's flagship future launcher programme (Credit: JAXA)

USA: Increase in SLS cost, delayed first launch and updates in U.S. next-generation military launch programme

The uncrewed inaugural test flight of Space Launch System (SLS), has been postponed to November 2021.[237] In January, SLS core stage has been installed at NASA's Stennis Space Center in Mississippi in January, where it underwent important trials, including a series of green run tests late in the year[238], and experienced some technical setbacks and delays.[239] The original test schedule was delayed due to COVID-19, delaying to 2021 also the shipping of the core stage to NASA's Kennedy Space Center (KSC) in Florida for final integration. At KSC, the assembly of rocket's twin solid boosters began in November.[240] In addition, NASA increased the cost estimate for the SLS to $9.1 billion, bringing the total SLS cost to 30% above the original baseline set in 2014.[241]

In the military domain, the U.S. Air Force selected ULA and SpaceX to launch satellites for the U.S. military and intelligence agencies as part of the National Security Space Launch (NSSL) Phase 2. The two companies will collectively conduct 34 missions (60% ULA and 40% SpaceX) between 2022 and 2027. ULA plans to use its forthcoming Vulcan Centaur launch vehicle, while SpaceX will rely on the Falcon 9 and Falcon Heavy. The ULA shift to the new launcher is compelled by a legislative obligation to end the DoD's reliance on ULA's Atlas 5 rocket, which uses Russian-made RD-180 engine, by December 31st 2022. In September, the U.S. Space Force issued SpaceX a contract modification, allowing it for the first time to reuse already flown boosters on upcoming GPS III launches 2021.[242] The Space Force also announced it will complete the transition to a fully reusable SpaceX fleet in 18 months.[243]

Iran: New launch vehicle successfully deploying Iran's first military reconnaissance satellite

In April, the Islamic Revolutionary Guard Corps (IRGC) launched Iran's first military reconnaissance satellite, using the Qased launch vehicle, which is a substantially modified version of the Iranian Space

[235] JAXA, "Signing of the "Basic Agreement on the Development of the Epsilon S Launch Vehicle and the Implementation of the Launch Service Business", (June 2020): https://global.jaxa.jp/press/2020/06/20200612-1-2_e.html
[236] JAXA, "Change of Schedule for the H3 Launch Vehicle Project", (September 2020): https://global.jaxa.jp/press/2020/09/20200911-2_e.html
[237] Space Policy Online, "SLS and EGS costs grow with latest launch slip to at least November 2021", (August 2020)
[238] Space.com, "NASA SLS megarocket testing stalled by temperature issues", (December 2020):
[239] Space.com, "NASA's SLS megarocket 'hot fire' test delayed after early shutdown in fueling trial", (December 2020)
[240] CNN, "NASA begins assembling the rocket for Artemis moon mission (November 2020)
[241] SpaceNews, "NASA increases cost estimate for SLS development", (August 2020)
[242] C4Isrnet, "Starting in 2021, SpaceX may reuse boosters for US Space Force launches" (September 2020): https://www.c4isrnet.com/battlefield-tech/space/2020/09/25/starting-in-2021-spacex-can-reuse-boosters-for-space-force-launches/
[243] SpaceNews, "SpaceX to transition to fully reusable fleet for national security launches", (November 2020)

Agency's (ISA) Safir launcher.[244] The Qased rocket was small enough to be launched from a Transporter Erector Launcher (TEL)[245], providing Iran with more flexibility. The launch took place near Shahroud instead of near Semnan where the Imam Khomeini Spaceport is located and where all previous satellite-launch attempts had taken place so far.[246] The most recent successful launch by Iran before this launch dates back to February 2015.

Canada: Ambition to become a launching state

During a national space conference, a representative of the Ministry of Transport confirmed the government's intention to become a launching state. [247] The announcement, which is in line with the 2019 Canadian Space Strategy, focused on Canada's intention to update and implement a legal and regulatory framework for launching services. No details were disclosed yet about whether Canada's ambitions also entail the development of domestic launch vehicles or spaceports.

Brazil: Government wants to develop the Alcântara launch site

The Brazilian government has been gradually stepping up its support for the Alcântara launch site, world's closest spaceport to the equator. With the U.S.-Brazil Technological Safeguards Agreement[248] signed in 2019 and ratified by the Brazilian Congress in 2020, the Alcântara launch site will be able to launch rockets, spacecraft and satellites equipped with American technology. [249] The Brazil Space Agency also further confirmed its willingness to attract small launch vehicles to Alcântara, issuing a public call on May 25th for companies and organizations to apply for a launch license to use the Alcantara spaceport.[250] Altogether 14 companies submitted their proposals. [251] One of the major limits of the Brazilian spaceport is related to its current incapacity to support liquid-fuelled launchers.[252]

Alcântara launch site (Credit: Brazil Space Agency)

[244] International Institute for Strategic Studies, "The IRGC gets into the space-launch business", (May 2020): https://www.iiss.org/blogs/analysis/2020/05/iran-military-satellite-launch-irgc
[245] Seradata, "Iran launches new Qased rocket type with Noor military sat aboard", (April 2020): https://www.seradata.com/iran-launches-new-qased-rocket-type-with-noor-military-sat-aboard/
[246] International Institute for Strategic Studies, "The IRGC gets into the space-launch business", (May 2020): https://www.iiss.org/blogs/analysis/2020/05/iran-military-satellite-launch-irgc
[247] SpaceQ, "Canada decides it wants to be a launching state", (October 2020): https://spaceq.ca/canada-decides-it-wants-to-be-a-launching-state/
[248] "Brazil (19-1216.1) – Agreement on Technology Safeguards Associated with U.S. Participation in Launches from the Alcantara Space Centre (December 2019): https://www.state.gov/brazil-19-1216.1
[249] Universidad de Navarra, "Brazil relaunches its space industry by opening the Alcântara base to the US", (January 2020): https://www.unav.edu/web/global-affairs/detalle/-/blogs/brazil-relaunches-its-space-industry-by-opening-the-alcantara-base-to-the-us
[250] SpaceNews, "Brazil looks abroad for small rockets seeking a little extra boost", (August 2020)
[251] Parabolic Arc, "Brazilian Space Agency Receives 14 Proposals for Use of Alcantara Spaceport", (August 2020)
[252] SpaceNews, "Brazil looks abroad for small rockets seeking a little extra boost", (August 2020)

1.2.2 Application programmes

Status and updates in major GNSS programmes

	In operation	In testing	In commissioning	In maintenance	In decommissioning	In orbit spare
Galileo [253]	22			4		
GPS[254]	31					
Glonass[255]	23	2		1		1
BeiDou[256]	44	1				

Table 6: Status on GNSS Satellite Constellation (Update: April 2021)

Galileo is one of the EU's flagship programmes. In 2020, the Search and Rescue (SAR) Return Link Service, a unique functionality, was activated, and the Galileo satellite constellation is now able to support fast localisation of emergency and distress messages with a confirmation of distress detection, thus further optimising the Search and Rescue services.[257] Announced in January as operational, Galileo's SAR Return Link Service has been developed by ESA, based on an agreement between the European Commission and the Cospas-Sarsat Programme that equipped 24 of the 26 Galileo satellites with SAR repeaters.

In August, following the European Commission's decision to accelerate development of Galileo Next Generation, ESA initiated procurement for the Galileo 2nd Generation (G2G).[258] In January 2021, the European Commission awarded two contracts for a total of twelve satellites with an overall value of EUR €1.47 billion, to Thales Alenia Space and Airbus Defence & Space. The goal is to start the deployment of the new infrastructure in 2024.[259]

In the EGNOS programme, the GEO-3 payload of EGNOS, hosted aboard the EUTELSAT 5 West B satellite, became operational in February 2020.[260] After the U.S. initiated the migration of GPS constellation from GPS Block II satellites to new generation GPS Block III satellites, the first GPS III satellites was introduced into the EGNOS services on July 27th.[261] The European Commission and GSA gained assurance on the "backward compatibility" of the GPS III satellites concerning GPS II in series of cooperation exchanges with the US.[262]

[253] European GNSS Service Centre, "Galileo Constellation Information", (Last accessed: May 2021): https://www.gsc-europa.eu/system-service-status/constellation-information
[254] GPS.gov, "GPS Constellation arrangement", (Last accessed: May 2021): https://www.gps.gov/systems/gps/space/#:~:text=GPS%20satellites%20fly%20in%20medium,20%2C200%20km%20(12%2C550%20miles).&text=The%20satellites%20in%20the%20GPS,slots%22%20occupied%20by%20baseline%20satellites
[255] GLONASS, "GLONASS Constellation" (Last accessed: May 2021): https://glonass-iac.ru/en/GLONASS/
[256] GLONASS, "BEIDOU Constellation Status": https://www.glonass-iac.ru/en/BEIDOU/index.php
[257] European GNSS Service Centre, "Galileo Return Link Service declared at European Space Conference" (January 2020): https://www.gsa.europa.eu/newsroom/news/galileo-return-link-service-declared-european-space-conference
[258] 'GPW World, "Directions 2021: Galileo expands and modernizes global PNT", (December 2020) https://www.gpsworld.com/directions-2021-galileo-expands-and-modernizes-global-pnt/
[259] "Commission awards €1.47 bn in contracts to launch the 2nd Generation of Galileo Satellites", available at: https://ec.europa.eu/defence-industry-space/commission-awards-eu147-bn-contracts-launch-2nd-generation-galileo-satellites-2021-01-20_en.
[260] "EGNOS payload enters service on EUTELSAT 5 West B", (February 2020): https://www.gsa.europa.eu/newsroom/news/egnos-payload-enters-service-eutelsat-5-west-b
[261] European GNSS Service Centre, "GPS III successfully introduced into EGNOS services", (August 2020): https://www.gsa.europa.eu/newsroom/news/gps-iii-successfully-introduced-egnos-services
[262] Available at: https://www.gsa.europa.eu/newsroom/news/gps-iii-successfully-introduced-egnos-services

Furthermore, several initiatives fostering the uptake of Galileo and EGNOS-enabled services were pursued during the year, including following projects:

- As part of the Enhanced Navigation in Service (ENSPACE) project funded by Horizon 2020, a Galileo/GPS enabled receiver was launched to the ISS, integrated into the CubeSat mission BOBCAT-1.
- As part of the EGNSS4RPAS project funded by the European Commission[263], the EGNSS-enabled drone flight trials demonstrated that the use of Galileo in dual constellation with GPS notably improves accuracy compared to GPS-only for both the horizontal and vertical dimension.

In the United States, the next-generation GPS III satellites (third generation of US navigation satellite), is manufactured by Lockheed Martin. They provide an improvement over their predecessors, especially regarding signal reliability, accuracy, integrity and anti-jamming capabilities.

In January and April, the two last operational GPS IIA satellite (Space Vehicle 34 and 36) were decommissioned,[264,265] while the GPS III constellation was further deployed with the third and fourth launch of GPS III satellites (SV 03 and SV 04).[266] They both are Military code (M-code) satellites added to the GPS constellation. GPS III SV 03 received Space Force's Operational Acceptance in July, becoming the third GPS III satellite to receive approval in less than a year, after that GPS III SV02 received it in March.[267]

The Ligado case and concerns of harmful radio interference to GPS services in the U.S.

On April 20th, the FCC unanimously authorised Ligado to deploy its terrestrial L-band 5G network in frequencies adjacent to those used for GPS services, despite the interference concerns and objections raised by the Department of Defense and industry representatives, asking for reversion of the FCC's decision.[268] According to the FCC, the approval of Ligado application ensures the protection of adjacent band operations, further guaranteed by technical changes in the 5G network design. [269]

In May, the Pentagon stated that it would formally appeal against the FCC approval, seeking help from the Congress to reverse the decision. Also in May, the FCC informally confirmed its decision addressing the criticism formulated by the Senate and the House of Representatives' Armed Services Committees.[270] In June five associations engaged in GPS services formed the "Keep GPS Working Coalition", announcing support to a Senate Committee bill that would require Ligado to provide financial relief to GPS users impacted by its 5G network. [271]

In 2018, the U.S. Air Force signed the deal with Lockheed Martin to purchase up to 22 upgraded GPS III satellites known as GPS IIIF. In December 2020, it was revealed that the Space Force has executed an option to purchase two more GPS IIIF spacecraft with a $511 million contract.[272]

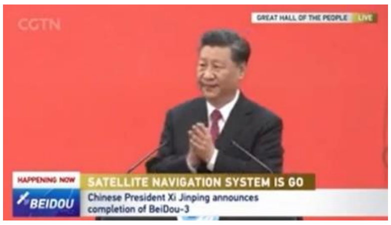
---

263 European GNSS Service Centre, "EC project showcases benefits of EGNSS for drones", (January 2020): https://www.gsa.europa.eu/newsroom/news/ec-project-showcases-benefits-egnss-drones
264 U.S. Space Force, "Space Force decommissions 26-year-old GPS satellite to make way for GPSIII constellation", (January 2020)
265 U.S. Space Force, "2 SOPS disposes 26.5 year old satellite" https://www.schriever.spaceforce.mil/News/Article-Display/Article/2150211/2-sops-disposes-265-year-old-satellite/-
266 Lockheed Martin, "Fourth Lockheed Martin-Built GPS III Satellite's On Board Engine Now Propelling It To Orbit" (November 2020)
267 U.S. Space Force, "GPS III SV03 Receives Operational Acceptance": https://www.losangeles.spaceforce.mil/News/Article-Display/Article/2307355/gps-iii-sv03-receives-operational-acceptance/
268 FCC, "FCC Approves Ligado L-Band Application to Facilitate 5G & IoT" https://www.fcc.gov/document/fcc-approves-ligado-l-band-application-facilitate-5g-iot
269 Forbes, "FCC Unanimously Approves Ligado's Hard Fought 5G Request" (April 2020):
270 National telecommunication and information Agency, "NTIA Files Petition for Reconsideration of FCC Grant of Ligado License Modification Applications", (May 2020): https://www.ntia.doc.gov/press-release/2020/ntia-files-petition-reconsideration-fcc-grant-ligado-license-modification
271 Politico, "New industry coalition to defend GPS against Ligado 5G plan", (June 2020)
272 SpaceNews, "Lockheed Martin gets $511 million contract for two GPS satellites", (December 2020):

In August, the U.S. Space Force has upgraded the GPS's ground segment, allowing it to partially use a new military GPS signal M-code. While this new and more secure signal (anti-spoofing, anti-jamming, encrypted) has been available on many GPS satellites for years, U.S. military has not had the corresponding ground and user equipment to leverage it.[273] At policy level, the White House issued the Executive order on Strengthening National Resilience through Responsible Use of Positioning, Navigation, and Timing Services, seeking stronger and more resilient critical U.S. PNT infrastructure.[274]

The GLONASS constellation is going to increase by 27 satellites produced by ISS-Reshetnev, following Russia's Science and Technical Council.[275] A GLONASS-M navigation satellite was launched on March 16th, bringing the total number of satellites to 24.[276] In addition, after six-year of interruption, GLONASS-K 15L satellite, part of the GLONASS-K series, was launched on October 25th.[277] As reported by a system's general designer, a high-orbit segment of GLONASS (comprising six satellites) will begin to be created in 2021.The first launch is planned for 2025, while entering in operational service by the end of 2027.[278]

In 2020, China has completed the third generation of its BeiDou system (BDS-3), which improves the availability and precision of the Chinese GNSS. In February, four satellites previously launched in 2019 were integrated in the constellation.[279] The launch of two additional satellite took place on March 9th and on June 23rd, with a Long March-3B carrier rocket.[280] The BeiDou-3 commissioning ceremony was held in Beijing on July 31.[281] The BDS-3 constellation relies on a combination of MEO and GEO/IGSO satellites and has both augmentation and search-and-rescue capabilities.



TV footage of President Xi Jinping speaking at the July ceremony on the completion and commissioning of BDS-3 (Credit: CGTN)

Later in the year, China announced that the new-generation BeiDou high-precision positioning chip for receiver devices should be put into mass production in the first half of 2021. The new chip will be compatible with other GNSS signals (GPS, Galileo, GLONASS) and will be quarter the size and consume significantly less power than the last generations.[282]

Progress of other satellite navigation system projects in the World

As of 2020, there are four operational Satellite-Based Augmentation System (SBAS) with plans for continued improvements – in USA, EU, Japan and India and five additional SBAS in various phases of development – In Russia, China, Africa, South Korea and Australia / New Zealand.[283]

- The UAE has initiated a satellite navigation project, The UAE plans to launch the first navigation satellite in 2021 and a second should follow the year after. The project aims to demonstrate technology and capability build-up without replacing existent GNSS. It is the first project of Satellite Assembly, Integration and Testing (AIT) Centre, which is a collaboration formed by Tawazun

[273] C4ISRNET, "US Space Force completes upgrade to help protect GPS capabilities" (August 2020):
[274] White House, "Executive Order on Strengthening National Resilience through Responsible Use of Positioning, Navigation, and Timing Services (2020) https://www.whitehouse.gov/presidential-actions/executive-order-strengthening-national-resilience-responsible-use-positioning-navigation-timing-services/
[275] GPS World, "GLONASS company to build 27 more satellites", (January 2020):
[276] GPS World, "GLONASS-M satellite launched into orbit", (March 2020)
[277] Space Flight Now, "Russia launches Glonass navigation satellite", (October 2020):
[278] SpaceWatch.Global, "Glonass to put layer of six new spacecraft in orbit by 2027", (October 2020):
[279] GPS World, "Four BeiDou satellites join system, last two launches set", (February 2020)
[280] CGTN, "China launches last BeiDou satellite, entering world powers of navigation system", (June 2020)
[281] GPS World, "U-blox technology platforms support BeiDou-3", (August 2020)
[282] CGTN, "China to deliver latest BeiDou positioning chip at the end of 2020", (September 2020)
[283] European GNSS Agency, (October 2020) https://www.gsa.europa.eu/sites/default/files/uploads/technology_report_2020.pdf

Economic Council with Airbus and the National Space Science and Technology Centre (NSSTC) of the UAE University, in Al Ain.[284]

- The 4th update of the Japan's Basic Space Plan confirmed that the Quasi-Zenith Satellite System (QZSS) remains one of Japan's highest prioritized programmes. The Japanese government decided to increase QZSS capabilities through launching 3 more satellites to form a 7 satellites constellation by March 2024. The government also aims to encourage the use of QZSS applications in wider range of fields (e.g., disaster mitigation, autonomous driving, smart agriculture, machine control…).[285]
- As part of the National Defense Authorization Act (NDAA) 2020, U.S. Congress designated the Indian NAVIC system as "allied system", along with Galileo and QZSS, while GLONASS and Beidou as a "non-allied system".[286] In addition, NAVIC was started to be supported by the Xiaomi smartphones.[287]

In addition, new SBAS capabilities are being gradually developed around the world, including e.g., in Australia / New Zealand or Africa. In 2020, the Agency for Air Navigation Safety in Africa and Madagascar (ASECNA) started providing an SBAS Open Service over the African continent and the Indian Ocean.[288] The capability is modelled based on the technology developed for EGNOS.[289]

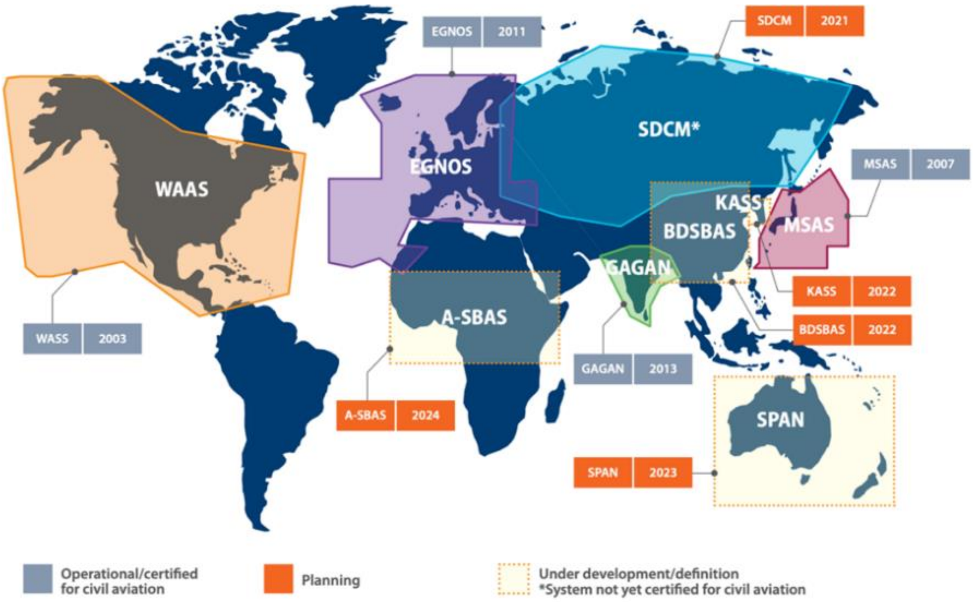


Figure 2: Indicative service areas and status of SBAS around the world (Credit: EU GNSS Agency)

Multi-billion batch of new Copernicus contracts and a successful launch of Sentinel-6 Michael Freilich

Building on the ESA Ministerial Council of 2019 (Space19+), ESA's Industrial Policy Committee approved a financial commitment of €2.55 billion in contracts for the development of six high-priority Sentinel expansion missions under the Copernicus Programme.[290] These new missions will be complementary to the currently operational Copernicus satellites, and each new mission will comprise two spacecraft:

[284] Emirates News Agency, "UAE to launch a navigation satellite next year", (August 2020): https://www.wam.ae/en/details/1395302861108
[285] Gps.gov, "QZSS Update" (September 2020): https://www.gps.gov/cgsic/meetings/2020/kogure.pdf
[286] Manifestia, "NAVIC AS ALLIED SYSTEM OF US (BASICS OF NAVIC)", (April 2020)
[287] Livemint, "Xiaomi to bring ISRO's NavIC technology to smartphones in 2020", (February 2020)
[288] GPS World, "ASECNA", (September 2020)
[289] European GNSS Agency, "ASECNA provides Africa's first early SBAS Open Service based on the European EGNOS technology", https://www.gsa.europa.eu/newsroom/news/asecna-provides-africa%E2%80%99s-first-early-sbas-open-service-based-european-egnos-technology
[290] ESA, "Contracts awarded for development of six new Copernicus missions", (July 2020): https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Contracts_awarded_for_development_of_six_new_Copernicus_missions

The Copernicus Hyperspectral Imaging (CHIME)	The CHIME mission will complement Copernicus Sentinel-2. It will carry a shortwave infrared spectrometer to provide observations for "new and enhanced services for sustainable agricultural and biodiversity management, as well as soil property characterisation.
The Copernicus Imaging Microwave Radiometer (CIMR)	The CIMR mission will carry microwave radiometer to provide observations of sea-surface temperature, sea-ice concentration, sea-surface salinity and other sea-ice parameters, especially in the Artic areas.
The Copernicus Anthropogenic Carbon Dioxide Monitoring (CO2M)	The CO2M mission will carry "a near-infrared and shortwave-infrared spectrometer to measure atmospheric carbon dioxide produced by human activity".
The Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL)	The CRISTAL mission will carry a dual-frequency Ku/Ka band radar altimeter supporting "activities in the polar region concerning "safety and security of navigation and scientific research, measuring sea ice thickness and snow depth with."
The Copernicus Land Surface Temperature Monitoring (LSTM)	The LSTM mission will carry an infrared sensor to provide observations of land-surface temperature, for improving agricultural productivity.
The L-band Synthetic Aperture Radar (ROSE-L)	The ROSE-L mission will carry an infrared sensor to provide observations of land-surface temperature, for improving agricultural productivity.

Table 7: Six high-priority Sentinel expansion missions under the Copernicus Programme funded in 2020

The prototype missions are co-financed by EU and ESA. The Sentinel programme funding is shared roughly between ESA (30%) and the European Commission (70%).[291] The key design phases (Phase B) of these six high-priority missions will be led by following prime contractors:[292]

- Thales Alenia Space France (€455 million) for the CHIME mission;
- Thales Alenia Space Italy (€997 million) for CIMR (€495 million) and ROSE-L (€482 million) missions;
- Airbus Defence and Space Germany (€300 million) for the CRISTAL mission;
- Airbus Defence and Space Spain (€375 million) for the LSTM mission; and
- OHB-System Germany (€445 million) for the CO2M mission.

Subsequently, phase C/D will commence after a favourable decision by the European Commission, ESA and EU Member States. The decision is planned in the second half of 2021.

[291] BBC, "New Sentinel satellites to check the pulse of Earth", (November 2020): https://www.bbc.com/news/science-environment-54926152
[292] ESA, "Contracts awarded for development of six new Copernicus missions", (July 2020): https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Contracts_awarded_for_development_of_six_new_Copernicus_missions

In November, SpaceX launched the Sentinel-6 Michael Freilich mission on Falcon 9 from the Vandenberg Air Force Base in California. The mission involves cooperation between NASA, NOAA, ESA, EUMETSAT and CNES. The data collected will be crucial for climate change analysis, operational oceanography, weather forecasting, and will support the Copernicus Marine Environment Monitoring Service (CMEMS).[293] Also called the Jason-Continuity of Service mission, Sentinel-6 will continue measurements made by the Jason and Topex/Poseidon missions. It will use a high-precision radar altimeter providing high-precision measurements of global sea-level. In addition, it will use GNSS radio occultation to assess temperature changes and support Numerical Weather Prediction (NWP) method.[294] Together with Sentinel-6B, scheduled for launch in 2025, the pair will be operational until 2030.

Sentinel-6 Michael Freilich satellite, launched in November, will conduct its oceans-observing mission from an orbit with a nominal altitude of 1336 km and 66º inclination (Credit: EUMETSAT)

U.S. military completes the AEHF constellation of hardened communication satellites

In March, the ULA conducted the first major launch for the U.S. Space Force, carrying onboard Atlas-V the sixth and final satellite of the Advanced Extremely High Frequency' (AEHF) satellite constellation. The first AEHF satellite was launched in 2010. The network is intended to replace the outdated Milstar communications satellites. With a complete surface coverage from 65° North to 65° South latitude, AEHF satellites will be used to relay secure communications for U.S., UK, Canadian, Australian and Dutch Armed Forces.[295]

The 6-ton AEHF-6 between Atlas V fairings (Credit: Lockheed Martin)

The AEHF constellation operates from GEO, individual satellites are equipped with the capacity to relay communications directly without passing through ground stations, which makes them more secure. The system incorporates advanced encryption, low probability of intercept and detection and an ability to penetrate the electromagnetic interference caused by nuclear weapons, to route communications, real-time video, maps and targeting data to users on land, sea or in the air.[296] The cost of the AEHF-6 satellite was $1.2 billion and the entire jam-resistant, blast-hardened constellation comprising 6 satellites is valued at more than $11 billion.[297]

[293] NASA, "US and European Partners Launch Mission to Monitor Global Ocean", (November 2020): https://www.nasa.gov/press-release/nasa-us-and-european-partners-launch-mission-to-monitor-global-ocean
[294] NASA, "Partners Name Ocean Studying Satellite for Noted Earth Scientist", (January 2020): https://www.nasa.gov/press-release/nasa-partners-name-ocean-studying-satellite-for-noted-earth-scientist
[295] Engineering and Technology, "US Space Force completes its first satellite launch for military communications", (March 2020): https://eandt.theiet.org/content/articles/2020/03/us-space-force-completes-its-first-satellite-launch-for-military-communications/
[296] America Space, "Space Force AEHF-6 Satellite Completes On-Orbit Testing", (September 2020)
[297] Wtop News, "U.S. Space Force launches billion-dollar military comms satellite", (March 2020): https://wtop.com/science/2020/03/u-s-space-force-launches-billion-dollar-military-comms-satellite/

Other application programmes news

- Canada begins to look for RADARSAT Constellation Mission successor.[298] Launched in June 2019 on a Falcon 9 rocket, the RCM is a three-satellite constellation developed by MDA, with a 7-year lifetime span, and designed to provide data for maritime surveillance, disaster management and ecosystem monitoring.
- European Commission launched the ENTRUSTED project. With a budget of €3 million under the Horizon 2020 programme, the ENTRUSTED project aims to develop secure, interoperable, innovative and standardised satellite communication for governmental end-users.[299] The project will run until February 2023 and shall facilitate the definition of the EU GOVSATCOM programme.[300] Under the leadership of the GSA, the project will be implemented by a consortium of almost 20 institutions representing EU Member States and EU agencies.
- €300 million contract to complete the COSMO-SkyMed Second Generation constellation (CSG). The Italian Ministry of Defence and the Italian Space Agency contracted Telespazio and Thales Alenia Space to launch the development of two additional CSG satellites and the upgrade of ground, logistic support and operational segments.[301] The two satellites will complete the constellation of four SAR satellites in total, along with the Proto-Flight Model (PFM) launched in 2019 and the Flight Model 2 (FM2), which is scheduled for launch at the end of 2021 onboard Vega C.
- EUMETSAT is *en route* to Meteosat Third Generation (MTG) and better data services. EUMETSAT Council approved the transition plan from the second to the third generation of Meteosat geostationary satellites for 2022-2026. As part of this plan, EUMETSAT will move Second Generation Meteosat-9 over the Indian Ocean in 2022 to replace the ageing Meteosat-8 and continue MSG observations of that region until at least 2025.[302] Throughout 2020, EUMETSAT has also begun phasing into operations the new data services, seeking a diversification, simplification, and acceleration of data access for its wide community of users.[303]
- ESA awarded Telespazio Vega UK a €25M service contract to lead the quality control operations, validation and final delivery of a broad range of EO data. The service includes data from both the ongoing ESA satellites missions and 3rd party missions, such as Landsat 1-7, and will implement AI technologies procedures to streamline and further improve the quality of the validation process.
- The U.S. Space Force released its Enterprise SATCOM Vision, under which military and commercial satellite providers would be integrated, allowing seamless transition between signals and networks to maintain connectivity.[304] The Space Force also progressed in the implementation of the SATCOM Enterprise Management and Control Program, selecting the National Security Technology Accelerator to manage the Space Enterprise Consortium, and be responsible for up to $12 billion worth of contracts over the next decade.[305]

---

[298] Government of Canada, "To stay at the cutting edge of Earth observation, Canada is seeking ideas from industry" (February 2020): https://www.canada.ca/en/space-agency/news/2020/02/to-stay-at-the-cutting-edge-of-earth-observation-canada-is-seeking-ideas-from-industry.html

[299] European GNSS Agency, "Launch of entrusted – a research project dedicated to the development of secure satellite communications for governmental users – GOVSATCOM" (October 2020): https://www.gsa.europa.eu/launch-entrusted-%E2%80%93-research-project-dedicated-development-secure-satellite-communications

[300] European Commission, CORDIS, "Secure governmental satellite communications – Launching ENTRUSTED" (September 2020): https://cordis.europa.eu/article/id/422145-secure-governmental-satellite-communications-launching-entrusted

[301] Telespazio, "Thales Alenia and Telespazio signed contract for two additional COSMO-SkyMed Second Generation satellites" (December 2020) https://www.telespazio.com/en/news-and-stories-detail/-/detail/csg-newcontract?f=%2Fnews-events%2Fpress-releases

[302] Eumetsat, "EUMETSAT plans transition to Meteosat Third Generation", (November 2020): https://www.eumetsat.int/eumetsat-plans-transition-meteosat-third-generation-and-decides-launch-two-satellites-ariane-6

[303] Eumetsat, "New pilot data services released", (November 2020): https://www.eumetsat.int/new-pilot-data-services-released

[304] C4Isrnet, "Here is the Space Force's new Enterprise SATCOM Vision", (Feruary 2020): https://www.c4isrnet.com/battlefield-tech/c2-comms/2020/02/20/here-is-the-space-forces-new-enterprise-satcom-vision/

[305] Breaking Defence, "Space Force To Focus SATCOM Management On JADC2 Needs" (December 2020): https://breakingdefense.com/2020/12/space-force-to-focus-satcom-management-on-jadc2-needs-exclusive/

- China progressed in deploying Gaofen-9 Earth observation satellites. Gaofen-9 is a series of civilian-led Earth-imaging high-resolution satellites. The prototype Gaofen 9-01 was launched in 2014. Throughout 2020, China successfully deployed 4 additional satellites of the series. While it is not clear whether the Gaofen-9 satellites are identical or only share a name, it was reported that all of the 2020-launched Gaofen-9s operate in optical spectrum and with a sub-meter resolution.[306]
- UK ordered new Skynet-6A satellite. In July, the UK Military signed a £500 million contract with Airbus to enhance and extend the Skynet fleet of military communications satellites in the geostationary orbit. The contract involves the manufacture, launch and ground segment upgrade for the Skynet-6A satellite. Skynet-6A is due for launch in 2025. [307]
- The Joint Research Centre (JRC) of the European Commission, which is the managing entity of the Copernicus Emergency Management Service, awarded a new contract to the Italian company e-Geos, leading a consortium of European subsidiaries. The service focuses on a variety of customised geospatial information and data to support the management of natural as well as human-made emergency situations. JRC has also increased collaboration with academia and industry to complement the EMS with a new Sentinel 1-based global flood monitoring product.[308]
- NASA contracted Airbus for provision of supplementary EO data under the Commercial Smallsat Data Acquisition Program (CSDAP). Airbus would join a few other companies providing NASA with EO data under the CSDAP initiative, including Maxar, Planet, Spire Global and Teledyne Brown Engineering.[309]
- Russia will start launching Sfera constellation satellites in 2024 instead of 2023 as previously planned.[310] The Sfera programme of a multi-orbit/multi-purpose constellation of more than 600 satellites was inaugurated by President Putin in 2018.

[306] Space Flight Now, "China launches another Gaofen Earth observation satellite" (August 2020)
[307] Gov.uk, "UK defence teams up with world leading UK space company to secure next generation of military communications" (July 2020): https://www.gov.uk/government/news/uk-defence-teams-up-with-world-leading-uk-space-company-to-secure-next-generation-of-military-communications
[308] Copernicus EMS, (October 2020): https://twitter.com/CopernicusEMS/status/1320731428016054273
[309] SpaceNews, "NASA taps Airbus for commercial satellite data buy" (May 2020)
[310] United News of India, "Russian space agency postpones launch of Sfera satellites for one year" (November 2020): http://www.uniindia.com/news/world/space-sfera-russiansatellite/2223344.html

1.2.3 Space exploration and science programmes

2020 Mars launch window: multiple missions and postponement of ExoMars launch

The complexity of space travel to Mars forces space agencies to seek the optimal orbital conditions for launches targeting the red planet, which occur every 26 months. This launch window appeared again in 2020 during July and saw three successful launches carrying U.S., Chinese and UAE's missions to the Red planet:

- On July 19th, the UAE's Hope Probe was launched from Japan´s Tanegashima Space Center onboard the H-IIA launch vehicle.[311] The mission design, development, and operations were led by the Mohammed bin Rashid Space Centre (MBRSC). The Emirates Mars Mission is the country's first interplanetary mission as well as the first planetary science mission to be led by an Arab country. Expecting to collect data about the climate and atmosphere of the Red Planet for two years, the Hope orbiter is equipped with three science instruments, including a high-resolution camera and two sophisticated spectrometers.
- On July 22nd, the Chinese Tianwen-1 mission was also successfully launched, marking the start of the first solo Chinese mission to Mars.[312] The Long March 5 rocket launched from Wenchang Satellite Launch Center, flying over the Philippines, using tracking support from ESA ESTRACK. The spacecraft is comprised of an orbiter and a lander with an attached rover, carrying 13 scientific payloads to study the atmosphere, magnetosphere, surface, subsurface and climate of Mars. Previously, China attempted a Mars mission known as Yinghuo-1, attached to the Russian Fobos-Grunt spacecraft, but the upper stage propulsion system failed, leaving it stranded in Earth orbit.
- On July 30th, NASA launched Mars 2020 mission on a ULA Atlas V rocket from the Cape Canaveral Air Force Station in Florida.[313] Mars 2020 includes the Perseverance rover and the Ingenuity helicopter drone. Mission objectives revolve primarily around astrobiology and geology, investigating the possibility of past life on Mars. The rover will collect samples of rock and soil, storing them in tubes and making them available for future retrieval. The goal is to return these samples to Earth by a follow up of with two future missions in partnership with ESA, with a secondary launch projected in 2022.

NASA's Ingenuity helicopter successfully conducted humanity's first powered flight on another planet in April 2021 (Credit: NASA/JPL)

All three missions successfully reached Mars in February 2021. A fourth Mars mission scheduled for lift-off in the 2020 launch window, the ExoMars Rosalind Franklin mission developed by ESA and Roscosmos, slipped to 2022 due to technical difficulties.[314] ExoMars was initially scheduled for launch in 2018 but was delayed to 2020 due to delays in European and Russian industrial activities. ESA Director-General stated this delay should not impact ESA-NASA Mars Sample Return mission, which is also scheduled for 2022.[315]

[311] BBC, "Hope probe: UAE launches historic first mission to Mars", (July 2020): https://www.bbc.com/news/science-environment-53394737
[312] SpaceNews, "Tianwen-1 launches for Mars, marking dawn of Chinese interplanetary exploration" (July 2020)
[313] SpaceNews, "Atlas 5 launches Mars 2020 mission", (July 2020)
[314] Science Magazine, European Mars rover delayed until 2022 (March 2020): 2
[315] SpaceNews, "ExoMars rover mission delayed to late 2022" (March 2020

Major achievements for sample return missions

Three sample return missions from near-Earth asteroids and the Moon reached important milestones:

- On October 20th, NASA's OSIRIS-Rex spacecraft, launched in 2016, approached Bennu[316], a near-Earth asteroid, and successfully performed a "Touch-And-Go" operation to collect samples from the surface. It was performed through the spacecraft's sampling arm, the Touch-And-Go Sample Acquisition Mechanism (TAGSAM). After successfully mitigating the problems with leaking material from the sample container, the mission team announced that spacecraft is carrying back to Earth around 2kg of collected material.[317] OSIRIS-Rex is expected to return to Earth in September 2023.
- On December 6th, JAXA's Hayabusa2 mission, launched in 2014, successfully delivered back to Earth dust and rock samples from near-Earth asteroid Ryugu, landing a sample return capsule in Australia. The main Hayabusa2 spacecraft begun an extended, 11-year astronomy mission.[318] In 2010, the first Hayabusa probe became the first ever to bring asteroid samples to Earth, returning a few micrograms of material from the asteroid Itokawa.

First peek into one of Hayabusa2 sample chambers (Credit: JAXA)

- In November and December, China successfully executed a 23-day lunar sample return Chang'e-5 mission. It was China's pioneering sample return endeavour and humanity's first sample return from the Moon in 44 years. The return capsule, containing around 2kg of lunar material, landed in the Inner Mongolia province on December 16th. Chang'e-5 was China's most complex robotic space exploration mission, requiring sample collection and storing, lunar ascent, robotic rendezvous and docking in lunar orbit as well as trans-Earth injection. This experience will help China in its upcoming lunar missions (Chang'e-7 and 8) as well as in planned near-earth asteroid and Mars sample return missions later in the decade.[319]

In addition, JAXA announced in February that its Martian Moons Exploration (MMX) mission had moved into development phase. The MMX is scheduled for launch in 2024 on H-3 towards the two Martian moons. It will carry a probe studying Phobos and Deimos and a lander on Phobos that will conduct the sample collection.[320] The lander will be designed jointly by CNES and DLR, building on a successful French and German involvement in the Hayabusa2 mission, for which CNES and DLR built the MASCOT lander.

UAE announces its first Moon mission amidst growing worldwide interest in lunar programmes

In October, the UAE disclosed its plans for a first national lunar mission carrying a small rover, to be built entirely at Dubai's Mohammed Bin Rashid Space Center (MBRSC). Due for launch in 2024, the robotic four-wheeled rover will be UAE's first spacecraft to land on another celestial body. It will be equipped with various imagers and is supposed to land in a previously unexplored area of the Moon, near the equator.[321]

---

316 NASA, "OSIRIS-REx TAGs Surface of Asteroid Bennu" (October 2020): https://www.nasa.gov/feature/goddard/2020/osiris-rex-tags-surface-of-asteroid-bennu/
317 Scientific American, "NASA's OSIRIS-REx Probe Successfully Stows Space-Rock Sample", (October 2020): https://www.scientificamerican.com/article/nasas-osiris-rex-probe-successfully-stows-space-rock-sample/
318 NASA Space Flight, "JAXA's Hayabusa2 asteroid sample return capsule lands in Australia", (December 2020): https://www.nasaspaceflight.com/2020/12/hayabusa2-returns-to-australia/
319 SpaceNews, "China recovers Chang'e-5 moon samples after complex 23-day mission (December 2020):
320 Techcrunch, "Japanese mission to land a rover on a Martian moon and bring back a sample is a go", (February 2020): https://techcrunch.com/2020/02/20/japanese-mission-to-land-a-rover-on-a-martian-moon-and-bring-back-a-sample-is-a-go/
321 CNN, "UAE hopes this tiny lunar rover will discover unexplored parts of the moon", (November 2020): https://edition.cnn.com/2020/11/24/middleeast/uae-moon-rover-mission-scn-spc-intl/index.html

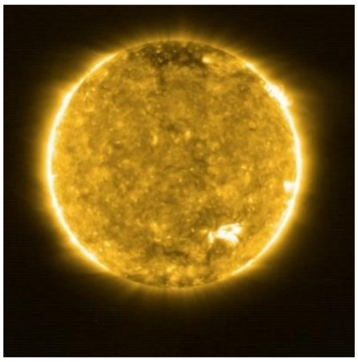
With this announcement, the UAE is joining the growing club of nations planning to land and operate spacecraft on the surface of the Moon, either as part of a partnership programme (e.g. Artemis), through bilateral cooperation or independently. So far, only Russia, USA and China have conducted a successful soft landing on the lunar surface. Concerning the recently disclosed plans:

- In 2019, both the Israeli Beresheet lander[322] and the Indian Vikram lander (with Pragyan rover as part of the Chandrayaan-2 mission)[323] were destroyed upon impact during their lunar landing attempts. India soon announced plans for Chandrayaan-3 rover mission, scheduled to launch in 2021.[324]
- In June 2020, ISRO and JAXA revealed details of their planned joint Lunar Polar Exploration mission, hoping to put a lander and a rover on the lunar south pole in 2023.[325]
- Earlier, in 2019, JAXA also signed a research agreement with Toyota to work on a manned pressurized lunar rover "LUNAR CRUISER", with an expected launch date in the latter half of the 2020s.[326]
- In November, the Canadian Space Agency (CSA) awarded contracts under the Lunar Exploration Accelerator Program (LEAP) to develop lunar science payloads and a small rover to fly to the Moon on a NASA-sponsored lander mission.[327]
- In December, Thailand unveiled new plans to launch a national lunar mission within 8 years and under approx. €80 million budget.[328] More details on this plan are expected to come in 2021.
- The first Brazilian lunar mission, a nanosatellite orbiter Garatéa-L, targets its launch date to 2022.[329] Brazil also expressed interest in contributing a robotic lunar rover to NASA's Artemis programme.[330]

Successful launch and first images by ESA-led Solar Orbiter Sun-observing satellite

In February, the Solar Orbiter mission developed by ESA with a major NASA involvement successfully launched onboard the Atlas V launch vehicle from Florida. Solar Orbiter aims to make significant breakthroughs in the understanding both of how the inner heliosphere works, and of the effects of solar activity on it.[331]

The spacecraft will also perform close observations of the polar regions of the Sun, which is difficult to do from Earth. This is possible due to Solar Orbiter's maximum orbital inclination relative to the solar equator of 25°. Because of its highly eccentrical heliocentric orbit, Solar Orbiter will make a close approach to the Sun every five months, conducting both in-situ and remote sensing measurements.



Solar Orbiter's first views of the Sun (Credit: ESA)

The unique aspect of this mission is that no other spacecraft has been able to take images of the Sun's surface from such close distance.[332] The first images from the Solar Orbiter in July have already revealed new phenomena - omnipresent miniature solar flares, dubbed 'campfires', near the surface of the Sun.[333]

---

322 Wired, "A Crashed Israeli Lunar Lander Spilled Tardigrades on the Moon", (May 2019)
323 NASA, "Vikram Lander Found" (December 2020): https://www.nasa.gov/image-feature/goddard/2019/vikram-lander-found/
324 Space.com, "India Is Officially Going Back to the Moon with Chandrayaan-3 Lunar Lander" ,(January 2020): l
325 Jagranjosh, "India-Japan Moon Mission: All you need to know about the ISRO and JAXA's joint lunar mission", (June 2020):
326 Toyota, "JAXA and Toyota Announce "LUNAR CRUISER" As Nickname for Manned Pressurized Rover", (August 2020): https://global.toyota/en/newsroom/corporate/33208872.html
327 SpaceNews, "Canada developing lunar rover and science payloads" (November 2020)
328 Thai Examiner, Thailand to launch a moon space programme to boost efforts to become a high-income economy (December 2020): https://www.thaiexaminer.com/thai-news-foreigners/2020/12/27/thailand-to-launch-a-moon-space-programme/
329 Societifica, "Missão lunar brasileira: projeto Garatéa planeja colocar satélite na órbita lunar" (August 2019):
330 NASA, "NASA Administrator Signs Statement of Intent with Brazil on Artemis Cooperation" (December 2020):
331 ESA, "Solar orbiter objective" (December 2020): https://sci.esa.int/web/solar-orbiter/-/44167-objectives
332 ESA, "Solar Orbiter's first images reveal 'campfires' on the Sun" (July 2020)
333 Ibid.

Major scientific discoveries on Solar System bodies

Some of the new space discoveries announced in 2020 have presented evidence further supporting prospects of the existence of life-sustaining environments on other celestial bodies:

Venus: detection of relatively large amounts of phosphine gas in planet's atmosphere[334]
The scientific team led by the Cardiff University used the James Clerk Maxwell Telescope (JCMT) in Hawaii and later confirmed the observation through the Atacama Large Millimeter/submillimeter Array (ALMA), a network of 66 radio dishes in Chile. Phosphine is considered a potential biomarker, so its presence could indicate life on Venus. In October, new peer-reviewed analyses have not confirmed the evidence of phosphine in the Venusian atmosphere, prompting further investigation.[335]
Moon: detection of water molecules on the sunlit surface[336]
This detection was a result of observations by the modified Boeing 747 NASA/DLR Stratospheric Observatory for Infrared Astronomy (SOFIA) and its mid-infrared camera and spectrograph FORCAST.[337] An evidence of water ice on the lunar surface was confirmed by NASA already in 2018, but this discovery only involved ice in the shadows of craters near the poles never lit by sunlight.
Titan: discovery of cyclopropenylidene (C3H2) molecules in Titan's atmosphere[338]
NASA argued that "this simple carbon-based molecule may be a precursor to more complex compounds that could form or feed possible life on Titan". Due to its similarities to Earth (stable liquid - methane on the surface), Saturn's moon Titan is already considered one of the most promising places to search for extra-terrestrial life and this new discovery adds to these prospects.

Table 8: Notable space science discoveries of 2020

Space telescopes: new developments in the United States, Europe and China

In the U.S. the James Webb space telescope (JWST) was further delayed, from March to October 2021, being a result of the COVID-19 pandemic and technical challenges.[339] This multi-billion programme faced a troubled development marked with major cost overruns and delays.[340] The work on another multi-billion telescope, the Nancy Grace Roman Space Telescope previously known as the Wide Field Infrared Survey Telescope (WFIRST), continued amidst uncertainties. The Telescope's primary mirror has been completed in September.[341] However, the prospect of major cost overruns and slow JWST progress led to a possible programme termination to be considered and discussed by the U.S. Congress. In April, NASA announced it would also fund an early-stage proposal to build a Lunar Crater Radio Telescope (LCRT), a

[334] Royal Astronomical Society, "Hints of life on Venus": https://ras.ac.uk/news-and-press/news/hints-life-venus
[335] National Geographic, "Promising sign of life on Venus might not exist after all", (October 2020)
[336] NASA, "NASA's SOFIA Discovers Water on Sunlit Surface of Moon", (October 2020): https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon/
[337] Oxford Instruments, "NASA's Flying Observatory SOFIA discovers water on the Moon", (October 2020): https://www.oxinst.com/news/nasa%E2%80%99s-flying-observatory-sofia-discovers-water-on-the-moon/
[338] NASA, "NASA Scientists Discover 'Weird' Molecule in Titan's Atmosphere, (October 2020): https://www.nasa.gov/feature/goddard/2020/nasa-scientists-discover-a-weird-molecule-in-titan-s-atmosphere/
[339] Space.com, "NASA delays launch of flagship James Webb Space Telescope to Oct. 31, 2021, (July 2020):
[340] The Guardian, "Spacewatch: Nasa delays James Webb space telescope to October 2021", (July 2020):
[341] NASA, "Primary Mirror for NASA's Roman Space Telescope Completed", (November 2020): https://www.nasa.gov/feature/goddard/2020/primary-mirror-for-nasas-roman-space-telescope-completed/

1km-diameter wire-mesh on the far side of the Moon.[342] Lunar far side offers ideal conditions for radio astronomy, unhindered by interfering radio signals emanating from the Earth.

Back in January, after 16 years of operating lifetime, NASA has decommissioned the infrared Spitzer Space Telescope.[343] While Spitzer's primary mission ended in 2009, engineers managed to extend its operating lifetime for 10+ years using partially only one of its instruments.[344]. An upcoming near-infrared NASA space telescope scheduled for launch in 2024 or 2025, SPHEREx, completed in October the preliminary design review.[345] In November, the Hubble Space Telescope launched UV Legacy Library of Young Stars as Essential Standards (ULLYSES), its largest observing programme ever in terms of the amount of time Hubble will dedicate to it.[346]

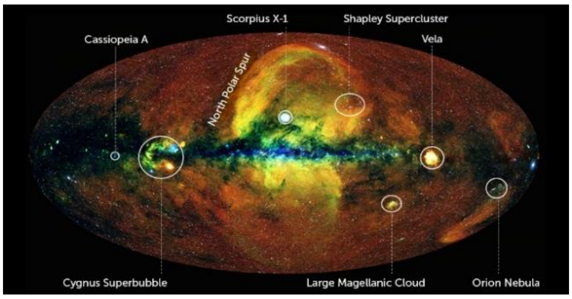
The Chinese space programme launched two space telescope missions in the second half of 2020. The Lobster Eye X-ray satellite, launched in July, is a pioneering experiment to verify ultra-large field of view imaging for searching for dark matter signals in the X-ray range.[347] The GECAM mission (Gravitational Wave High-energy Electromagnetic Counterpart All-sky Monitor), launched in December, will focus on detecting electromagnetic counterparts of gravitational waves, high-energy radiation from fast radio bursts, various gamma-ray bursts, and magnetar flares.[348] On the ground, after three years of trials and testing, China declared the full operational capability of its 500-meter Aperture Spherical Radio Telescope (FAST).[349] FAST is world's largest and has become the last remaining giant, single-dish radio telescope, after the U.S. National Science Foundation decommissioned in November the renowned 305-meter radio telescope at the Arecibo Observatory in Puerto Rico[350], In December, it was announced China aims to make FAST increasingly open to international astronomers.[351]

China's 500m Aperture Spherical Radio Telescope (FAST) (Credit: Chinese Academy of Sciences)

In Europe, ESA moved ahead with the Atmospheric Remote-Sensing Infrared Exoplanet Large-survey (ARIEL) space telescope after ESA Member States formally adopted the mission in November. ARIEL was selected as ESA's fourth Medium Class mission in its Cosmic Vision in 2018.

Having formally received the green light from ESA Member States, ARIEL is now due for launch in 2029, to study how exoplanet atmospheres form and evolve. It will operate from an orbit around the Sun-Earth L2 point. The estimated mission cost is ~€550 million. The Consortium providing the scientific payload comprises more than 50 institutes from 17 European countries and includes also NASA.[352]

[342] NASA, "Lunar Crater Radio Telescope (LCRT) on the Far-Side of the Moon", (April 2020)
[343] NASA, "NASA's Spitzer Space Telescope Ends Mission of Astronomical Discovery" (January 2020): https://www.nasa.gov/press-release/nasa-s-spitzer-space-telescope-ends-mission-of-astronomical-discovery
[344] Ibid.
[345] NASA, "A New NASA Space Telescope, SPHEREx, Is Moving Ahead", (January 2021): https://www.jpl.nasa.gov/news/a-new-nasa-space-telescope-spherex-is-moving-ahead/
[346] NASA, "Hubble Launches Large Ultraviolet-Light Survey of Nearby Stars", (November 2020): https://www.nasa.gov/feature/goddard/2020/hubble-launches-large-ultraviolet-light-survey-of-nearby-stars
[347] SpaceNews, "China launches Ziyuan Earth observation and lobster eye X-ray astronomy satellites", (July 2020):
[348] China Daily, "China plans to launch new space science satellites", (July 2020)
[349] News Week, "China's Enormous Alien-Hunting Telescope Is Now Fully Operational, (January 2020):
[350] SciTechDaily, "It's the End for Iconic 1,000-Foot-Wide Telescope at Arecibo Observatory After Second Cable Break" (November 2020)
[351] Phy.org, "China to open giant telescope to international scientists" (December 2020)
[352] ESA, "Ariel moves from blueprint to reality", (November 2020): https://www.esa.int/Science_Exploration/Space_Science/Ariel_moves_from_blueprint_to_reality



Results of the first all-sky survey by the eROSITA X-ray telescope (Credit: eSASS and IKI, via ScienceNews)

A major milestone was reached by the eROSITA X-ray telescope onboard the Russian-German Spektr-RG spacecraft, launched in July 2019. From December 2019 to June 2020, eROSITA, built by the Max Planck Institute for Extraterrestrial Physics, conducted the first of its eight planned all-sky surveys, cataloguing 1.1 million X-ray sources across the cosmos.[353] The survey has thus doubled the number of known X-ray emitters and revealed much fainter objects than the last survey of the whole X-ray sky conducted by the ROSAT space telescope in the 1990s.

Other space exploration and science news

- NASA selected four finalists for next Discovery-class mission. The smallest out of three NASA's planetary programmes ($450 million cost-cap per mission excl. launch vehicle operations, data analysis or partner contributions), the Discovery programme features planetary science spacecraft that can be built in 36 months or less.[354] Two of shortlisted proposals (final decision due in 2021) are Venus missions – DAVINCI+ (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging Plus) atmospheric probe and VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy) orbiter. The remaining finalists are Io Volcano Observer (IVO) to explore Jupiter's moon Io and the Trident mission to this highly active icy moon of Neptune.
- India to launch Shukrayaan-1 Venus orbiter no earlier than 2024 with a significant international involvement. The spacecraft will be ISRO's first mission to Venus. India has been planning a Venus mission since 2012. The Shukrayaan-1 spacecraft will host several international scientific payloads provided by France, Russia, Sweden or Germany and through their collaborative contributions.[355]
- DLR and JAXA to cooperate on low-cost asteroid mission. DLR and JAXA agreed on the Demonstration and Experiment of Space Technology for Interplanetary voyage with Phaethon flyby and dust science (DESTINY+) mission. The Japanese spacecraft is planned to be launched in 2024 on an Epsilon S from the Uchinoura Space Centre. During the four-year journey to Phaethon asteroid, the German DESTINY+ Dust Analyzer (DDA) instrument will collect cosmic dust particles.[356]
- NASA patented new route to the Moon suitable for piggybacking small spacecraft. On June 30th, the U.S. Patent and Trademark Office granted and published NASA's patent for a series of orbital manoeuvres relying on Earth's gravity assists that, although timelier, should facilitate space travel to the Moon for robotic missions that have difficulties to afford direct launch trajectories.[357]

---

[353] Science News, "This is the most comprehensive X-ray map of the sky ever made", (July 2020):
[354] NASA, "NASA Selects Four Possible Missions to Study the Secrets of the Solar System", (February 2020): https://www.nasa.gov/press-release/nasa-selects-four-possible-missions-to-study-the-secrets-of-the-solar-system
[355] OneIndia, "Shukrayaan: India's proposed Venus mission attracts international payload proposals", (November 2020)
[356] Deutsches Zentrum für Luft und Raumfahrt, "DESTINY+ – Germany and Japan begin new asteroid mission", (November 2020): https://www.dlr.de/content/en/articles/news/2020/04/20201112_destiny-germany-and-japan-begin-new-asteroid-mission.html
[357] Business Insider, "NASA patented a faster, cheaper route to the moon" (November 2020): https://www.businessinsider.com/nasa-patent-moon-travel-farside-lunar-orbit-dapper-dark-ages-2020-8

2 Industry & Innovation

2.1 Space Industry highlights and trends in 2020

2.1.1 Rising interest in commercial spaceports

Spaceports have traditionally been established and operated by states as part of their space strategies. However, the advent of New Space trends has led to a rising interest in commercial spaceports globally. Commercial spaceports are either jointly operated in the framework of a public-private partnership where the government is the principal owner, or privately owned and operated. They can serve both institutional and commercial demand and provide solutions for vertical and/or horizontal launches to orbit and suborbital spaceflight. The rising interest in commercial spaceports observed recently stems from multiple factors including states' willingness to foster the development of their national space sector, seize potential commercial opportunities, and share costs to develop an autonomous access to space.

The multiplication of commercial spaceports in Europe

In Europe, the space transportation industry has been, so far, mostly centred around large public programmes (Ariane, Vega) and the involvement of a few major companies (ArianeGroup, Avio) and their suppliers. Launch operations are carried out from the Centre Spatial Guyanais in Kourou. However, as the market for small satellites is increasing and demand for commercial launches is rising, several European start-ups started the development of micro launchers with a growing support from public agencies. Micro launchers have been the subject of a spike in investments by ESA, national space agencies and the private sector in 2020. As micro launchers gain ground, considerations for new spaceports are also emerging as part of national space strategies. A multitude of spaceport projects are now being considered by European countries. There was a major progress on this front in 2020 and multiple policies and agreements have been signed for the construction or operation of new spaceports in continental Europe or in European overseas territories.

Several motives drive European countries to consider the construction of a spaceport on their soil. For instance, in the United Kingdom, spaceports are viewed as initiatives that can support economic growth, job creation, skills development, accelerate the development of the British space ecosystem and drive investments. In Norway, the Andøya Spaceport is being developed to provide autonomous access to space, diversify the local economy from fossil fuels as well as to promote activities in and out of the space sector to create synergies between the Andøya Spaceport and other types of activities. In Germany, the development of micro launchers by German start-ups such as Rocket Factory Augsburg, Isar Aerospace, and HyImpulse Technologies as well as the increasing demand for small satellites pushed the Federation of German Industries (BDI) to submit a proposal for a spaceport.[358] In Sweden, spaceports are mostly developed through public investments in order to absorb the demand for small satellites launches and make it a key infrastructure for "research, development, demonstration, test activities and other space-related activities" in Europe.[359] In Italy, commercial spaceport developments are mainly driven by the goal to achieve autonomous access to space, which prompted the Italian Civil Aviation Authority to adopt a regulation on suborbital commercial activities that enable the construction and operation of spaceports in Italy.[360]

[358] OHB, "A spaceport in the North Sea would catapult Germany into the future as a location of the aerospace industry ", (October 2020)
[359] Government of Sweden, "A Strategy for Swedish space activities", (Last accessed : May 2021) : https://www.government.se/4a74f2/contentassets/ea187b8c0a814ac09c36b8a43154eb49/a-strategy-for-swedish-space-activities.pdf
[360] Aeronewsx, "Italy becomes first country in Europe to approve construction of spaceports " (October 2020)

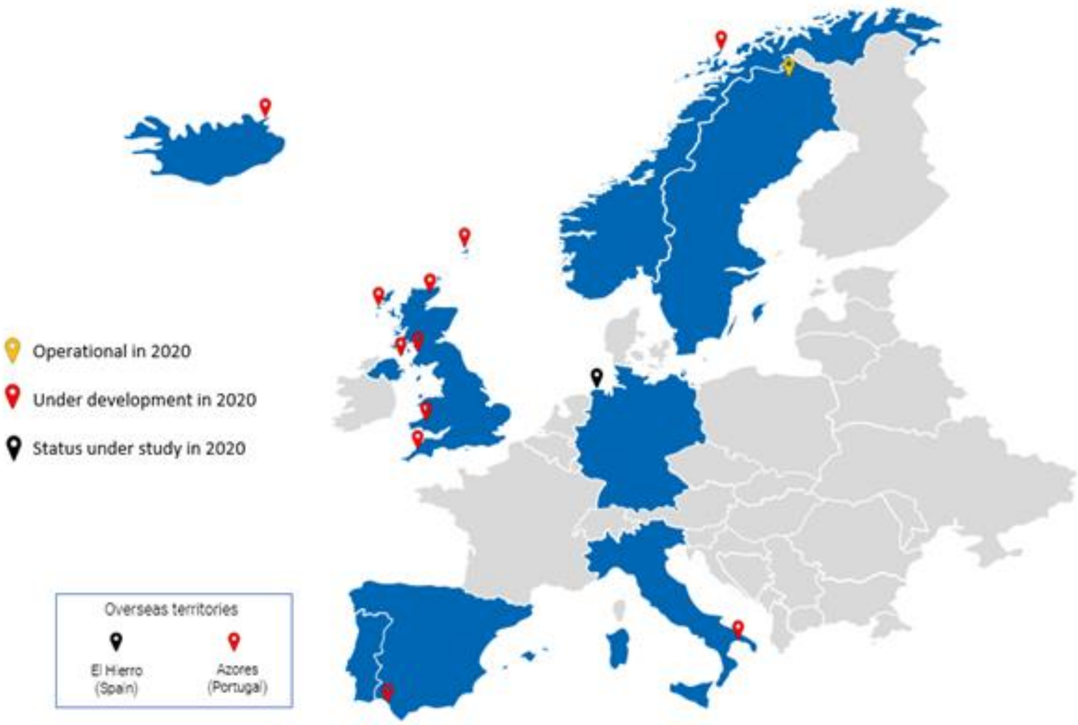


Figure 3: Commercial spaceports in Europe

Country	Spaceport	Status
United Kingdom	Shetland Space Centre	Under development
United Kingdom	Space Hub Sutherland	Under development
United Kingdom	Prestwick Airport	Under development
United Kingdom	Machrihanish Airbase	Under development
United Kingdom	Snowdonia Spaceport	Under development
United Kingdom	Spaceport Cornwall	Under development
United Kingdom	North Uist (Spaceport 1)	Under consideration
Germany	German Sea Platform	Under consideration
Norway	Andøya Space Centre	Under development
Sweden	Esrange Space Center	Operational
Iceland	Langanes Peninsula	Under development
Italy	Airport of Taranto Grottaglie	Under development
Portugal	Azores	Under development
Spain	El Hierro	Under consideration
Spain	El Arensoillo Launch Base	Under development

Table 9: List of commercial spaceport projects in Europe

The United Kingdom

In the United Kingdom, seven locations have been identified as potential commercial spaceports for both vertical and horizontal launches.

The Shetland Space Centre, located in Scotland, reached a key milestone in 2020 as the Scottish company Skyrora launched its Skylark Nano rocket, which was the first suborbital launch conducted from Shetland.[361] Additionally, Lockheed Martin announced that it will move its UK Pathfinder Launch mission from Sutherland to the Shetland spaceport, two years after the UK Space Agency awarded $31 million to Lockheed Martin and $7 million to Orbex to develop Small Launch Orbital Maneuvering Vehicle (SL-OMV) in order for Lockheed Martin to be Shutherland's first customer.[362] Lockheed Martin later announced it selected ABL Space Systems to launch the first orbital rocket from UK soil in 2022, using the Shetland launch pad in Scotland.[363] Following this announcement, the Shetland Space Centre managed to secure £1.43 million investment from Wild Ventures.[364]

The Space Hub Sutherland, also located in Scotland, UK, received final approval from the government to conduct up to 12 launches per year.[365] In January, the U.S. company TriSept Corporation booked the Orbex Prime rocket for a rideshare mission that will launch from the Sutherland Spaceport in 2022. The mission will likely launch between 8 and 20 CubeSats.[366] Then, Orbex raised $24 million in a funding round, bringing the company enough capital to get it through the mid-2022 inaugural launch from Scotland's Sutherland spaceport.[367]

The Prestwick Airport, located in Glasgow, Scotland, is a spaceport project for horizontal launches to enable space tourism, satellite launches, and gravity free flying combined with the creation of an innovation hub. To this end, the Prestwick Airport obtained government approval to launch satellites and received a £80 million investment under Ayrshire Growth Deal.[368]

The Machrihanish Airbase, located in Scotland, a former RAF military air base, is looking to become a spaceport. In 2020, the first suborbital launch from the Machrihanish airbase was successfully conducted by UK Launch Services Ltd's Raptor Aerospace Kestrel-100LD rocket.[369] Machrihanish Airbase is also interested in horizontal launches as the UK Space Agency awarded £488,000 in funding to the Machrihanish Airbase Community Company (MACC) to explore horizontal spaceport development services with UK Launch Services Ltd.

Spaceport Cornwall is a planned horizontal launch site located at Newquay Airport in the United Kingdom. In 2020, Virgin Orbit and Spaceport Cornwall held an online conference and announced that the Cornwall Airport Newquay is seeking to host Virgin Orbit's LauncherOne air-launch system from early 2022.[370] Licences for Spaceport Cornwall to operate as a spaceport will go through Parliament next summer, which will enable Virgin Orbit to apply for licences to launch its rocket from there.[371]

---

[361] SatNews, "Scotland's Skyrora Sends First Ever Launch from Shetland. SatNews", (June 2020)
[362]SpaceNews, "Lockheed Martin, Orbex to launch from new British spaceport, (July 2020)
[363] ArsTechnica, "ABL Space tapped to launch the first orbital rocket from Britain", (August 2021)
[364] Scottish Financial News, "Shetland Space Centre secures £1.43m investment from Wild Ventures Limited" (November 2020)
[365] Press and Journal, "Sutherland spaceport given final approval for lift off. The Press and Journal. Alistair Munro (August 2020)
[366] ViaSatellite, "TriSept Secures Rideshare Mission Aboard Orbex Prime", (January 2020)
[367] Space Intel Report ,"UK's Orbex small-launcher startup raises $24m, says fully capitalized through 1st launch from Scotland in 2022", (December 2020
[368] Daily Record, "Prestwick Airport to launch human space flights as money for venture pours in", (November 2020)
[369] Machrhanish Airbase Community Company, "Rocket Launch At MACC" (August 2020)
[370] Virgin Orbit moving ahead with U.K. launch plans. SpaceNews. Jeff Foust (June 2020) https://spacenews.com/virgin-orbit-moving-ahead-with-u-k-launch-plans/
[371] Ibid.

Germany

The German Sea Platform, is a commercial sea-based spaceport project under consideration, to be located in the German Exclusive Economic Zone (EEZ) in the North Sea:

- In September 2020, the Federation of German Industries (BDI) submitted a proposal to establish a public-private partnership with Isar Aerospace to create a mobile sea-based launchpad in the North Sea. The spaceport would host micro launchers for commercial and institutional customers.[372]
- In October 2020, OHB endorsed the BDI's proposal to establish the German North Sea Maritime Platform, saying it would enable Rocket Factory Augsburg (its subsidiary) to launch from Germany, offer a launchpad infrastructure in the EU for institutional customers and boost economic growth.[373]
- This proposal raised some concerns regarding flight safety due to the presence of oil rigs in the North Sea and the associated liability risk. All oil rigs in the flight's path would have to be insured in case of launch failures, which could put the feasibility and profitability of this project at risk.[374]

Norway

In Norway, the Andøya Space Centre is owned by both the Norwegian Ministry of Trade and Industry and the company Kongsberg Defense Systems. Several developments took place in 2020:

- In June, the Norwegian Parliament approved funding to the Andøya Space Centre of around NOK365 million (around €34 million). This aims to consolidate the development of a proper launch facility inside the space centre and attract further investments to the centre, as well as to the national space economy. Located in the Arctic circle, the spaceport is expected to be fully operational by 2025, but with the possibility of launch operations from 2021. The goal is to host up to 30 launches per year by 2025.[375]

RFA's rendering of RFA One on the future launch pad at Andøya Space Centre (Credit: RFA)

- In September, Boeing and Andøya Space signed a partnership agreement to expand the capability of Andøya Space to conduct complex testing and experimentation for the Norwegian Armed Forces and NATO.[376]
- In September, the German start-up Rocket Factory Augsburg selected the Andøya Spaceport and signed an MoU with Andøya Space for the maiden launch of its RFA One small-satellite vehicle by 2022. The company will use the new medium-lift launch complex that Andøya Space is developing on Andøya island, 35 km south of its existing suborbital launchpad.[377]

---

[372] BBC News, "Germany eyes space satellite launchpad in North Sea", (September 2020)
[373] OHB, "A spaceport in the North Sea would catapult Germany into the future as a location of the aerospace industry", (October 2020)
[374] Space Intel Report, "UK's Orbex small-launcher startup raises $24m, says fully capitalized through 1st launch from Scotland in 2022", (December 2020)
[375] #SpaceWatchGL Opinion: Norway's space ambition: from oil to orbit. SpaceWatchGlobal (November 2020) https://spacewatch.global/2020/11/spacewatchgl-opinion-norways-space-ambition-from-oil-to-orbit/
[376] Boeing, "Boeing, Andoya Space Partner to Expand Norwegian, NATO Testing." (September 2020) https://www.boeing.com/global/boeing-in-europe/news/2020/boeing-andoya-space-partner-to-expand-norwegian-nato-testing.page
[377] SpaceNews, "German startup Rocket Factory Augsburg picks Norway for maiden flight of RFA One smallsat launcher", (October 2020),

- Isar Aerospace, which develops a micro launcher named Spectrum, signed a 20-year lease with the Andøya Space Centre to have privileged access to one of the two launch pads that are still under construction.[378]

Sweden

In Sweden, the Esrange Space Center, which is located near Kiruna, is dedicated to suborbital launches and vertical launches for small launchers:

- In October, the Esrange test facilities were inaugurated by Rocket Factory Augsburg to conduct the first tests of its RFA One micro launcher's combustion engine.[379] The Esrange Space Center will host small satellite launches.
- In October, the Swedish government announced $10.2 million investment to upgrade the Esrange Space Center in order to start orbital launching activities in 2022.[380]
- In October, ESA announced its plans to conduct the first reusability test flights of the Themis Programme from Esrange by 2022.[381]

The Esrange Space Center (Credit: SSC)

- In August, the German start-up HyImpulse announced that it was considering launching a sounding rocket from the Esrange Space Center in March to test the engine of its orbital vehicle.[382]

Rest of Europe

In Langanes, Iceland, the Scottish company Skyrora successfully tested its Skylark Micro rocket from its own mobile launch site. The launch served as a test for its future Skyrora XL rocket that is planned to launch by 2023.[383]

In Portugal, Portugal Space is developing a spaceport on Santa Maria Island in the Azores archipelago with the aim of launching small satellites into LEO by 2021. In 2018, a study concluded that it was technically and financially viable to provide micro launchers services in the Azores.[384] A consortium was supposed to be selected this year among 14 preliminary bids to set up the spaceport and equip it with a launch vehicle, but no progress has been announced. However, ESA is considering the Azores spaceport as a landing zone for the Space Rider's first mission, even though the Guiana Space Centre is still considered as the first option at the moment.[385]

In Spain, the Spanish launch start-up PLD space completed the testing of its company's Teprel-B rocket engine, expected to power the single stage suborbital Miura 1 launch vehicle, bringing PLD one step closer to launching the mission from the El Arenosillo test range.[386]

This rising interest in commercial spaceports is not exclusive to Europe. These developments were first observed in the United States. Nonetheless, it is worth noting that these developments are all driven by similar interests related to the rising commercialisation of space, increasing demand for small satellite launches and the development of micro launchers and horizontal launchers.

378 SpaceNews, "German startup Isar Aerospace signs first launch contract", (April 2021)
379 SatNews, "UPDATED: Rocket Factory Augsburg Inaugurates Esrange Test Site For RFA ONE Main Engine", (October 2020)
380 SpaceNews, "Sweden ups investment to bring orbital launches to Esrange by 2022", (October 2020)
381 SSC, "SSC to launch satellites from Esrange Space Center", (October 2020)
382 SpaceNews, "DLR spinoff HyImpulse plans small launcher debut in 2022", (August 2020)
383 TechCrunch, "Skyrora launches its small demonstration rocket from mobile launch site in Iceland", (August 2020)
384 Deimos Elecnor Group, "Azores spaceport study", (November 2018), https://elecnor-deimos.com/azores-spaceport-study/
385 SpaceNews, "€167 million Space Rider contract funds construction of Europe's first orbital spaceplane", (December 2020)
386 SpaceNews, "PLD Space completes critical testing of its Teprel-B rocket engine", (August 2020)

Commercial spaceports developments in the United States

In the United States, there are 4 entirely privately-owned and operated spaceports, 12 commercial spaceports with a Federal Aviation Administration (FAA) license and 12 additional commercial spaceports which have begun the licensing process.[387] In 2020, several developments took place in the United States:

- In May, the FAA established a spaceport office to facilitate the attribution of spaceport licences, provide technical support, infrastructure improvements and promote the launch sites as part of a reorganisation of the Office of Commercial Space Transportation.[388]
- In June, the Global Spaceport Alliance released a National Spaceport Network Development Plan. The purpose of this plan is to provide "the information needed to assist in the development of a network of spaceports in the U.S. that would support civil, commercial, and national security requirements for access to space. It aims at enabling the upgrade and modernization of national spaceport facilities, alleviating the congestion and schedule backlog at the Eastern and Western Ranges, lowering costs with advanced technologies and streamlined commercial business practices and allowing for a more robust and more resilient space launch infrastructure."[389]
- In November, Voyager Space Holdings announced its plans to acquire The Launch Company, which provides rocket, spacecraft and ground equipment for launch sites. The company aims to create launch sites for multi-user launch systems and to allow their customers to lease time on launch pads depending on their needs.[390]
- In November, the FAA announced that SpaceX applied for licences for suborbital and orbital launches of its Starship spacecraft from its Boca Chica Launch Site, which triggered an environmental review of the spaceport under the National Environmental Policy Act (NEPA).[391]
- Virgin Galactic conducted two test flights of its SpaceShipTwo suborbital vehicle that was launched from the WhiteKnightTwo aircraft from Spaceport America, in southern New Mexico, in May and June.[392, 393] In December, Virgin Galactic aborted a third attempt due to engine failure.

Other commercial spaceports' developments in the world

The Whalers Way Orbital Launch Complex is a commercial spaceport developed by the company Southern Launch in South Australia. Australia also established a rocket test range in Koonibba and enables suborbital launches for testing purposes prior to orbital launches from the Whalers Way Orbital Launch Complex.[394] In September, a first suborbital launch carrying Defence Electronic Warfare Company's experimental electronic warfare payload failed to launch due to a rocket misfire. A second launch was successfully conducted later that month.[395]

---

[387] Global Space Portal Alliance, "National Spaceport Network Development Plan", (June 2020)
[388] SpaceNews, "FAA establishes spaceport office to support growing number of launch sites", (May 2020)
[389] Global Speceport Alliance, "National Spaceport Network Development Plan. (June 2020) f
[390] SpaceNews, "Voyager Space Holdings to acquire The Launch Company", (November 2020)
[391] Space.com, "SpaceX's Texas launch site undergoing FAA environmental review for Starship flights", (December 2020)
[392] SpaceNews, "SpaceShipTwo makes first flight from Spaceport America", (May 2020) /
[393] SpaceNews, "SpaceShipTwo makes second glide flight at Spaceport America", (June 2020) /
[394] South Australian Space Industry Centre, "Koonibba Test Range And Whalers Way Orbital Launch Complex. (September 2020) https://www.sasic.sa.gov.au/precincts/koonibba-test-range-and-whalers-way-orbital-launch-complex/
[395] ASPI, "Australia one step closer to a sovereign launch capability", (October 2020)

In New Zealand, there is one commercial spaceport owned and operated by Rocket Lab on the Mahia Peninsula called Launch Complex 1, which is being extended with a second launch pad. Several developments took place in 2020:

- In November, Rocket Lab launched its own Electron rocket from this new launch pad, put 29 small satellites into orbit and recovered the first stage of the rocket.[396]
- In December, Rocket lab launched the Japanese company Synspective's SAR satellites from the same launch pad.[397]

In Japan, Virgin Orbit signed a partnership with the Japanese Oita Prefecture in April to build a spaceport at the Oita Airport on the Kyushu island and accommodate horizontal launches by 2022.[398] In October, the Space Port Japan Association unveiled its proposal for the architecture of Spaceport City, a spaceport that would be able to host horizontal launchers for space tourism.[399]

Design concept of Japan's Spaceport City (Credit: Space Port Japan Association).

In India, the Indian Space Research Organisation (ISRO) declared in July that private companies will be allowed to set up their own launch pads at the Sriharikota Launch Center as part of a broader move to involve private actors in India's space sector.[400]

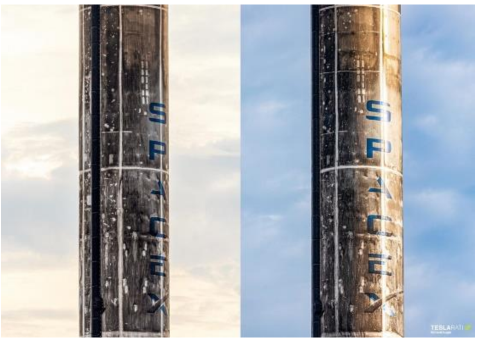
[396] SpaceNews, "Rocket Lab launches Electron in test of booster recovery", (November 2020)
[397] Space.com, "Rocket Lab launches Japanese Earth-imaging satellite into orbit from New Zealand", (December 2020)
[398] TechCrunch, "Virgin Orbit announces new plans for first Asian spaceport in Oita, Japan", (April 2020) /
[399] Business Insider, "Futuristic architecture, entertainment hubs and kinetic solar panels: This is what spaceports could look like if commercial space flights become a reality", (November 2020)
[400] Times of India, "Isro will allow private sector to set up own launchpad at Sriharikota", (July 2020)

2.1.2 Multiplication of reusable launcher programmes across the Globe

The year was marked by multiple announcements regarding the development of reusable launchers and related technologies. A large majority of the global launcher industry, which used to question the economic viability of reusability and did not show much enthusiasm for this feature, is now actively exploring the concept and planning R&D activities and budgets for this purpose.

SpaceX and American firms continue to lead developments

In 2020, SpaceX successfully reached one of its most important milestones by conducting the 100th launch of its Falcon 9 rocket as it continues to develop the reusability of its launcher. SpaceX performed a record of 25 orbital launches over the year, accounting for 68% of all launches from U.S. soil (25 out of 37). 7 launches were operated for the U.S. government (primary payload), while the 14 remaining launches were related to the launch of Starlink, leaving 3 launches for commercial customers.



Falcon 9 booster after its sixth and seventh flights. (Credit: Richard Angle)

The company first demonstrated the viability of the technology in 2015 during Falcon 9's 20th flight by successfully landing the rocket's full thrust booster[401]. The company then became the first to successfully re-use a previously recovered booster in 2017[402], when it launched the SES-10 geostationary satellite from the Kennedy Space Center. With as many as 48 projected Flacon 9 and Falcon Heavy launches planned for 2021,[403] the American company is set to reach some of its most important long-term objectives related to the reusability of the system. In parallel, the full reusability model is in continued development through the Starship project.

- Since the first successful recovery of Falcon 9's first stage in 2015, SpaceX has now repeated the operation over 75 times. In contrast, the company has only failed to recover one of its Falcon 9 Block 5 first stage boosters 3 times.
- With regards to the reusability of a single booster, one of the company's earliest long-term goals was to perform the launch of a recovered booster at least 10 times. SpaceX met this goal in May 2021 with its B1051 booster, following the launch of a new batch of Starlink satellites. The company's B1049 and B1058 boosters have also completed 9 and 8 launches and landings respectively.
- The company has in addition carried out 65 successful launches with a previously recovered booster.[404]
- The company also appears to be leading by a margin in terms of the pricing of each launch, with the reusability of its systems playing an important role in the cost reduction for its launches. SpaceX currently prices the launch of its Falcon 9 at $62 million,[405] which is expected to remain the standard plan until 2022. Although there are no official calculations made available of the cost reduction made possible due to the reusability of its system, the company has stated that the booster represents approx. 60% of the total cost of the launcher.[406] The company's CEO Elon Musk also unveiled the reduction of payload capacity induced by the use of a reusable booster, stating that it is of roughly 40% for the Falcon 9.[407]

[401] NBC News, "SpaceX makes history successfully launches and lands falcon 9 rocket", https://www.nbcnews.com/tech/innovation/spacex-makes-history-successfully-launches-lands-falcon-9-rocket-n483921
[402] Space Intel Report, "SpaceX Reusability effort faces one more big challenge", (March 2017),
[403] Space flight Now, "SpaceX delivers for Turkey in first launch of 2021", (January 2021)
[404] SpaceX stats, (Last accessed May 2021): https://www.spacexstats.xyz/#reuse-reused-flights
[405] SpaceX, "Capabilities&Services", (Last accessed May 2021): https://www.spacex.com/media/Capabilities&Services.pdf
[406] CNBC, "Here's everything Elon Musk told reporters about the reusable rocket that will fly twice within 24 hours", (May 2028)
[407] Inverse, "SpaceX: Elon Musk breaks down the cost of reusable rockets", https://www.inverse.com/innovation/spacex-elon-musk-falcon-9-economics

In addition to developing the reusability of Falcon 9 first stage, SpaceX has also been able to recover and reuse payload fairings in 2019.[408] In total, the company has successfully recovered over 10 payload fairings since,[409] failing 16 times in the process. The recovery and reuse of the fairings is an additional component driving the price of every marginal launch for the company, as they represent approx. 10% of the rocket cost.[410] SpaceX has also started to use recovered boosters to launch third-party payloads more frequently.[411]

Reusable launchers are becoming more widely accepted, including for critical missions. Notably, NASA modified a contract with SpaceX in June to allow the company to reuse Falcon 9 first stages and Crew Dragon spacecraft in the future. Previously, it was planned to use a new Crew Dragon for each flight.[412]

As the Falcon Heavy uses the same class of boosters as the Falcon 9 rocket, SpaceX's commercial heavy-lift launch vehicle successfully launched and landed all three of its boosters in 2019.[413] The company had managed to successfully recover only two of the three boosters in the maiden flight a few months earlier.

The SN-10 during its test flight (Credit: SpaceX)

With the development of its new Starship system, SpaceX aims to cement its reusability strategy by making the launcher fully reusable and reinforcing the technical concepts and associated business models of its two reusable launcher classes. The Starship system is essentially composed of two reusable stages, the first one being the Super Heavy booster stage and the second one, also called Starship, meant for in-space transportation from orbit. The Super Heavy booster has not been tested in 2020, with the company planning to begin in mid-2021. While it was expected to land the same way as Falcon 9 boosters using its Raptor engines to perform a soft landing, SpaceX is projecting an innovative landing manoeuvre that would involve the launch tower arms catching the booster before it lands.[414]

The second stages' reusability also brings innovative elements to those developed by previous reusable launch systems designed to host a crew, as the company has attempted to use a controlled re-entry manoeuvre to recover the capsule.[415] The manoeuvre makes use of an active aerodynamic control made possible by the aft flaps fitted on the vehicle that slow down the Starship before reignition of the Raptor engines to enable a precise landing. The Starship system is projected to become the most powerful launch vehicle ever developed, and the company expects it to support manned missions to Mars as well as to the Moon.

In the past year, testing of the SpaceX Starship has progressed substantially. Pressure tests were conducted on the first flight design in February,[416] as well as a mostly successful three engine flight test in December[417] followed by a successful landing of its SN-10 prototype in March 2021.[418] The company is projecting to launch both components of the Starship to orbit in 2023.

---

408 Space Flight Now, "SpaceX to reuse payload fairing for first time on Nov. 11 launch", (November 2020)
409 SpaceX stats, (Last accessed May 2021): https://www.spacexstats.xyz/#reuse-reused-flights
410 CNBC, "Here's everything Elon Musk told reporters about the reusable rocket that will fly twice within 24 hours", (May 2028)
411 CNBC, "Starting in 2021, SpaceX may reuse boosters for US Space Force launches" (September 2020)
412 SpaceNews, "NASA to allow reuse of Crew Dragon spacecraft and boosters", (June 2020)
413 NasaSpaceFlight, "SpaceX Falcon Heavy launches Arabsat-6A", (April 2019)
414 Space.com, "SpaceX targets bold new 'catch' strategy for landing Super Heavy rockets", https://www.space.com/spacex-starship-super-heavy-landing-plans
415 SpaceX, Vehicles, "https://www.spacex.com/vehicles/starship/
416 Space.com, SpaceX Starship SN1 prototype bursts videos, "https://www.space.com/spacex-starship-sn1-prototype-bursts-videos.html"
417 CNN, "SpaceX Starship SN8 test flight recap", https://edition.cnn.com/2020/12/10/tech/spacex-starship-sn8-test-flight-recap-scn/index.html
418 BBC News, "SpaceX's Starship rocket lands but then explodes", https://www.bbc.com/news/science-environment-56274183

An additional company that is developing a reusable first stage is the U.S./NZ firm Rocket Lab. Although Rocket Lab CEO Peter Beck was not planning to incorporate reusability into the Electron rocket design,[419] explaining that the economic viability of reusability strongly depends on refurbishment costs, the company has now actively explored technical options.[420] The Electron is now the world's first orbital-class reusable small rocket, able to launch 300kg to LEO. Although the company has managed to recover a booster, it has yet to reuse one.

Recovery of Rocket Lab's Electron first stage (Credit: Rocket Lab)

Rocket Lab's technology differs from that developed by SpaceX as it does not plan for a soft landing using booster engine, rather opting for a manoeuvre that involves the mid-air capture of the Electron's first stage booster.[421] The company first demonstrated the technology in April 2020, with an helicopter successfully catching the test article of a first stage with a grappling hook following its slowed descent by means of a parachute.[422] In November it then used parachutes for the first time to slow the descent of the first stage after a launch, after which the stage was retrieved from the ocean.

As Rocket Lab's Electron rocket is designed mainly for the launch of small satellites and is considerably smaller than SpaceX's Falcon 9, the launcher would not have the sufficient fuel capacity to enable the reignition of boosters as the Falcon 9 does. However, the company has recently raised new funds through a merger with the SPAC company Vector Acquisition Corporation[423], which it plans to use to fund the development of a larger reusable launch vehicle called the Neutron. The Neutron would be a medium-lift rocket similar to the Falcon 9, with a projected reusable first stage that would also make use of a propulsive landing manoeuvre.[424]

While SpaceX and Rocket Lab are the only two companies that have demonstrated reusability for orbital-class vehicles, other U.S. companies are continuing the development of technologies to include reusability in their launchers.

Blue Origin, which is currently continuing the development of its New Shepard suborbital rocket and of its New Glenn orbital-class heavy-lift rocket, both of which are designed to be reusable. Its fully reusable suborbital New Shephard programme completed its 14th test flight in January 2021, while the reusability record for a single vehicle was set in October 2020 when the launcher lifted off and landed for the 7th time, carrying 12 commercial payloads.[425] Furthermore, its orbital New Glenn rocket is designed to have a reusable first stage but has yet to fly. Following the recent decision from the Space Force to halt the support for the launcher's development through the NSSL contracts, which were awarded to ULA and SpaceX, the company updated its schedule and expects its maiden flight to occur no earlier than Q4 2022[426]. In December, Blue Origin nevertheless received a NASA launch services contract, allowing the firm to compete for future NASA missions from 2025.[427]

[419] Teslarati, "SpaceX competitor ULA CEO still questions the economic value of reusable rockets", (April 2020)
[420] Space Intel Report, Rocket Lab, Relativity Space, LandSpace: CEOs from launcher startups with $4.2B in valuation discuss strategy", (Decembre 2020)
[421] Space Filght Now, "Rocket Lab reports recovery test success", (April 2020)
[422] SpaceNews, "Rocket Lab tests Electron stage recovery", (April 2020)
[423] Concluded a definite merger agreement
[424] NasaSpaceFlight, "Rocket Lab reveals Neutron", (March 2021) /
[425] Daily Mail, "Liftoff! Jeff Bezos' Blue Origin breaks the record for rocket recycling by launching and landing its reusable New Shepard craft for the SEVENTH time" (October 2020)
[426] ArsTechnica, "Blue Origin's massive New Glenn rocket is delayed for years. What went wrong?" (March 2021)
[427] NASA, "NASA Awards Launch Services Contract to Blue Origin for New Glenn Launch Services", https://www.nasa.gov/press-release/nasa-awards-launch-services-contract-to-blue-origin-for-new-glenn-launch-services/

ULA (United Launch Alliance) also plans to incorporate reusability into its Vulcan rocket designs and kicked off technology developments under a project known as SMART. ULA CEO Tory Bruno had previously questioned the economics of reusability.[428] The SMART concept uses parachutes and a helicopter but catches only the engines of the first stage. Catching the engines means extra fuel does not have to be spent on slowing and landing the entire booster. ULA explained that the engines represent 65% of the total booster cost. The Vulcan rocket is still in development, and in August ULA received $337 million in National Security Space Launch (NSSL) Phase 2 contract, which the company will also use to finish funding its development.[429] The first flight of the Vulcan rocket is expected in mid-2021.[430]

In addition to these systems that mainly make use of a rocket booster as a reusable fist stage, the U.S. government and private companies have also developed other reusable designs and technologies. The U.S. government regularly launches a reusable orbital space plane through its X-37B programme. Operated by the Space Force, the vehicle first flew in 2010 and launched for the sixth time in May.

Cosmic Girl launching Virgin Orbit's LauncherOne (Credit: Virgin Orbit)

Companies such as Virgin Orbit are developing suborbital vehicles to launch payloads into space. Through this model, companies make use of airplanes or other suborbital vehicles to carry the second stage of the vehicle to the necessary altitude, in the same way as a first booster. A recent example of this technology includes Virgin Orbit's system, which makes use of a Boeing 747-400 named Cosmic Girl to launch the two-stage rocket called LauncherOne. The company succeeded in reaching orbit in its second test flight, successfully launching the ELaNa 20 mission for NASA under their 2015 Launch Demo 2 contract.[431]

Similarly, the U.S. start-up Aevum unveiled its rocket launching drone for small satellites known as RAVN-X in December. With this design, the company uses the drone as a first stage, autonomously taking off from an airport and releasing a rocket for small satellites. The company is aiming to target the small satellites market, in particular for scientific remote sensing payloads that may necessitate an added degree of precision and must be launched in a custom orbit. Having already concluded agreements totalling over $1 billion in contracts, Aevum plans a 2021 launch for the U.S. Space Force.[432]

[428] Aviation Week, "Economics Of Rocket Reuse Still Up In The Air (April 2020)",
[429] U.S. Department of Defence, "Contracts For Aug. 7, 2020", https://www.defense.gov/Newsroom/Contracts/Contract/Article/2305454/
[430] NasaSpaceFlight, "Vulcan on track as ULA eyes early-2021 test flight to the Moon", (June 2020) https://www.nasaspaceflight.com/2020/06/vulcan-2021-moon-flight/
[431] SpaceNews, "Virgin Orbit reaches orbit on second LauncherOne mission", (January 2021)
[432] Science Magazine, "Rocket-launching drone ready to take satellites into orbit", (December 2020)

Europe starts to explore reusability for launcher programmes

In Europe, agencies and the industry are beginning to explore reusability more actively even though the viabilities of such projects are still under study.[433]

ESA has been studying technologies and concepts related to reusability of launch vehicles in the framework of the Future Launchers Preparatory Programme (FLPP) since 2004, and has recently ramped up efforts to develop the next generation of European launch systems that will make use of reusability.[434]

The Prometheus engine (Credit: ArianeGroup)

With the maiden flight of the Ariane 6 rocket expected to take place in 2021,[435] European stakeholders are intensifying the efforts towards its successor. For this purpose, the CNES Launcher Directorate and ArianeGroup are assessing options for the future rocket known as Ariane NEXT, which is expected to include a reusable first stage when it replaces Ariane 6 after 2030.[436]

In order to develop the technology needed to manufacture the Ariane NEXT, the agency is first planning to bring some of the key aspects of reusability to maturity. To this end, ESA is actively working on the development of reusable engines, notably through the design of the Prometheus engine, and on the development of a reusable stage demonstrator within the scope of the Themis programme.[437] The Themis programme is being developed in the frame of the ESA FLPP NEO project following important decisions taken at Council level at the Space19+ conference[438] where ESA member states reinforced their willingness to support the space industry through a historic budget. In addition to the Themis booster and the Prometheus engine, whose initial designs were created through a strong partnership between ArianeGroup and CNES already starting in 2015, the advancement of the programme will also necessitate breakthroughs in the developments of a recovery demonstrator called Callisto and a lightweight upper stage named PHEOBUS/ICARUS[439].

433 Space Intel Report, "ArianeGroup CEO on Ariane 5 anomaly, government dithering on Ariane 6, and rocket reusability", https://www.spaceintelreport.com/arianegroup-ceo-on-ariane-5-anomaly-government-dithering-on-ariane-6-and-rocket-reusability/
434 ESA, " FLPP preparing for Europe's next-generation launcher", http://www.esa.int/Enabling_Support/Space_Transportation/New_Technologies/FLPP_preparing_for_Europe_s_next-generation_launcher
435 SpaceNews, "https://spacenews.com/esa-request-230-million-euros-more-for-ariane-6-as-maiden-flights-slips-to-2022/
436 European conference for aeronautics and space sciences, "Ariane Next, a vision for a reusable cost-efficient European rocket", https://www.eucass.eu/component/docindexer/?task=download&id=5506
437 Science Direct, " https://www.sciencedirect.com/science/article/abs/pii/S0094576520300631
438 European conference for aeronautics and space sciences, "PROMETHEUS, A LOX/LCH4 REUSABLE ROCKET ENGINE", https://www.eucass.eu/doi/EUCASS2017-537.pdf
439 ibid

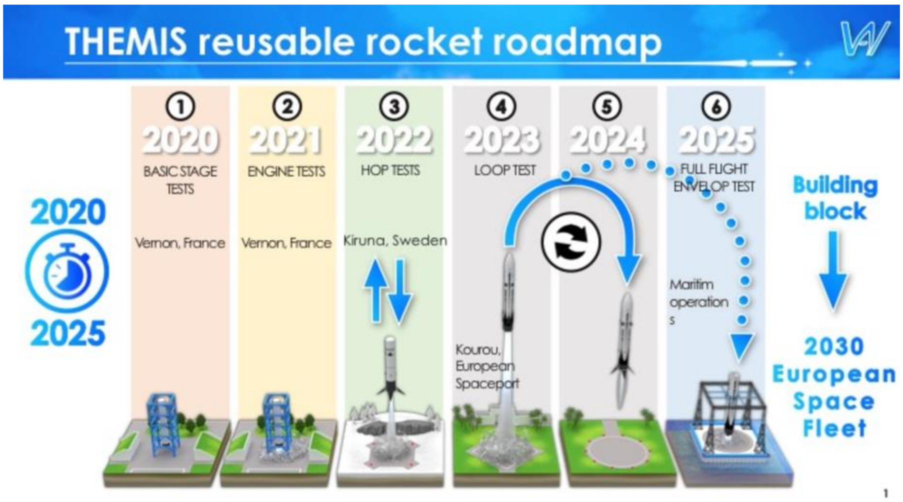


Figure 4: Roadmap to Themis rocket (Credit: ESA)

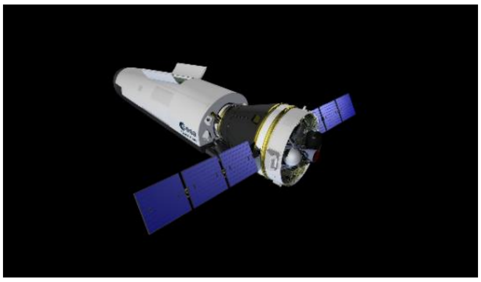
The first steps towards its development were taken as ESA awarded a €33 million contract to ArianeGroup for the design and manufacture of a reusable prototype first stage for Themis together with CNES, named the "Themis Initial Phase".[440] CNES will participate to the development of the reusable launchers within ArianeWorks, a team put together by the French agency and Ariane to accelerate the work on future launchers.[441]

The Themis first stage is set to be powered by the Prometheus rocket, which is being built by ArianeGroup in Ottoburn and which is also expected to be a prototype for future European engines, potentially even in an evolution of the Ariane 6 rocket.[442] The initial testing phase for some elements of the booster were carried out successfully in the Ariane site in Vernon in November 2020, with ArianeWorks announcing the start of the second phase in February 2021. The following steps in the development phase include a first hop test expected to be conducted in Kourou in 2022 according to the company's working schedule, with the initial launch projected in 2025.

15 ESA Member States are currently part of the FLPP including Sweden, which is participating in the Themis programme together with Belgium and Switzerland and will provide its Esrange Space Center as an additional test bed for the booster.[443]

The technologies related to the recoverability of launcher systems are also being studied by the DLR and CNES together with JAXA, which are collaborating on the Callisto project whose primary objectives include the study of the behaviour of different fuels, as well as demonstrating successful reusability.[444]

[440] ParabolicArc, "CNES, ArianeGroup Move Forward on Themis Reusable Rocket Project," (Febuary 2021) https://www.esa.int/Enabling_Support/Space_Transportation/ESA_plans_demonstration_of_a_reusable_rocket_stage#:~:text=ESA%20is%20taking%20the%20first,on%20future%20European%20launch%20vehicles.
[441] ParabolicArc, "A Look at Europe's reusable Themis booster project", (September 2020),
[442] Ariane Groupe, "ArianeGroup signs contract with ESA to develop Themis reusable stage demonstrator"(December 2020) https://www.ariane.group/en/news/arianegroup-signs-contract-with-esa-to-develop-themis-reusable-stage-demonstrator/
[443] Space Intel Report, https://www.spaceintelreport.com/sweden-commits-to-satellite-launch-capability-says-expanded-esrange-will-support-orbital-missions-in-2022/
[444] Space.com, "Europe's ArianeWorks Aims for Reusable Rockets (with a Very SpaceX Look)", https://www.space.com/arianeworks-reusable-rockets-themis-callisto-video.html



Artist rendition of ESA's Space Rider (Credit: ESA)

In addition to plans regarding the Themis programme, plans for a European reusable space plane have also progressed substantially in 2020. Led by Italy's PRIDE programme, Space Rider is an ESA reusable uncrewed orbital space plane aiming to enable routine cost-effective access to space. The spacecraft is designed to be integrated with ESA's future Vega C launcher and will be able to carry out missions lasting up to two months in orbit. In December, a €167 million contract was signed to Thales Alenia Space and Avio to develop the system,[445] with the launch expected to take place in 2023.

In the private sector, various companies across Europe are developing small launch vehicles, some of which are designed to be partially reusable. In 2020, European small launcher companies received over €126 million in investments. They are also often supported by governments both financially and with access to infrastructure, in particular spaceports. Whilst many of these companies have yet to perform a first orbital launch, most consider integrating elements of reusability in the design of their vehicles. German start-up Isar Aerospace for instance, who raised €75 million in 2020, has previously mentioned reusability as a future plan.[446] Similarly, UK-based company Orbex raised approx. €20 million in 2020 and is also projecting to develop the technology necessary to have a reusable rocket.[447] These companies are nonetheless primarily focused on reaching orbit with expendable designs, while also attempting to reduce costs through other means such as 3D printing of rocket parts.

RETALT1 spacecraft concept (Credit: RETALT)

In the United Kingdom, Reaction Engines has also continued the development of SABRE, a hybrid turbine/rocket engine planned to eventually power the Skylon single-stage-to-orbit rocket. In December, the company concluded an ESA study that was launched in collaboration with Bryce Space & Technology and ArianeGroup, for the purpose of evaluating the usability of the SABRE engine in a reusable first stage meant to address the needs of the European launch market post-2030.[448] The study suggested that the concepts under consideration would be beneficial to remain competitive and address future markets. In August, Reaction Engines received a £20 million investment from engine maker Rolls-Royce, building on an initial investment in 2018 of £26.5 million. The company will begin demonstration of SABRE's air breathing core in 2021.[449]

While the main institutional actor for future launcher technology development in Europe is ESA, the European Commission also has a shared interest in the exploration of disruptive concepts such as reusability especially within the wider context of enabling European autonomous access to space. To this end, it is of note that the European Commission started the funding of the RETALT project in 2019 in the

[445] Space Intel Report, "It took 30 years, but Europe will now have a reusable space plane for LEO missions", (December 2020),
[446] SpaceNews, "German launch startup raises $17 million with help from Airbus Ventures and an ex-SpaceX employee", (December 2019)
[447] Techcrunch, "UK space launch startup Orbex raises $24 million for its reusable rockets" (December 2020)
[448] Reaction Engines, "SABRE-Powered Launch study conclusion for the anticipated 2030+ reusable launch market", https://www.reactionengines.co.uk/news/news/sabre-powered-launch-study-conclusion-anticipated-2030-reusable-launch-market
[449] Aerospace testing international, "Sabre air-breathing rocket engine successfully completes key testing milestones", https://www.aerospacetestinginternational.com/news/engine-testing/sabre-air-breathing-rocket-engine-successfully-completes-key-testing-milestones.html

framework of Horizon 2020.[450] The project is mainly coordinated by the German DLR with industrial collaboration coming from Switzerland, Spain and Portugal, and its main objective is the development of know-how related to Retro Propulsion Assisted Landing Technologies. In particular, the RETALT project aims to investigate a launch system using retro propulsion technology in order to perform soft landing such as those carried out by the Falcon 9 boosters, as well as a similar technology also making use of aerodynamic control surfaces to slow down re-entry.[451] The project is projected to take place until 2022 and has received approx. €3 million since its launch.

Initiatives such as this one are undertaken in the context of broader EU ambition in the space sector. Commissioner Thierry Breton emphasised the importance of not missing disruptive technologies such as reusability in January 2020,[452] and reiterated the importance of supporting the European launcher industry from the earliest stages of development in order to meet the current international standards at the 13th European Space Conference.[453]

Most spacefaring nations are now actively exploring reusability

In November, the China Aerospace Science and Technology Corporation (CASC) announced that it started the development of a vertical take-off and landing rocket expected to be operational in 2025. The first Long March 8 conducted its first launch in December[454] with an expendable version of the rocket. CASC nonetheless projects to have partial reusability technology similar to that of SpaceX's Falcon 9 by 2025 and aims to reach full reusability by 2035[455]. Under CASC, two entities are developing reusable rockets: the Shanghai Academy of Spaceflight Technology (SAST) is developing a reusable version of the Long March 6; and the China Academy of Launch Vehicle Technology (CALT) is investigating aerial recovery of first stages, similar to Rocket Lab's.

Long March 8 rocket before its maiden flight (Credit: China Daily)

In addition to rockets, China is developing a reusable spaceplane through the China Aerospace Science and Industry Corp. (CASIC), as part of its next five-year plan. The Tengyun spaceplane will comprise a two-stage spaceplane, with horizontal take-off and landing capabilities.[456] It is planned to be completed by 2025. In addition, China may have tested another spaceplane in September,[457] and there are also numerous private commercial plans for space planes.[458]

Russia's Roscosmos also announced plans for a reusable two stage rocket in October 2020. The Amur Rocket is planned to launch for the first time in 2026 and will land back at the Vostochny Cosmodrome.[459]

---

[450] European Commission, "Retro Propulsion Assisted Landing Technologies", https://cordis.europa.eu/project/id/821890
[451] Retro propulsion Assiste Landing Technologies, "Project", https://www.retalt.eu/project/
[452] Space Intel Report, "European space, defense commissioner Breton: Galileo outage due to complicated multi-agency oversight" (January 2020)
[453] "Speech by Commissioner Thierry Breton at the 13th European Space Conference", (January 2021) https://ec.europa.eu/commission/commissioners/2019-2024/breton/announcements/speech-commissioner-thierry-breton-13th-european-space-conference_en
[454] Parabolic Arc, "China's Long March 8 Rocket Makes Successful Debut in Step Toward Reusability", (December 2020)
[455] Global Times, "Long March-8 rocket likely to try out vertical landing in 2021: Chinese developer", (March 2021)
[456] SpaceNews, "China's CASIC reveals five-year plan for reusable spaceplane, commercial space projects", (October 2020)",
[457] NPR, "New Chinese Space Plane Landed At Mysterious Air Base, Evidence Suggests", (September 2020)
[458] China Aerospace Blog, "China's Spaceplane Projects: Past, Present and Future", (May 2020)
[459] Space.com, "Russia planning to go reusable in 2026 with new Amur rocket" (October 2020), https://www.space.com/russia-announces-reusable-rocket-amur

India, through ISRO, has its own reusability plans through the Reusable Launch Vehicle (RLV), which has been in testing since 2016.[460] The RLV is a scaled down prototype of an eventual reusable launch vehicle. A landing test, where the vehicle is dropped from a helicopter, was scheduled for December but is now postponed to 2021.

Japan has been in the process of developing reusable rocket technology since 1999, but has not been able to create a viable vehicle so far mainly due to budget restraints. The H3 rocket manufactured by Mitsubishi Heavy Industries (MHI) is currently the first vehicle that could incorporate elements of reusability in the future as the company faces competition from SpaceX and Blue Origin. However, the company is experiencing delay with the maiden flight of the expendable version of the H3 now expected in spring of 2021.[461] In addition to partnering with CNES and DLR on the Callisto project, Japan is also focusing on reducing refurbishment cost of reusable rockets, with the view to developing a fully reusable system in future. This could come as early as 2025.[462]

In New Zealand, another spaceplane is progressing. In December, the Dawn Aerospace Mk-II Aurora test vehicle received New Zealand Civil Aviation Authority approval to fly. The 4.8 m long unmanned aerial vehicle will eventually take off from conventional airports to perform suborbital flights to over 100 km altitude. The first test flights are expected in 2021.

[460]First post, "ISRO's Space Shuttle-like Reusable Launch Vehicle will attempt its first landing in Karnataka", (October 2019), https://www.firstpost.com/tech/science/isro-space-shuttle-like-reusable-launch-vehicle-will-attempt-its-first-landing-in-karnataka-7506051.html
[461] SpaceNews, "First H3 launch slips to 2021", (September 2021)
[462] Arstechnica, " Quietly, Japan has established itself as a power in the aerospace industry"

2.1.3 C-Band clearing stimulates GEO satcom market

The worldwide drive for a ubiquitous, high-speed connectivity, embodied especially in the roll-out of 5G cellular networks, has greatly increased the demand for spectrum rights. This demand has also grown in frequencies long serving the satellite community, such has the C-band in 3.7-4.2. GHz range.

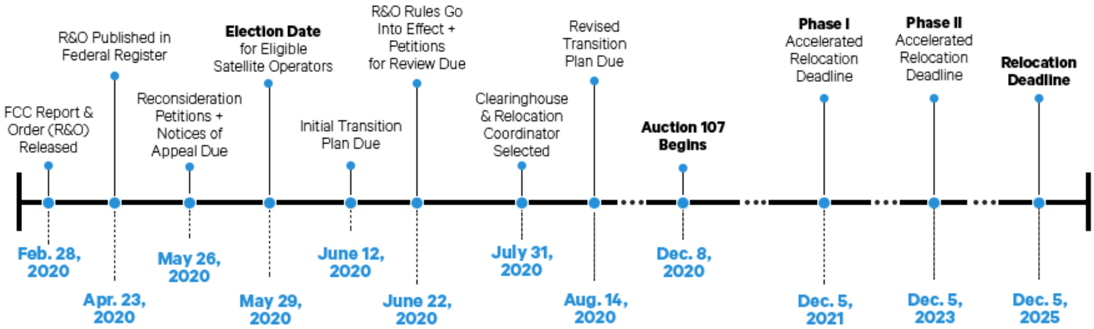


Figure 5: U.S. C-band clearing timeline (Credit: SES)

In 2019 and 2020, the most prominent C-band clearance from satellite to mobile 5G played out in the United States. In November 2019, the U.S. Federal Communications Commission (FCC) decided to clear lower 280 MHz of the 3.7-4.2 GHz range for use by terrestrial operators for 5G services. The FCC decided to run a public auction of C-band spectrum instead of a direct private sale of spectrum rights from satellite operators to 5G wireless operators.[463] In February 2020, the FCC released the final decision on repurposing the C-band spectrum. The lower 280 MHz of the 3.7-4.2 GHz range shall be cleared no later than December 5th, 2025.[464] The public auction for frequencies launched in December 2020. It has far exceeded estimates, yielding more than $80 billion, which is more than any previous FCC auction.[465]

As a result of this overall process, satellite operators with an active C-band business in the U.S. market (Intelsat, SES, Eutelsat, Telesat and Claro) are to migrate their C-band services to the 4.0-4.2 GHz range, for which they received assurances from the FCC that they will be:

- Reimbursed for relocation costs associated with moving out of the spectrum (estimated $3.5-$5.2 billion for procurement of new satellites, TT&C and gateway consolidation, technology upgrades…).
- Entitled to receive accelerated relocation payments totalling $9.7 billion if they commit to, and succeed in, clearing the spectrum early (two deadlines in December 2021 and December 2023).

Per the FCC's Final C-band decision, Intelsat will be eligible to receive about $4.87 billion; SES about $3.97 billion; Eutelsat about $507 million; Telesat $344 million; and Claro $15 million.[466] Intelsat and SES constitute more than 90% of U.S. satellite C-band market share.[467] Transition plans submitted by operators to the FCC over the summer revealed the justified relocation costs would likely be lower than anticipated, totalling less than $3 billion.[468]

[463] FCC, "Fact Sheet Expanding Flexible Use of the 3.7 to 4.2 GHz Band", (February 2020) https://docs.fcc.gov/public/attachments/DOC-362358A1.pdf
[464] FCC, "Expands Flexible Use of the C-band for 5G" , (February 2020) https://www.fcc.gov/document/fcc-expands-flexible-use-c-band-5g
[465] Rcr Wireless, "Auction slows as it surpasses $80 billion", (January 20201): https://www.rcrwireless.com/20210111/spectrum/auction-slows-as-it-surpasses-80-billion
[466] FCC, "FCC Expands Flexible Use of the C-band for 5G", (March 2020): https://www.fcc.gov/document/fcc-expands-flexible-use-c-band-5g-0
[467] SatNews, "NSR Analysis: The Grand C-band Debate: Too Early to Predict a Winner?", (November 2019): http://www.satnews.com/story.php?number=231146069&menu=1
[468] ViaSatellite, "Intelsat, SES Detail C-Band Transition Plans", (June 2020), (August 2020) https://spacenews.com/eutelsat-scraps-plan-for-replacement-c-band-satellite/; Eutelsat, Telesat, and Claro Share C-Band Transition Plans (June 2020)

New GEO satellite orders

In June, the FCC announced that the clearing of C-band spectrum will move forward on an accelerated timeline, after securing commitments from all eligible satellite operators.[469] As a result, Intelsat and SES unleashed a flurry of C-band satellite orders. While Eutelsat, Telesat and Claro have not decided to order replacement satellites, the total of 13 new orders by Intelsat and SES has largely stimulated commercial GEO satellite orders in 2020. Out of a remarkably high number of 21 commercial GEO satellites ordered in 2020, 13 were C-band replacements for the U.S. market. In each of the previous three years, there were less competitively awarded GEO orders by commercial operators – 15 in 2019, 5 in 2018 and 7 in 2017.

Operator	Satellite ordered	Manufacturer	Satellite bus	Purpose	Launch provider	Launch vehicle	Launch year
Intelsat	Galaxy-31	Maxar	SSL-1300	C-band (U.S.)	SpaceX	Falcon 9 (dual launch)	2022
Intelsat	Galaxy-32	Maxar	SSL-1300	C-band (U.S.)			
Intelsat	Galaxy-33	Northrop Grumman	GEOStar	C-band (U.S.)	SpaceX	Falcon 9 (dual launch)	2022
Intelsat	Galaxy-34	Northrop Grumman	GEOStar	C-band (U.S.)			
Intelsat	Galaxy-35	Maxar	SSL-1300	C-band (U.S.)	Arianespace	Ariane 5 (dual launch)	2022
Intelsat	Galaxy-36	Maxar	SSL-1300	C-band (U.S.)			
Intelsat	Galaxy-37	Maxar	SSL-1300	C-band (U.S.)	Arianespace	Ariane 64	2023
SES	SES-18	Northrop Grumman	GEOStar-3	C-band (U.S.)	SpaceX	Falcon 9 (dual launch)	2022
SES	SES-19	Northrop Grumman	GEOStar-3	C-band (U.S.)			
SES	SES-20	Boeing	BSS-702SP	C-band (U.S.)	ULA	Atlas V (dual launch)	2022
SES	SES-21	Boeing	BSS-702SP	C-band (U.S.)			
SES	SES-22	Thales Alenia Space	Spacebus-4000B2	C-band (U.S.)	Described as "contingency satellites", agreement with SpaceX (Falcon 9) to rapidly launch one if needed in 2022		
SES	SES-23	Thales Alenia Space	Spacebus-4000B2	C-band (U.S.)			
Hispasat	Amazonas Nexus	Thales Alenia Space	Spacebus-NEO	C-/Ku- band (Americas)	TBA	TBA	2022
Optus	Optus 11	Airbus	OneSat	Ku-band (Australia)	TBA	TBA	2023
Arabsat	BADR-8	Airbus	Eurostar-NEO	C-/Ku-band (MENA)	TBA	TBA	2023
Yahsat	Thuraya 4	Airbus	Eurostar-NEO	L-band (MENA)	TBA	TBA	2024
APT Satellite	APStar 6E	CGWIC	DFH-3E	Ku-band (Asia/Pacific)	CALT	Long March 2C	2023
Intelsat	Intelsat 40e	Maxar	SSL-1300	C-/Ku-/Ka (Americas)	SpaceX	Falcon 9	2022
Intelsat	TBA	Airbus	OneSat	TBA	TBA	TBA	TBA
Intelsat	TBA	Airbus	OneSat	TBA	TBA	TBA	TBA

Table 10: Commercial GEO satellite orders in 2020 – prevalence of U.S. C-band replacement satellites

469 Fierce Wireless, "C-band clearing to move ahead on accelerated timeline", (June 2020) https://www.fiercewireless.com/regulatory/c-band-clearing-to-move-ahead-accelerated-timeline

Analysts agree that new C-band orders have been a welcome relief for the satellite manufacturing industry, but would most likely remain a one-time stimulus (U.S. industry only signed one commercial contract for a GEO satcom in addition to the 13 C-band-related contracts). Uncertainties remain on the horizon of the GEO satcom market as a result of multiple forces on the side of the demand, of the competition (emerging large non-GEO constellations) as well as of technology and innovation (HTS/VHTS, small GEO, flexible payloads, in-orbit services, etc.).[470]

U.S. space industry a big winner in the bidding spree

Thales Alenia Space was the only European satellite manufacturer to win two of the 13 C-band replacement satellite orders in 2020 and Arianespace secured two launches. The fact that all remaining manufacturing and launch contracts have been awarded to U.S. providers was a particularly favourable result for the U.S. space industry.

Public sources did not provide for evidence of a mandatory "buy U.S." policy for satellite operators in C-band satellite orders. FCC Chair Ajit Pai stated such measure could have been considered exclusively if there were national security concerns.[471] An absence of a "buy U.S." obligation was criticised by one U.S. Senator.[472]

Bearing in mind that satellite operators would be reimbursed through auction revenue made available by payments from U.S. 5G wireless operators, a "soft" U.S. political pressure has likely contributed to the overall result. In this regard, SES' CEO Steve Collar has acknowledged that in choosing launch and manufacturing providers for SES C-band replacement satellites, "utilizing a very strong U.S. space manufacturing and launch industry was an important consideration".[473]

Strong competitive dynamics and quarrels among satellite operators

The U.S. C-band clearing in 2020 caught satellite operators in visible disputes resulting in accusations, administrative appeals and even legal claims. These developments stood in stark contrast to October 2018, when Intelsat, SES, Eutelsat and Telesat formed the C-Band Alliance (CBA)[474], an industry consortium advocating for a market-based approach to managing and funding C-band spectrum clearing:

- The C-Band Alliance has had a rather short existence. Eutelsat left the consortium in September 2019 claiming lack of effort and slow progress on consensus build-up.[475] CBA's outlook was further diminished just a few weeks later when the FCC ultimately decided for a public C-band auction.[476] Its fate was sealed for good in early 2020, when Intelsat went ahead with an individual effort at the FCC (new request for a bigger piece of the reimbursement pie), prompting a displeased response by SES.[477]
- In July 2020, several weeks after Intelsat filed for Chapter 11 bankruptcy protection in the U.S.[478], SES filed a legal claim against Intelsat seeking at least $1.8 billion in damages for Intelsat's withdrawal from the C-Band Alliance. The claim was filed at the same Virginia court handling Intelsat's bankruptcy. In defence, Intelsat argued that SES purposely misled the FCC in presenting a study that

[470] SpaceNews, "C-band bonanza bails out sluggish year for satellite orders", (November 2020)
[471] C-Span, "Senate Hearing on Broadband Infrastructure", (June 2020)
[472] John Kennedy, "Sen. Kennedy urges FCC to buy American satellites for 5G services", (May 2020) https://www.kennedy.senate.gov/public/2020/5/sen-kennedy-urges-fcc-to-buy-american-satellites-for-5g-services
[473] ViaSatellite, "SES CEO Steve Collar Talks ULA, SpaceX C-Band Launch Contracts", (August 2020)
[474] Satellite Today, "Intelsat, SES, Eutelsat Form the C-Band Alliance", (October 2018)
[475] SpaceNews, "Eutelsat leaves C-Band Alliance as spectrum decision looms", (September 2019)
[476] FCC, "Fact Sheet: Expanding Flexible Use of the 3.7 to 4.2 GHz Band", (February 2020): https://docs.fcc.gov/public/attachments/DOC-362358A1.pdf
[477] Fierce Wireless, "Intelsat declares C-Band Alliance dead as it seeks more money from FCC", (February 2020)
[478] SpaceNews, "Intelsat declares bankruptcy as means to fund C-band spectrum clearing", (May 2020)

the FCC had used to apportion C-band payments.[479] In December, a new SES filing at the Bankruptcy Court reiterated SES' position, accusing Intelsat of violating a contractual agreement that the two operators would equally divide any incentive proceeds stemming from the U.S. C-band Auction.[480]

- In Q2 2020 **Hughes, Inmarsat (both without C-band satellites) and Eutelsat teamed up in a vocal criticism of Intelsat's and SES' C-band transition plans,** arguing proposals of both operators seemingly included payments for costs unrelated to the relocation process. Pointing out to Intelsat plan to include other than C-band capacity on replacement spacecraft and SES plan counting with ground spares, the trio of operators appealed to the FCC that the reimbursement payments should be used neither to launch an excessive number of new satellites nor to subsidise satellite capacity in other spectrum bands and neighbouring markets outside the U.S., which could potentially lead to an unfair competitive advantage.[481, 482]

---

479 Space Intel Report, "Intelsat: SES purposely misled FCC in presenting study that FCC used to apportion C-band payments", (October 2020)
480 Space Intel Report, "SES: We may take legal action against Intelsat affiliates that profit from C-band incentive payments", (December 2020)
481 SpaceNews, "Hughes, Inmarsat urge FCC restrictions on subsidized C-band satellites", (June 2020)
482 SpaceNews, "Eutelsat scraps plan for replacement C-band satellite", (August 2020)

2.1.4 Developments in U.S. Human Spaceflight programmes and Human Landing System

2020 was marked by major developments for several public-private partnerships in the field of Human Spaceflight, some of which have already led to interesting outcomes:

Dragon capsule docking with the ISS (credit NASA)

- The United States recovered their capacity to launch astronauts from national soil with a commercially built and operated American spacecraft. Indeed, SpaceX's Crew Dragon 2 was successfully launched in May 2020, while the first operational flight occurred in November 2020.
- The first crewed test flight of another commercial solution, Boeing´s CST-100 Starliner, was postponed to late 2021 due to several technical concerns throughout the year.
- In addition, NASA awarded three contracts for the first phase of the development of the Human Landing System (HLS) in April 2020, and selected SpaceX for the Option A of the programme on April 16th, 2021.

SpaceX and Boeing were awarded the contracts in the framework of the NASA's Commercial Crew Programme (CCP). The CCP programme was launched in 2010 with the aim to enable U.S. space transportation systems developed by private companies for crewed spaceflight, with the goal of achieving access to and from the ISS and other destinations in LEO. After an initial selection of four companies including Sierra Nevada Corporation and Blue Origin, NASA started two commercial partnerships with SpaceX and Boeing in September 2014, to develop Crew Dragon and CST-100 Starliner respectively. The CCP is strictly related to the Commercial Orbital Transportation Services (COTS) programme. COTS was announced by NASA in 2006 with the goal to coordinate the development of vehicles for the delivery of crew and cargo to the ISS by private companies. Based on the CCP formula, each company would remain the owner of the human spaceflight system it is developing.

Successful outcome for NASA´s approach to cargo and crew transportation services: SpaceX Crew Dragon

The successful launch of SpaceX's Crew Dragon 2 in May 2020, which brought two American astronauts – Robert Behnken and Douglas Hurley – to the ISS, concluded a decade-long plan for the United States to recover their strategic human spaceflight capacity.

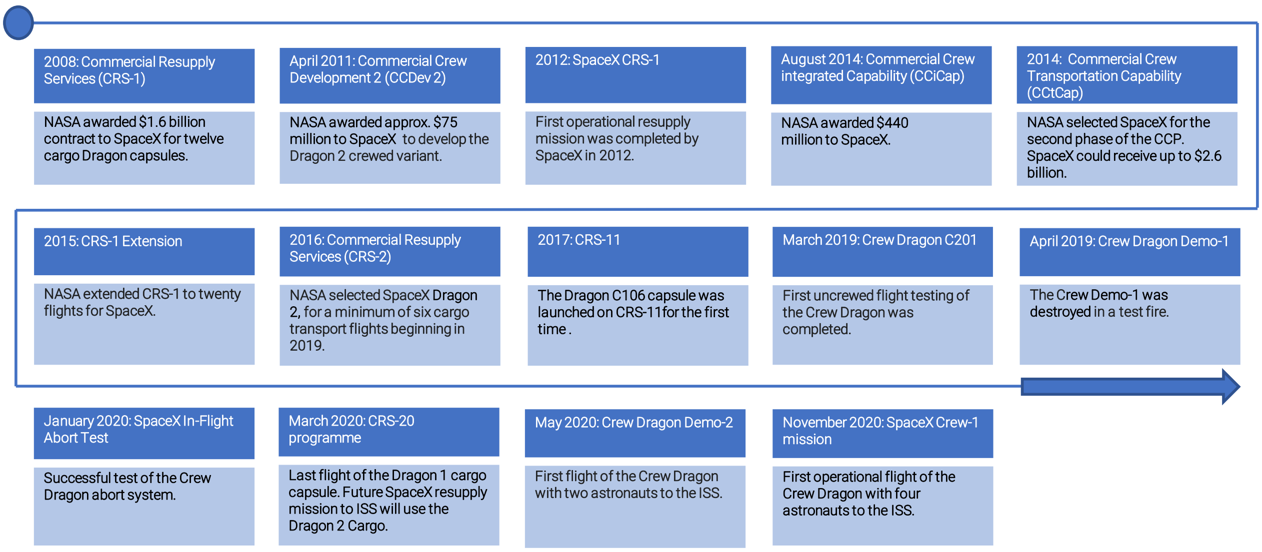


Figure 6: SpaceX-NASA timeline for Dragon developments

The Demonstration-2 mission (DM-2) launched from the Kennedy Space Center Launch Complex on May 30th, 2020 onboard a Falcon 9 rocket, and Crew Dragon 2 autonomously docked to the ISS approximately 19 hours after the launch. This was the first time American astronauts returned to orbit from American soil since the retirement of the space shuttle in 2011. Indeed, since 2011, the United States has relied on negotiations with Roscosmos to secure seats on Soyuz rockets to reach the ISS. According to a NASA Inspector General report of 2019, NASA has spent approx. $3.9B on 70 Soyuz seats since 2006 – $1B since 2017.

The Dragon 2 Cargo was developed under phase 2 of NASA´s Commercial Resupply Services (CRS) to resupply the ISS. Subsequently, SpaceX developed the Dragon 2 crewed variant, a second version that includes the capability to transport people, through NASA’s Commercial Crew Programme (CCP).[483] The Crew Dragon DM-2 mission in May 2020 was the final demonstration mission to validate SpaceX’s crew transportation system and certify the Crew Dragon for operational, long-duration missions to the ISS under the CCP.[484] It was built on the previously successful DM-1 mission and an in-flight abort test to permit crewed flights.[485] Finally, the first operational commercial crew flight occurred later in the year. The SpaceX Crew-1 mission to the ISS was launched on November 15th, docking with the ISS the day after. It carried three NASA astronauts – Mike Hopkins, Victor Glover, Shannon Walker – and one JAXA astronaut – Soichi Noguchi. The astronauts stayed in the ISS for six months, before returning to Earth. Following the success of the Crew-1 mission, NASA authorised the reutilisation of both Dragon capsules and Falcon-9 boosters for further manned missions. The Crew-2 mission was launched on April 22nd, 2021.

Boeing Starliner still facing hurdles

Besides the SpaceX Crew Dragon, NASA’s CCP is also working with Boeing to develop additional U.S. commercial crew space transportation capabilities. The first crewed test flight of CST-100 Starliner is now planned to be launched in late 2021, after having suffered considerable delays due to technical concerns throughout the year.


Boeing Starliner capsule (credit NASA)

In December 2019, the first Orbital Flight Test (OFT) of Boeing's Starliner spacecraft experienced technical problems that prevented the spacecraft from docking with the ISS. After this failure, NASA and Boeing started investigations.[486] NASA released the results of an independent investigation, revealing that Boeing did not run a full test in the 48 hours before launch, instead breaking it into different blocks. This resulted in the spacecraft using an incorrect mission elapsed time from the Atlas V launch vehicle, expending too much fuel and failing to dock with the ISS. Additionally, a software error, which was rectified hours before the vehicles return to Earth, would have critically affected the spacecraft. The findings included a set of 80 recommendations for Starliner development, specifically highlighting the lack of proper hardware and software integration testing, which has to be carried out with better oversight and documentation. In light of this information, members of NASA’s independent Safety Advisory panel expressed further concerns regarding Boeing Starliner quality control during a July 23rd teleconference. They recommended the completion and approval of all recommendations prior to the next orbital flight test, at least 75% of which have already been implemented.

[483] NASA, “Your Guide to NASA's Commercial Crew Program”: https://www.planetary.org/space-missions/commercial-crew
[484] NASA, “SpaceX Demo-2 Will Showcase Public-Private Partnership Benefits”: https://blogs.nasa.gov/commercialcrew/2020/05/07/spacex-demo-2-will-showcase-public-private-partnership-benefits/
[485] SpaceNews, “SpaceX performs in-flight abort test of Crew Dragon spacecraft” (January 2020)
[486] SpaceNews, “NASA safety panel calls for reviews after second Starliner software problem”, (February 2020)

NASA and Boeing announced that they do not plan to fly the Starliner OFT-2 before August or September 2021. OFT-2 is a repeat of the OFT-1 unsuccessful test and will be self-funded by Boeing at a cost of $410 million. Should it be successful, the Crew Flight Test (CFT) with three astronauts would then likely occur by the end of the year.[487]

Overall, the CCP is reported to be NASA's lowest-cost human spaceflight programme since Mercury in 1959, drastically cutting the cost per-seat compared to the Shuttle and Soyuz missions. NASA estimates that the CCP is poised to save the Agency approx. $20 billion-$30 billion in comparison to the Constellation Programme and provide two crew transportation systems. Boeing received a substantial amount of extra funding in comparison to SpaceX.[488]

Commercial Crew Programme (CCP)	SpaceX	Boeing
Commercial Crew Development phase 1 (2010–2011)	–	$18.0M
Commercial Crew Development phase 2 (2011–2012)	$75.0M	$112.9M
Commercial Crew integrated Capability (2012–2014)	$440.0M	$480.0M
Certification Products Contract phase 1 (2013–2014)	$9.6M	$9.9M
Commercial Crew Transportation Capability (2014-current)	$2,600.0M	$4,200.0M
Additional Funding (2019)	–	$287.2M
Total Funding (2010–current)	$3,144.6M	$5,108.1M

Table 11: Comparison of funding and timelines between SpaceX and Boeing

Human Landing System (HLS) moves forward

HLS contracts have been awarded under the Next Space Technologies for Exploration Partnerships (NextSTEP-2) Appendix H Broad Agency Announcement (BAA).[489] On April 30th, NASA announced the selection of three teams that will be awarded a firm-fixed price ten-month study contract, with an overall value of $967M.[490] The HLS proposed by Boeing was not selected, and the bid was also subject to an investigation by the NASA's Inspector General and the Justice Department for an information leak. Indeed, NASA associate administrator for human spaceflight Doug Loverro was accused to provide Boeing with additional information, which prompted the company to revise its lunar spacecraft bid.[491]

Based on the NextSTEP-2 H, NASA intends to purchase services from private companies to transport astronauts from and to the Lunar Gateway to the Moon's surface and back. Instead of procuring the landers themselves through traditional government contracting methods, the landers are being procured through the PPP model. Similarly to the CCP, the selected company will be in charge of designing, developing, building, and launching the landers to Gateway and retain the ownership of the system. NASA

487 SpaceNews, "Next Starliner test flights slips to late summer", (April 2021)
488 NASA, "Commercial Crew Program – Essentials": https://www.nasa.gov/content/commercial-crew-program-the-essentials
489 NASA, "NextSTEP H: Human Landing System": https://www.nasa.gov/nextstep/humanlander2
490 NASA, ""NASA Names Companies to Develop Human Landers for Artemis Moon Missions", (April 2020): https://www.nasa.gov/press-release/nasa-names-companies-to-develop-human-landers-for-artemis-moon-missions
491 The Seattle Times, "NASA official's tip prompted Boeing to revise lunar spacecraft bid, sparking DOJ probe", (November 2020)

will procure landing services through a separate contract, and the company will also be able to sell the service to other costumers.

The main companies that have been selected are Blue Origin, Dynetics and SpaceX.

- Blue Origin National Team (together with Lockheed Martin, Northrop Grumman and Draper) was awarded a $579 million contract to develop an Integrated Lander Vehicle (ILV) to be launched on the Blue Origin New Glenn rocket or ULA Vulcan launch system. In August, Blue Origin delivered a mock-up of its lunar lander for NASA evaluation and critical feedback so Blue Origin can improve the design ahead of the final selection by NASA.[492]
- Dynetics (together with twenty-five other companies) was awarded a $253 million contract. The international consortium includes Thales Alenia Space, Sierra Nevada, Maxar, L3Harris, and Astrobotic. They are developing the Dynetics HLS (DHLS) that will be launched on the ULA Vulcan launch system. Thales Alenia Space will be focused on the design of the main volume of the crew module, including the primary structure, hatch & Extra Vehicular Activities (EVA) door, windows and thermal and micrometeoroid protection, together with the primary production of the basic tools.[493]
- SpaceX was awarded a $135M contract, with the aim of working on a modified version of the Starship.

On January 27th, 2021, NASA announced the execution of a two-month no-cost extensions to the three teams participating in the HLS programme. Indeed, while it was set to end on February 28th, the HLS base period of performance was run through mid-April. NASA conducted a "continuation review" to assess which project was closer to completion and will perform initial demonstration missions.

SpaceX's HLS Starship was the only company to receive "Option A" awards for lander development on April 16th, 2021.[494] The fixed-price, milestone-based contract has a total value of $2.89 billion, and covers the development of a crewed lunar lander, at least one uncrewed test flight to land on the lunar surface, as well as a crewed demonstration mission.

While NASA officials previously stated they would be in favour of making more than one Option A award in order to preserve competition and to rely on multiple suppliers in the programme,[495] the selection of a sole recipient (SpaceX) was explained by the restricted budget received by NASA in the FY2021 for that programme ($850 million instead of the requested $3.4 billion). The selection of SpaceX´s Starship vehicle also deviates from the original finding of the NASA Source Selection Statement.[496] Indeed, the lander proposal presented by Dynetics ranked highest in the technical and management rating, while the SpaceX was classified as "acceptable", and queries were raised on the capability of making it ready for a 2024 landing.[497] Furthermore, the choice has led to criticism by some members of Congress due to the fact that the selection took place before the start of the new NASA administrator and deputy administrator.

The future service contracts will be based on full and open competition, allowing other competitors to compete with SpaceX, but those companies will be in disadvantage as they will lack SpaceX's Option A contract to fund lander development.

[492] Blue Origin, "Blue Origin-Led National Team Delivers Lunar Lander Engineering Mockup to NASA", (August 2020)
[493] Thales, "Thales Alenia Space selected by Dynetics to partner in "Back to the Moon" Challenge", (January 2021)
[494]NASA, "As Artemis Moves Forward, NASA Picks SpaceX to Land Next Americans on Moon", (April 2021): https://www.nasa.gov/press-release/as-artemis-moves-forward-nasa-picks-spacex-to-land-next-americans-on-moon
[495] SpaceNews, "NASA says maintaining competition a priority for lunar lander procurement", (February 2021)
[496] Artemis, "Source Selection Statement, (April 2020): https://bit.ly/3fSP846
[497] SpaceNews, "NASA Evluation sees SpaceX Lunar Lander as Innovative but Risky", (May 2020)

2.2 Other outstanding developments in the space industry

2.2.1 OneWeb back in business

2020 proved to be a tumultuous year for OneWeb. Following the primary impacts of COVID-19 and, primary backer Softbank decided not to pursue additional investment, forcing OneWeb to file for Chapter 11 Bankruptcy in the United States.[498]

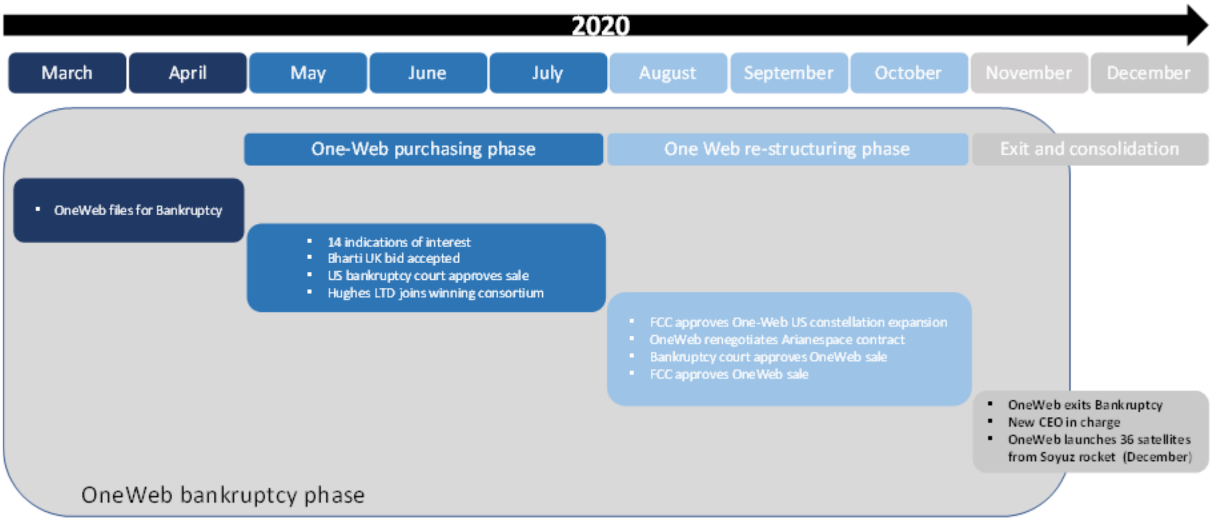


Figure 7: OneWeb Bankruptcy Timeline

OneWeb files for bankruptcy

On March 27th, 2020, OneWeb filed for relief under Chapter 11 of the Bankruptcy Code in the United States.[499] The company had been in advanced negotiations to secure more funding for its deployment and commercial launch. Up until then, the company had launched 74 satellites out of a planned 648, secured valuable spectrum rights and raised considerable financial and public interest in its worldwide broadband coverage concept.

OneWeb purchasing phase

In an interesting turn of events, OneWeb received 14 indications of interests by May 4th, many of which were motivated by the Ku and Ka band frequencies secured by OneWeb.[500] With a mix of private and national potential investors, and with three parties supported by China[501], the OneWeb case gained global coverage.

On July 3rd, OneWeb accepted a bid by BidCo 100 ltd., a consortium led by Bharti Global and the UK Government, for a total of $1 billion joint bid ($500 million each). This will provide Bharti Global and the UK Government a 45% stake each of OneWeb,[502] with OneWeb's existing shareholders owning the rest of the balance. The sale was accepted on July 10th during a U.S bankruptcy court hearing. The court also approved replacing SoftBank and Grupo Elektra with BidCo 100 ltd. as OneWeb's interim financial backer, allowing work to resume on the constellation.[503]

498 Financial Times," OneWeb collapses after SoftBank funding talks fall through", (March 2020)
499 OneWeb, "OneWeb files for Chapter 11 restructuring to execute sale process", (March 2020)
500 Quilty Analytics, "Focused Financial and Thematic Research on the Satellite & Space Industry". Last accessed May 2021.
501 France Science, "Bulletin d'actualité Espace n°20-06-Constellations", (March 2020).
502 Financial Times, "UK-Bharti bid for OneWeb gets green light from US court" (March 2020)
503 Space News, "Bankruptcy court frees payment to OneWeb Satellites to restart satellite manufacturing", (July 2020)

Bharti Enterprises, through Bharti Airtel, is the third largest mobile operator in the world with almost 500 million customers. Using its extensive South-Asian and Sub-Saharan African networks, it will serve as a testing ground for all OneWeb products and services, essentially acting as an anchor customer for large scale OneWeb services.[504] On July 27th, Hughes Network Systems, LLC (HUGHES), a global leader in broadband satellite networks and services, announced its participation in the bidding consortium, contributing a total of $50 million. Through this, Hughes will be able to continue its distribution and technological partnerships with OneWeb and develop upon its pre-existing partnership with Bharti Airtel, with which it owns a subsidiary in India (HCIL)[505].

The bid, led by the UK Government, raised interrogations.[506] The unusual governmental investment led the permanent secretary to the Department for Business Energy and Industrial Strategy to pursue a ministerial direction. In addition, Darren Jones MP (BEIS chair) held an enquiry into how the decision was made. The decision The UK Space Agency also performed a technical assessment, highlighting significant technical and operational hurdles, as well as the need for additional funding prior to profitability. A lack of transparency in the decision-making process has also been put forward as a cause for concern.

OneWeb re-structuring phase

Following the purchase of One-Web by the BidCo 100 ltd consortium, the FCC approved an expansion of One-Web's constellation on August 26th.[507] While 720 Ku- and Ka-band satellites were already approved by the FCC in 2017, OneWeb is now expanding its satellite constellation with an additional 1,280 MEO satellites. The FCC requires OneWeb to launch and operate half of the maximum number of proposed satellites by August 2026 with the remaining satellites to be launched and in operation by August 2029.

One-Web satellite (Credit: OneWeb)

In further re-structuring developments, on September 21st, OneWeb announced it would resume launches under an amended contract with Arianespace.[508] The contract will cover 16 launches rather than the initial 19, starting from December 2020. Each launch will put 34-36 satellites into orbit. When first signed, it was the largest commercial launch contract ever, worth over $1 billion. As OneWeb's restructuring process continues, the bankruptcy court approved $235 million of debtor in possession (DIP) loans for OneWeb to continue its operations[509]. As part of the restructuring, Softbank has been reported to convert $87 million of DIP loans into an equity stake in the company[510].

OneWeb exit and consolidation

On October 2nd, the U.S. bankruptcy court approved OneWeb's reorganisation plan, allowing the company to exit bankruptcy and resume full business operations.[511] The FCC also approved the sale on October 27th.[512] The UK government and Bharti Global's acquisition of OneWeb still requires CFIUS approval and

504 OneWeb, "OneWeb announces HMG and Bharti Global Limited consortium as winning bidders in court supervised sale processes", (July 2020)
505 Hughes, "Hughes to Join UK Government and Bharti Enterprises in New OneWeb Consortium", (July 2020)
506 Financial Times, "UK ministers were warned of financial risk of $500m OneWeb deal", (July 2020)
507 Federal Communications Commission, (August 2020): https://aboutblaw.com/SOJ
508 OneWeb, "OneWeb and Arianespace to restart launches in December 2020", (September 2020)
509 Space Intel Report, "OneWeb bankruptcy court OKs additional $235 million in DIP financing for space, ground network", (September 2020)
510 The Telegraph, "SoftBank takes $87m stake in OneWeb in rescue deal", (September 2020)
511 OneWeb, "Court approves sale of OneWeb to the UK Government and Bharti Global", (October 2020)
512 SpaceNews, "FCC approves OneWeb sale as Starlink begins public beta", (October 2020)

is expected to complete before the end of the year. Furthermore, OneWeb has terminated its stake in its joint venture with Roscosmos subsidiary Gonets, formed in 2015 to access the Russian market.[513]

The acquisition of OneWeb by the UK government and Bharti Global closed on November 20th, allowing the company to emerge from Chapter 11 bankruptcy.[514] The nomination of a new CEO, Neil Masterson, was also announced, replacing Adrien Steckl, who will advise the board.

The company raised over $3 billion to date but will require a further $2 billion to complete the constellation of 648 satellites. On December 17th, 36 OneWeb satellites were launched on a Soyuz spacecraft marking the re-start of all OneWeb operation.

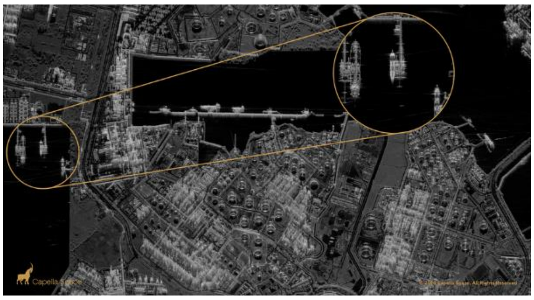
2.2.2 EO industry sees value in SAR imagery

Synthetic Aperture Radar (SAR) satellites enable to observe the Earth during the night and through clouds. According to NSR, the SAR market is expected to reach $1.7 billion by 2028[515] as customer markets expand beyond defence and intelligence agencies. According to Euroconsult, the EO data market as a whole is expected to reach $8 billion by 2029.[516]

The expansion of this market has been enabled by new regulations in the United States. Indeed, in May 2020, the U.S. Department of Commerce released new remote sensing regulations for commercial satellites to ease legal restrictions, improve the licensing process with NOAA and keep the country competitive in this sector. This new regulation eliminated the restrictions on spatial resolution for SAR satellites, which was limited to 0.5 meters.[517]

Following its adoption, several developments took place:

- In December 2020, Capella Space released 50 cm resolution images generated by its SAR satellite, named Sequoia. Capella Space CEO Payam Banazadeh announced that the company will upgrade and release images with a resolution up to 25 cm thanks to the new regulation.[518]
- In February 2021, Alpha Insights, which acquired the SAR assets of Urthecast, announced its plan to build dual band SAR satellites with a 40 cm resolution.[519]
- In March 2021, Umbra announced that the SAR microsatellite it plans to launch later this year will have a 15 cm resolution per pixel thanks to an FCC license.[520]



Capella Space radar satellite image (Credit: Capella Space)

In 2020 and early 2021, SAR companies have been raising capital, which indicates investors' confidence in SAR imagery.

[513] Advanced Televison, "OneWeb severs Russian ties", (October 2020)
[514] OneWeb, "OneWeb Successfully Emerges From Chapter 11, Announces New CEO and Recommences Satellite Launches ", (November 2020)
[515] NSR, "EO SAR: Trick or Treat?", (October 2019)
[516] SpaceNews, "Governments continue to dominate radar satellite data market", (December 2020)
[517] Geospatial World, "Industry welcomes new commerce dept norms for remote sensing sector", (May 2020)
[518] SpaceNews, "Capella Space releases high-resolution Spotlight imagery" (December 2020)
[519] SpaceNews, "Alpha Insights reveals plans for dual-band SAR satellites", (February 2021)
[520] SpaceNews. "Umbra advertises SAR imagery with 15-centimeter resolution", (March 2021)

- After ICEYE demonstrated that small satellites can carry SAR payloads,[521] it raised $87 million in a Series C funding round in September 2020, bringing its total raised capital to $152 million, and indicating a rising commercial interest in SAR.
- In January 2021, Umbra raised $32 million in an investment round led by Passport Capital for a radar constellation.[522]
- MDA announced that it intends to go public to raise $500 million (Canadian dollars) in order to reimburse its debt and invest in SAR satellites. One part of these investments will aim at replacing its SAR satellite Radarsat-2 with another SAR satellite called SARnext. MDA expects SARnext to generate over $2 billion in revenues over a 15-year period.[523]

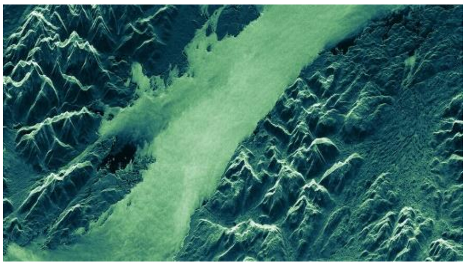
Furthermore, SAR technologies are now integrated in small satellite constellations. Several launches and announcements took place over the past year:

- In January 2020, Capella Space unveiled a new design for its Whitney constellation of SAR satellites. The size of solar arrays has doubled, and the mesh-based reflector antenna is designed to provide high-contrast, low-noise imagery with a 0.5-meter resolution.[524]
- In June 2020, PredaSAR announced it will send 48 SAR satellites into orbit in 2021 to constitute the world's largest SAR constellation.[525]
- In August 2020, Rocket Lab successfully launched the Sequoia SAR satellite into orbit for Capella Space's constellation.[526]
- In April 2020, Rocket Lab signed a contract with the Japanese company Synspective to launch the StriX-α satellite, the first of a planned constellation of 30 SAR satellites which was launched on December 15, 2020.[527]
- In December 2020, Chinese company Spacety launched its first commercial SAR satellite, Hisea-1 which aims at providing data for marine and coastal research. Spacety´s goal is to build and launch a SAR constellation with dozens of satellites in the coming years.[528] The company later released the first images, which have a three-meter resolution.[529]
- In January 2021, SpaceX Falcon 9 launched three ICEYE SAR satellites, two Capella Space SAR satellites and one iQPS SAR satellite on the Transporter-1 rideshare mission.[530]

Finally, in Europe, the Finnish company ICYE signed $50 million in contracts last year and is now looking to adapt some of its services to the needs of US customers.[531] It is also considering manufacturing in the US.[532] ICEYE increasingly expanded and made several announcements in the past year:

[521] SpaceNews, "SAR Renaissance: Pandemic slows but doesn't stop constellation progress", (September 2020)
[522] SpaceNews, "Umbra raises $32 million for radar satellite constellation", (January 2021)
[523] SpaceNews, "MDA files to go public", (March 2021)
[524] SpaceNews, "Capella unveils radar satellite design", (January 2020)
[525] SpaceNews, "PredaSAR to send 48 satellites into initial radar constellation", (June 2020)
[526] Rocket Lab USA, "Successfully Deploys Satellite for Capella Space on 14th Mission", (August 2020)
[527] Spacewatch.Global, "Japan's first StriX satellite to launch on Rocket Lab's Electron", (November 2020); Space.com, "Rocket Lab launches Japanese Earth-imaging satellite into orbit from New Zealand", (December 2015)
[528] SpaceNews, "China launches first Long March 8 from Wenchang Spaceport", (December 2020)
[529] SpaceNews, "Spacety shares first images from small C-band SAR satellite", (January 2021)
[530] SpaceNews, "SpaceX launches record-setting cluster of smallsats", (January 2021)
[531] CNBC, "Satellite imagery specialist ICEYE continues U.S. expansion, with $50 million in contracts last year", (March 2021)
[532] Via Satellite, "Iceye Will Begin Massive Commercial Market Expansion, Says US CEO", (September 2020)

- In January 2020, it launched its Dark Vessel Detection service dedicated to governmental customers, combining SAR and AIS data for maritime security purposes.[533]
- In May 2020, it demonstrated the first interferometric capability from SAR satellites under 100 kg, enabling millimetre-scale change detection.[534]
- In July 2020, it announced that its SAR satellite images are now openly available through ESA's Earthnet.[535]
- In February 2021, it released the first images generated by the three SAR satellites launched in January by SpaceX.[536]



ICEYE radar satellite image of Alaska (Credit: ICEYE)

2.2.3 Trends in the Ground stations as a Service (GSaaS) domain

In the past few years, digital giants such as Amazon and Microsoft have been entering the ground segment business by leveraging their infrastructure to integrate ground stations into the cloud.

Ground Stations as a Service (GaaS) is a cloud computing service that enables satellite operators to use a network of ground stations to control their satellite, retrieve and process the data in the cloud. GaaS can be seen as an application of the sharing economy to the space sector in which companies share ground stations with others and only pay for the antenna time used by their systems, thereby significantly reducing their operating costs, and enabling GaaS providers to maximize the use of a ground station with near zero marginal cost.[537] As a result, companies can allocate their time and money to mission specifics instead of building and managing their own ground infrastructure. In practice, satellite data is received by the ground station, digitized, and transferred to the user's Virtual Private Cloud (VPC) through IP protocols to be accessed and processed by the end user. The user can then return the commands to the satellite if needed. In this emerging market, there are various players:

- Cloud companies relying on a network of ground stations built by established space companies to offer GSaaS, while also building their own antennas (e.g., Amazon, Microsoft).
- Space companies which have their own ground stations and offer the spare capabilities of their antennas to GSaaS providers (e.g., RBC Signals, Viasat).
- Companies creating digital tools and products such as data processing software to be integrated into the services of GSaaS providers (e.g., Kratos, Thales).

Amazon and Microsoft leading the cloud ground station market

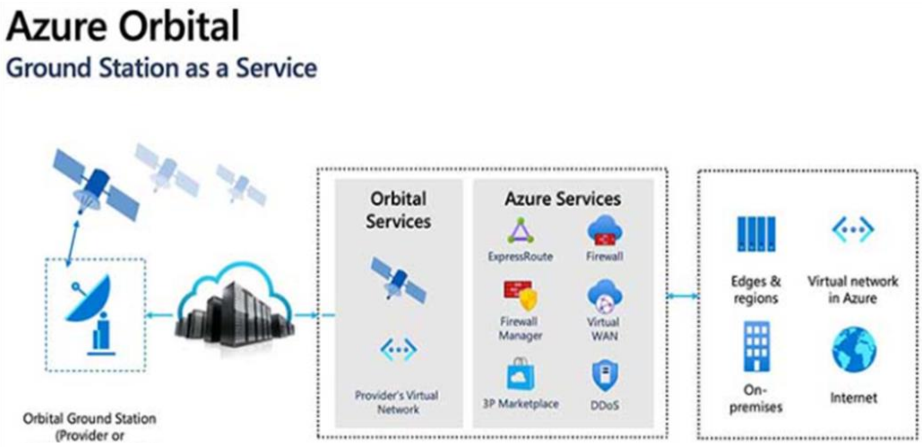
In 2019, Amazon launched Amazon Web Services Ground Station, a global network of ground station antennas providing GSaaS. In 2020, the service was extended to Africa[538] and the Asia Pacific region.[539] It also unveiled the "Aerospace and Satellite Solutions" business segment, a new business unit to complete the AWS Ground Station. This unit will assist space companies in the building of their space system architecture and will launch space-based data processing services.[540]

---

[533] ICEYE , "ICEYE Dark Vessel Detection Now Globally Available for Government Organizations", (January 2020)
[534] ICEYE, "SAR Interferometry Demonstrated with an 18-day Global Repeat by ICEYE", (May 2020)
[535] ICEYE, "ICEYE SAR Satellite Imagery Available Through the ESA Earthnet Third Party Mission. Press Release", (July 2020)
[536] SpaceNews, "Iceye releases images from latest SAR satellites", (February 2021)
[537] SatSearch, "Ground station service providers: an overview of telemetry and telecommand communication services and networks for small satellites", (September 2019)
[538] Amazon, "AWS Ground Station is now available in the Africa (Cape Town) region", (September 2020)
[539] Amazon, "AWS Ground Station is now available in the Asia Pacific (Syndney) Region in Australia", (April 2020)
[540] Tech Crunch, "Microsoft launches Azure Orbital to connect satellites to its cloud", (September 2020)

Additionally, in March 2021, Amazon launched, together with the British venture investment firm Seraphim Capital a space accelerator program for space startups, which aims at providing space startups with technical training, including on AWS cloud services.[541]

Capella Space joined Thales Alenia Space, Myriota, NSLComm, Spire Global and Open Cosmos[542], as a customer of AWS Ground Station. It is now running its entire IT infrastructure on AWS including for Command and Control.[543] In December 2020, AWS expressed its interest in offering India its cloud solutions since the country opened its space sector to private actors.[544] Amazon and ISRO will work together through AWS's Aerospace and Satellite Solutions business segment.[545]



Microsoft Azure Orbital's ground station architecture (Credit: Microsoft)

While Amazon relies on Lockheed Martin's Verge ground station network, it is also building its own antennas.[546] In 2020, Amazon built 6 ground stations out of the 12 it has planned to build. The reason for this is that customer demand led the company to relocate some ground stations to where they were most needed (e.g., in Sweden to accommodate polar orbiting satellites) in order to avoid a downlink bottleneck.[547]

In September 2020, Microsoft unveiled Azure Orbital, a network of cloud ground stations that will provide GSaaS and process data in Microsoft Azure Cloud using Azure AI services and Machine Learning to compete with AWS Ground Station. The FCC granted Microsoft a temporary license to demonstrate data download from Urthecast Deimos-2 to the cloud.[548]

Microsoft is working with several partners such as:

- SpaceX to connect Starlink ground stations to Azure. Regarding the space segment, SpaceX also signed a contract with the Space Development Agency to develop a Space Tracking Layer defense system for missile detection in which Azure's orbital emulator will be used.
- AMERGINT to develop satellite modems for Azure Orbital's customers.
- KSAT to integrate Azure to its network of antennas.
- SES to collocate its O3b mPOWER teleports with Azure datacenters and provide gateway infrastructure to enable data transfers from Azure Orbital's ground stations and the cloud. [549]

[541] SpaceNews, "Amazon Web Services launches space accelerator program for startups", (March 2020)
[542] GeekWire, "Azure Orbital launches Microsoft into cloud-based space race with Amazon", (September 2020)
[543] Michael Sheetz. Twitter (November 2020): https://twitter.com/thesheetztweetz/status/1326206694922334208?s=20
[544] SaveDelete, "AWS comes forward to help India chart its new space journey", (December 2020)
[545] Analytics India, "WS Introduces New Business Segment To Support India's Innovation In Space Sector", (December 2020)
[546] SpaceNews, "Amazon-Lockheed venture casts shadow on ground station startups", (November 2018)
[547] SpaceNews, "AWS completes six ground stations, changes rollout strategy", (August 2020)
[548] Geospatial World, "Microsoft takes on Amazon as it enters ground station as a service business", (September 2020)
[549] Parabolic Arc, "Microsoft's Azure Space Partners with SpaceX, SES, Viasat and Others", (October 2020)

- VIASAT to integrate its network of ground antennas, Viasat Real-Time Earth, into Azure Orbital.[550]

Start-up developments

Start-ups are also entering this business. Their solutions are often either interoperable with AWS, Azure and Google Cloud or relying on their infrastructures:

- Japanese startup Skygate Technologies secured funding to develop GSaaS by 2021. Their cloud ground stations will be interoperable with AWS, Google Cloud Platform and other cloud services.[551]
- Arctic Space Technologies, a Swedish company, developed GSaaS and real-time data processing and storage in the cloud.[552]
- Kratos Defense and Security Solutions and Microsoft Azure Orbital launched the OpenSpace software-defined platform for ground stations that can be integrated by GSaaS providers.[553]
- Infostellar, a Japanese startup, is offering GSaaS by relying on a network of 13 existing ground stations (e.g., Azercosmos, Viasat, etc). This year, it has raised $3.5 million from Airbus Ventures, Sony Innovation Fund, Daiwa Energy Infrastructure, Mitsubishi UFJ Capital, and Mitsubishi UFJ Lease & Finance, bringing the total capital raised by the company to $11.5 million.[554]
- Italian GSaaS provider Leaf Space supplies various services such as LeafLine (a ground station service suited for small satellite operators)[555] and Leaf Key (a ground station management service suited for medium-large constellations). In March 2021, Leaf Space announced it was expending its activities to the United States to provide GSaaS solutions to companies such as Kleos Space, Kepler Communications or Swarm. [556]

Google Cloud also entering the cloud ground segment market

Google Cloud has been providing cloud services to space companies since 2016 by storing and processing catalogues of satellite images (e.g., Landsat, Sentinel-2, Planet Lab, etc). Although it is not GSaaS, Google Cloud is now integrating ground infrastructures such as telescopes into the cloud. In December 2020, Google Cloud signed a three-year agreement with Rubin Observatory to host its Interim Data Facility (IDF), a cloud-based platform in which the data collected by the Vera C. Rubin Observatory will be stored and processed.[557] The IDF will collect data to train the telescope to detect images of the solar system before it becomes operational in 2023. The Rubin Observatory will use Google Cloud Storage, Google Kubernetes Engine, and Google Workspace to enable scientists to remotely access the data from the telescope which is under construction in Chile.[558]

At the moment, the cloud ground segment market is dominated by digital giants such as Amazon and Microsoft, as they have the computing and data storage capacities to easily integrate an entire ground infrastructure into the cloud.

---

[550] Viasat, "Viasat Real-Time Earth Ground Service Available via Microsoft Azure Orbital" (September 2020)
[551] SpaceWatch Global, "Skygate Technologies Receives Seed Investment for Ground Station as a Service", (September 2020)
[552] Arctic Space Tech, "Ground Station Service. Arctic Space Technologies", Last accessed May 2021.
[553] Space News Feed, "Kratos introduces OpenSpace platform supporting dynamic, software-defined satellite ground systems", (October 2020)
[554] Satellite Today, "Infostellar Raises Additional Capital in Attempt to Disrupt the Ground Station Market", (April 2020)
[555] European Commission, "The First Global Ground Station Network to Fully Exploit Microsatellites Data", (2020): https://cordis.europa.eu/article/id/413501-ground-station-network-as-a-service-for-next-generation-satellites
[556] PR News Wire, "Leaf Space Announces U.S. Expansion", (March 2021)
[557] SpacenNews, "Rubin Observatory turns to Google Cloud for data hosting" (December 2020)
[558] Google Cloud, "Google Cloud fuels new discoveries in astronomy", (December 2020)

2.2.4 Commercial developments in the space safety and sustainability domain

The issue of space safety and sustainability is becoming increasingly more prominent for policy-makers and space agencies but also for private actors. Besides various advances in public programmes and international partnerships (listed in section 1.1.8), year 2020 was also marked with significant developments in the commercial sphere. These new commercial developments could be broken down in two categories:

- advancement of private space situational awareness capabilities
- demonstrations of commercial in-orbit services for satellite servicing and active-debris removal

Commercial SSA capabilities and solutions: New operational services and investments in infrastructures

- In March 2020, ArianeGroup announced that it will add an 8th station to its GEOTracker network, an SSA service for GEO and MEO based on a global system of optical sensors.[559]
- In April 2020, the U.S start-up Numerica launched an SSA and collision alert service for both government and commercial actors. The service can also provide information on orbit determination, change detection, pattern-of-life learning and dim object detection.[560]
- In May 2020, the U.S company LeoLabs launched its Collision Avoidance platform which is a cloud-based service providing Space Situational Awareness data and conjunction alerts to satellite constellation operators.[561] LeoLabs also announced it will build its fourth radar station in Costa Rica in 2021, complementing its infrastructure of three radar stations in Texas, Alaska and New Zealand.[562]
- In October 2020, the U.S Kayhan Space announced that its Kayhan Satellite Collision Assessment and Avoidance System will integrate algorithms to provide customers with precise collision avoidance alerts to collision avoidance manoeuvres more autonomous.[563]
- In November, Canadian company NorthStar Earth and Space has selected Thales Alenia Space to build its first three Skylark satellites of the planned constellation of at least 12 spacecraft to track other satellites. The first three satellites are scheduled for launch in 2022.[564]
- In late 2020, engineering software firm Ansys acquired AGI for $700 million. The deal included spinning off AGI's Commercial Space Operations Center subsidiary as an independent company: Comspoc Corporation. Comspoc retains the intellectual property, contracts, products and services developed since 2014 and its research arm, the Center for Space Standards and Innovation.[565]

European	ArianeGroup, GMV, Deimos, Safran Data Systems, Indra, Share My Space, Etamax, Northern Space and Security Ltd.
Non-European	ExoAnalytic Solutions, LeoLabs, Comspoc, L3Harris, NorthStar, Numerica, Orbit Logic, SpaceNav, Schafer, Lockheed Martin, Applied Technology Associates, Kratos, Polaris Alpha

Table 12: List (non-exhaustive) of major private SSA actors as of 2020

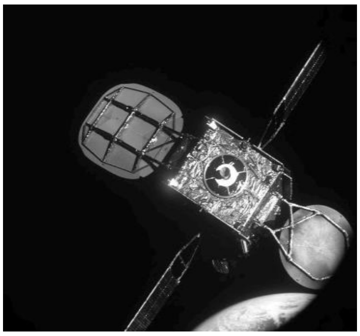
While commercial perspectives for the provision of SSA services are growing, this segment continues to rely heavily on public contracts. In particular, the U.S. military organisations have long been spearheading the public support to private SSA actors and this trend was visible also in 2020 with hundreds of millions

[559] ArianeGroup , "Looking up: GEOTracker space surveillance network gets even bigger" (March 2020)
[560] SpaceNews, "Numerica expands space surveillance services aimed at satellite operators", (April 2020)
[561] Via Satellite, "LeoLabs Deploys Automated Satellite Collision Avoidance Platform", (May 2020)
[562] SpaceNews, "LeoLabs to construct fourth radar in Costa Rica", (July 2020)
[563] SpaceNews , "Startup seeks to automate process of avoiding satellite collisions", (October 2020)
[564] SpaceNews, "NorthStar orders three satellites to collect space situational awareness data", (October 2020)
[565] SpaceNews, "Comspoc embraces startup mentality after AGI spinoff", (December 2020)

of U.S. dollars provided to U.S. industry in different contracts by the U.S. Department of Defense, the Space Development Agency or the U.S. Space Force.

In-orbit services: Northrop Grumman's MEV-1 the first servicing spacecraft to dock with an active GEO satellite

In the course of 2020, commercial in-Orbit Servicing (IOS) has noticeably experienced a boost due to the success of the MEV-1 mission by Northrop Grumman. In February 2020, the 2019-launched MEV-1 spacecraft successfully approached, captured and docked with Intelsat 901 to extend its life by 5 years. The costs of the MEV-1 services are approx. $70M, over the initial duration of 5 years of the mission ($13-14M per year) that could also be extended by an agreement between Intelsat and Northrop Grumman.



MEV-1 view of the Intelsat 901 satellite in GEO (Credit: Northrop Grumman)

With its successful docking, the MEV-1 demonstrated the technology readiness for these services and increased market awareness.[566] An Ariane 5 rocket then launched the MEV-2, which docked with the IS-1002 Intelsat satellite in its operational orbit in April 2021 to carry out a life extension service.[567] Moreover, Northrop Grumman is developing other capabilities to expand its portfolio of IOS applications through its subsidiary SpaceLogistics, amongst which the less expensive Mission Extension Pods (MEP) and the more advanced Mission Robotics Vehicle (MRV).

Beyond the major success of MEVs, there were also additional notable developments in the IOS field:

- In June 2020, the Japanese company Astroscale acquired the intellectual property rights of the Space Drone of the Israeli IOS company Effective Space Solutions, thereby positioning the company in the GEO satellite servicing market. With this acquisition, Astroscale expended its activities beyond ADR.[568] In October 2020, Astroscale brought total capital raised to $191 million after a Series E Funding Round.[569] Astroscale's first ADR mission, ELSA-d (End-of-Life Service by Astroscale)-d (demonstration) composed of two spacecraft (chaser and target), launched in March 2021 onboard Soyuz 2.1a operated by GK Launch Services.
- In November 2020, OrbitFab announced that its in-orbit fuel depot mission Tanker-001 will launch in 2021.[570]
- After the success of MEV-1, the American company Xtar sold its satellite Xtar-Eur to Hisdesat, but signed a lease agreement with the Spanish company to keep using it. Hisdesat and Xtar have expressed their interest in life extension services as both the Xtar-Eur and SpainSat satellites are reaching their end of life.[571]

[566] Northrop Grumman, "Northrop Grumman Successfully Completes Historic First Docking Of Mission Extension Vehicle With Intelsat 901 Satellite, (February 2020)
[567] Northrop Grumman, "Northrop Grumman and Intelsat Make History with Docking of Second Mission Extension Vehicle to Extend Life of Satellite", (April 2021)
[568] SpaceNews, "Astroscale moving into GEO satellite servicing market", (June 2020)
[569] SpaceNews, "Astroscale raises $51 million in Series E, $191 million overall", (October 2020)
[570] SpaceNews, "Orbit Fab to launch first fuel tanker in 2021 with Spaceflight", (November 2020)
[571] SpaceNews, "Xtar sells satellite to Hisdesat, shifts to lease agreement", (July 2020)

2.2.5 Europe explores breakthrough technologies

Artificial intelligence

The Intel Movidius board used on Φ-sat-1 (Credit: ESA)

The 16th flight of the European Vega launcher in September, which was also the first Vega Small Spacecraft Mission Service (SSMS), successfully launched and deployed into orbit Φ-sat-1 (PhiSat-1), an experimental artificial intelligence Earth Observation mission developed by ESA, Intel and Ubotica. The 6U CubeSat, contained the Hyperscout-2 instrument, which takes images of the Earth in hyperspectral, thermal infrared and visible bands. The images were processed on an Intel Movidius board, using a deep neural network algorithm to identify clouds on the images. Using AI on the images allows for only useful, non-cloudy images to be returned to Earth, saving downlink capacity and reducing the volume of data to be processed by operators. The satellite was a technology demonstration, originally presented in the 2017 Copernicus Masters competition and was developed by a consortium of European organisations. It was funded by ESA under the Φ-sat programme. In addition to the AI demonstration, the satellite also provides useful data for climate science.[572]

AI has also applications for satellite subsystems. ESA and the European Defence Agency announced in January that they are collaborating to develop AI based systems for Guidance, Navigation and Control (GNC). AI will be used to increase the ability of the satellite to localize and navigate, with AI used on the vision-based navigation systems to improve feature tracking. This could increase the potential autonomy of rendezvous missions, including for in-orbit services and asteroid missions. [573]

Preligens presents their AI technology (Credit: Emmanuel Chiva / Twitter)

On the ground, AI continues to be developed by many smaller analytics companies, particularly in defence domains. One such company is French startup Earthcube, which in November changed its name to Preligens and raised a $20 million series A round. Funders included Definvest, the French defense investment fund. In October, Preligens partnered with Airbus to develop a site monitoring solution for defence applications. Preligen's AI based solutions will automatically identify features on images from Airbus's Pléiades satellites.[574]

Even before images are analysed for useful information, they must be processed for quality control. Telespazio UK introduced artificial intelligence to this process, ensuring that remote sensing data remains high quality even when the amounts of it greatly increase with the launch of new satellites. In March, Telespazio was awarded a €25 million contract to manage and further develop quality control for ESA and international satellites. [575]

ESA has also begun a new collaboration with the German Research Centre for Artificial Intelligence (DFKI) for the creation of a new research centre in Kaiserslautern focused on the development of AI services and technologies specialised in the interpretation and analysis of Earth Observation data. This type of bilateral collaboration on the topic of AI is similar with ESA's previous collaborations with Oxford and College

[572] ESA, "FSSCat/Φ-sat-1 ready for launch", (June 2020)
[573] ESA, "ESA and EDA joint research: advancing into the unknown", (June 2020)
[574] Airbus, "New strategic sites monitoring solution developed by Airbus and Earthcube", (October 2020)
[575] Telespazio, "Telespazio UK to lead new service to quality control ESA mission data", Last accessed May 2021

London University, and is in keeping with the agency's cooperation on robotics with Germany through the DFKI's institute in Bremen.

Applications for AI are not limited to the downstream. In space, the increasing amount of satellites in orbit requires new approaches to constellation management. In April, telecommunication software company 2Operate partnered with CubeSat manufacturer GomSpace and Aarhus University to evaluate how AI used for telecommunications could manage future satellite constellations more effectively. Ultimately AI could reduce the workload required to operate satellites by automating tasks and managing network incidents. The project, known as MegaMan, is funded by Innovation Fund Denmark. [576]

Quantum

Digital assembly in Bucharest (Credit: EC)

Governments and corporations over the world are developing quantum technologies, primarily as a way of enhancing computing power. Quantum computing allows for certain complex calculations to be performed far faster than traditional computing. The development of quantum computers has ramifications for cryptography, as quantum computers could overcome traditional cryptographic methods, though this is not currently possible. One solution to this is to use satellites to distribute cryptographic keys using quantum-based methods, known as Quantum Key Distribution (QKD). QKD allows the user to see whether someone has intercepted their message, adding a safeguard to the transmission.

In June, UK-based satellite QKD company Craft Prospect commenced a feasibility stuffy with ESA to develop a service concept for a new QKD system.[577] The demonstration mission, known as ROKS, will launch in 2022. In December Craft Prospect was awarded £345k from the UK Space Agency, under the National Space Innovation Programme, to develop the payload for the mission.

On the 14th of June 2019 at the digital assembly in Bucharest, the representatives of 7 countries had signed a letter of intent agreeing to explore the methods in which they could develop and deploy a quantum communication infrastructure across Europe with as primary service making use of such infrastructure the Quantum Key Distribution (QKD).[578] In line with this, the development of quantum technology is poised to gain an increasing role in European space projects, as highlighted by Commissioner Thierry Breton at the 13th European Space Conference in Brussels.[579] The commissioner stressed the importance of projecting Europe into the quantum era to enhance its strategic autonomy, specifically through the elaboration of a third constellation besides Galileo and Copernicus to ensure quantum encrypted communication and guarantee continued secure connectivity on the continent.

In November, the UK and Canada released the results of their Quantum Technologies Competition, conceived in 2017.[580] The programme involves industry led partnerships with £2 million from UK Research and Innovation and CAD$4.4 million from the Natural Sciences and Engineering Research Council of Canada. Eight projects, each involving both companies and academia, are funded under the programme.

[576] Gom Space, "2Operate and GomSpace to boost constellation management with artificial intelligence", (April 2019)
[577] ESA Business, "A-QKD-S - Augmented Quantum Key Distribution Services", (October 2020)
[578] European Commission, "The future is quantum: EU countries plan ultra-secure communication network", (March 2021)
[579] European Commission, "Speech by Commissioner Thierry Breton at the 13th European Space Conference", (January 2021)
[580] UKRI, " UK and Canada launch world-first programme of quantum technologies", (November 2020)

Blockchain

Blockchain, which relies on "append-only" decentralised databases, has built-in system properties which may be valuable for the space sector, including the potential to:

- Secure and control communication and data transmission between different systems, preventing the success of cyber-attacks against space assets.
- Improve data transparency, accuracy, and reliability along complex chains such as in the satellite supply-chain tracking process for example.
- Offer solutions for data sharing that ensure data quality, integrity, and confidentiality as it would be needed in domains such as SSA and STM.
- Simplify patterns of the transaction through smart contracts and create a record of initial ownership for Intellectual Property Rights purposes.

In December, PwC highlighted that blockchain can also be employed for financing of space missions and has potential applications in supply chain management, procurement and satellite communications.[581]

In August, the first multisignature blockchain transaction was executed in space, by SpaceChain UK.[582] The demonstration involved the receipt, authorization and retransmission of a blockchain transaction with a private key. Supported by the ESA Kick-start Activity programme, the transaction occurred on Nanoracks hardware installed on the ISS. SpaceChain UK aim to create a decentralized orbital constellation for business transactions. Furthermore, in December, BlockChain received a £440k grant from EUREKA's Globalstars initiative, to develop their decentralized satellite system.

In October, ESPI published the brief "Blockchain applications for space systems security". The brief covered in detail some of the key projects initiated to investigate Blockchain applications in the space domain and its potential limitations and as such the need for standardisation (more detail available at www.espi.or.at).[583]

[581] PWC, "Main Trends and Challenges in the Space Sector", (December 2020)
[582] SpaceChain Foundation, "SpaceChain Executes First Multisignature Blockchain Transaction In Space With GomSpace Hardware", (August 2020)
[583] ESPI, "Blockchain applications for space systems security", (October 2020)

2.2.6 European micro-launchers "take-off"

Over the span of one year, the European micro launcher industry raised record of €107 million over a total of 7 primary deals comparing to a total 3 deals which raised €15 million in 2019.

Increase in number of deals

The end of 2020 proved to be highly eventful with two of the largest investments in European micro launcher companies seen up until now.

The biggest fund raising of the year happened through the Munich based German company Isar Aerospace. On December 9th 2020, Isar raised a 75 million series B investment, making it the biggest sum ever raised for a European micro launcher.[584] The round was led by European venture funds Earlybird and Vsquared. Isar Aerospace had previously raised 15 million in October 2019 in a round also led by Earlybird Ventures bringing the total investment into Isar to €90 million as of December 2020.

"Spectrum" Vehicle (Credit: Isar Aerospace)

The latest round of investments will allow Isar Aerospace to be completely financed until their maiden flight, expected to be in 2022, and to pursue the development of their "Spectrum" vehicle which is capable of placing up to 1T in LEO. The company had also signed an agreement with the French CNES to conduct launches from Kourou in French Guiana.[585]

Following, Isar Aerospace's announcement, the Scotland based micro launcher company Orbex also disclosed it had closed a €20 million funding round led by BGF and Octopus Ventures.[586] The latest round brings the total amount raised by the company to €52 million following the €30 million investment led by Heartcore Capital and High-Tech Gründerfonds in July 2018. Orbex also benefited from public financial support in its funding rounds, as it won a €2.5million grant from the European Horizon 2020 SME Instrument programme in its latest round and was previously awarded a €6 Million grant funding from the UK space agency in 2018. The Horizon 2020 grant makes it the first UK based space company to receive direct backing by the EU through this instrument.

The latest investment will allow Orbex to maintain its rapid expansion and development phase, enabling them to remain on track for the up and coming first launch at the Sutherland spaceport in 2022. The company is also on track to develop its rocket with a unique biopropane fuel which will cut CO^2 emissions by 90% compared to traditional rocket fuel, and has already confirmed the signing of 6 commercial satellite launch contracts. As of August 2020, Orbex has been granted the permission to launch from the northern coast of Scotland.

The third European company that was able to attract considerable funds for its micro-launcher was the Spanish company PLD Space. The company is headquartered in Elche and raised €7 million euros in a Series B funding round led by Arcona in September 2020.[587] This brings their total money raised to 27 million euros, following its €17 million Series A in 2019. The latest round will allow the company to expand

---

[584] Tech Crunch, "Germany's Isar Aerospace raises $91M to get its satellite launch vehicle off the ground", (December 2020)
[585] Isar Aerospace, "Isar Aerospace prepares for the launch of its rockets from space centre CSG and hires Alexandre Dalloneau as Head of Mission and Launch Operation", (October 2020)
[586] Orbex Space, "Orbex Secures $24 million funding round for UK Space Launch", (December 2020).
[587] Startups Real, "PLD space closed €7 million investment in tie-up with Arcano Partners", (Septembre 2020)

Orbex's unique Bio Propane rocket (Credit: Orbex)

its workforce from 40 to 50 employees and to prepare for its first projected suborbital rocket flight, set to take place in early 2022.

PLD Space has concluded two agreements for its inaugural launch in 2022, which should thus include two scientific experiments for the universities of Florida and for Bremen's centre of Applied Space Technology. One of the characteristics of PLD's launch vehicles, the "Miura 1 and Miura 5" is the fact that they be are partly reusable and are designed to offer research possibilities in both upper atmosphere and Low Earth Orbit (LEO). PLS Space's Miura 1 and Miura 5 launch vehicles will be partly reusable and are designed to offer research possibilities in both upper atmosphere and LEO.

Finally, the recently founded (2019) French micro-launcher company Venture Orbital Systems (VOS) raised 750 000 euros in a Series A round led by UI investment.[588] VOS is specialized in 3D printing and plans to launch micro-satellites with their up-and-coming launcher named "Zephyr". The projected inaugural launch in set in 2024.

ESA accelerates its investment into micro-launchers

As private interests in the micro-launchers market are accelerating, public institutions are also intensifying their support to the sector.

This was the case also in Europe, as ESA inaugurated the first part of its "Boost!" programme by awarding three companies a total of €1.5 million worth in support contracts.[589] The programme is divided in two main axes, the first being the Commercial Space transportation Services element. By actuating the programme, the agency aims to provide financial as well as technical tailored support to European companies in the sector of innovative new space commercial transportation. The first companies to be selected for consideration in the programme were the German micro-launcher companies Isar Aerospace, Rocket Factory Augsburg and HyImpulse Technologies. The companies were each awarded €500 thousand in support contracts after claiming the first stage of the DLR's micro-launcher competition in July 2020.

The Boost! Commercial Space Transportation Services and Support Programme was adopted during the Space19+ ESA Ministerial Council and will manage a €25 million award made available by the German Federal Ministry for Economic Affairs and Energy for the three-stage competition. The winners for each round of the competition are also set to receive support contracts, which establish the specific means whereby they will receive support from the agency to meet their upcoming milestones.

The three selected companies are in different stages of their production and are planning to use the support contracts to reach different objectives:

- Isar Aerospace is projecting to use its Spectrum Launch Service Development Support contract in order to receive assistance on the development of their two-stage rocket's Reaction Control System and to finance the expansion of their production line in Ottobrunn.
- HyImpulse announced it would use the contract to support the finalisation of the design phase for its three-stage hybrid propulsion SL1 rocket. The company is also pursuing the development of associated ground segment for the rocket.

---

[588] UI Investissement, "UI Investissement met VOS sur Orbite", (December 2020).
[589] Copernical, "ESA awards €1.5 million to three German launch startups", (November 2020)

- Rocket Factory Augsburg on the other hand is seeking support for the manufacturing and detailed design of the first stage demonstrator of its three-stage RFA ONE rocket.

New European micro-launchers inaugurate first flight

With the intensification of the developmental phases for European micro launchers and spaceports, maiden flights are expected to take place in the next two years.

Skyrora model (Credit: rocketeers)

The UK based rocket company Skyrora completed all of the 100 planned static test fires for the third stage of their Skyrora XL orbital launch vehicle in 2020.[590] Having previously signed over 20 letters of intent from envisaged customers, the company is expected to perform its first Skylora XL launches in 2023, whereas its Skylora L vehicles is set to launch in 2021. The vehicles are designed to consider the environmental impact of their launches as they utilize a type of fuel called Ecosene, which is partly composed of recycled plastic. ABL Space Systems is also set for the first launch of their RS1 small satellite launch vehicle as part of their UK Pathfinder Launch programme contract with American aerospace company Lockheed Martin.[591] The launch is expected to take place in 2022 from the Shetland Space Centre will result in the deployment of a small launch orbital manoeuvring vehicle capable of carrying six CubeSats. The UK based small launch vehicle start-up Orbex is also planning its first launches from the Sutherland Space port in 2022 after confirming six launch contracts.[592]

Baden-Württemberg based company HyImpulse expects to launch its SR-75 suborbital hybrid sounding rocket from the Esrange Space Centre in Sweden in 2021 following a MoU signed with microgravity provider company yuri to deliver their payload.[593] The maiden flight of their SL1 orbital rocket is projected to take place in 2022. Isar Aerospace expects to launch its Spectrum orbital launch vehicle from the Guiana Space Centre in Kourou in 2022 following an agreement signed with CNES,[594] and signed a 20-year agreement with Andoya Space for exclusive access to its facilities.[595] The German company Rocket Factory Augsburg is also expecting to launch their RFA ONE rocket in 2022 following a MoU signed with Andøya Space for a launch from the Norwegian Andøya Spaceport.[596] In addition, Rocket Factory Augsburg plans to launch from the Guiana Space Centre after having reached new milestones in the initial launch planning phase.

590 The Edinburgh Reporter, "Skyrora makes space in Edinburgh", (November 2020).
591 Satellite ProMe, "Lockheed Martin selects ABL Space Systems for UK launch", (February 2021).
592 Orbex Space, "Orbex Secure $24 million funding round for UK Space Launch", (December 2020)
593 HyImpulse , "HyImpulse signs agreement with yuri as a pilot customer for Sounding Rocket SR75's maiden flight in 2021, (November 2020)
594 Isar Aerospace, "Isar Aerospace prepares for the launch of its rockets from space centre CSG and hires Alexandre Dalloneau as Head of Mission and Launch Operation", (October 2020)
595 Space Intel Report, "Norway's Andoya spaceport signs multi-year exclusive-access deal with German rocket startup Isar Aerospace", (April 2020)
596 SpaceNews, "German startup Rocket Factory Augsburg picks Norway for maiden fligh of RFA One Smallsat launcher", (October 2020)

2.2.7 Starlink becomes the first mega-constellation to roll-out service

In 2020, SpaceX greatly progressed in deploying its Starlink LEO constellation, adding record-breaking 833 satellites to the 122 launched in 2019, and gradually launching beta services to customers in the U.S.

Figure 8: 26 SpaceX launches in 2020 (all successful, using Falcon 9 Block 5 launch vehicle)

Starlink user terminal with 59cm dish (Credit: Twitter / Pranay Pathole, SpaceX)

After conducting private beta testing during summer, in October, Starlink began a paid-for public beta in the U.S., charging $499 for a tripod, a WiFi router, and a terminal to connect to the satellites, plus $99 for a monthly subscription.597 The beta testing seemingly impressed users, with the averages for latency, download speed, and upload speed of 50 ms, 45.2 Mbps, and 12.475 Mbps respectively. Some users even topped 200 Mbps download speed.598 Starlink was also tested and used by military actors in the field – by the U.S. Air Force in support of its Advanced Battlefield management system during a live-fire exercise599, and by Washington state emergency responders in areas devastated by wildfires.[600]

SpaceX also progressed towards the expansion of Starlink service beyond the U.S., by obtaining the telecommunications services licence in Canada[601] and securing approval from French regulator ARCEP for 3 gateways in France, which will cover also major parts of western Europe.[602] It could be expected that Starlink service will roll out in the UK Canada, Norway, India, and some EU countries 2021.[603]

In December, SpaceX has been awarded $885 million by the FCC to provide Starlink broadband to rural and urban areas in 35 states. SpaceX was one of the biggest winners in the FCC's Rural Digital Opportunity Fund (RDOF) round that awarded $9.2 billion to 180 broadband providers, with no other LEO operator subsidised (GEO operator Hughes got $1.27 million over 10 years).[604]

Elon Musk said in November that lowering Starlink terminal cost remains the most difficult technical challenge[605]. Ground terminals are one of key factors of the viability of megaconstelllations' business models and drive innovation. In December, one of Starlink competitors, Amazon's Project Kuiper, revealed details on its prototype Ka-band phased-array antenna, announcing it will be even smaller than the one of SpaceX (30cm vs 59cm in diameter) and support max throughput of 400 Mbps.[606]

---

[597] InputMag, "Starlink is charging almost $600 to beta test its satellite internet network", (October 2020)
[598] VehicleSuggest, „SpaceX's Starlink Satellite Internet Speed Topping 200 Mbps, Beta Testing Impresses Users", (November 2020)
[599] Investors, „SpaceX Starlink Impresses Air Force Weapons Buyer In Big Live-Fire Exercise", (September 2020)
[600] CNBC, "Washington emergency responders first to use SpaceX's Starlink internet in the field: 'It's amazing'", (September 2020)
[601] CBC, "Elon Musk's satellite internet plan gets green light from Canadian regulator", (October 2020)
[602] Reddit, "@Arcep authorized @SpaceX #Starlink gateways in 3 municipalities covering much of Western Europe", (October 2020)
[603] Mashable, "Elon Musk: Europe to get Starlink as early as February, more U.S. invites coming soon", (November 2020)
[604] Arstechnica, "SpaceX Starlink users provide first impressions and unboxing pictures", (November 2020)
[605] Business Insider, "SpaceX's Starlink internet speeds are consistently topping 150 Mbps — now Elon Musk says the biggest challenge is slashing the $600 up-front cost for users", (November 2020)
[606] Ars Techncia, "Amazon's answer to SpaceX Starlink delivers 400Mbps in prototype phase", (December 2020)

2.3 Selected company profiles in 2020

This section provides an overview of outstanding developments including corporate developments, announcements, achievements, contracts, and partnerships for the following companies.

This section is based on publicly available information (e.g. press releases, company websites, news articles…) and does not provide a comprehensive coverage for all businesses in 2020.

Companies	Space systems development	Launch service	Satellite operation
Airbus Space and Defence	•		
Antrix		•	
Arianegroup	•		
Arianespace		•	
Asiasat			•
Astroscale	•		•
Avio	•		
Blue Origin	•		
Boeing	•		
China Great Wall Industry Corporation		•	
Echostar			•
EUTELSAT			•
Glavkosmos		•	
Globalstar			•
Hispasat			•
ILS		•	
Inmarsat			•
Intelsat			•
Iridium			•
Lockheed Martin	•		
MAXAR	•		
Measat			•
Mitsubishi Electric	•		
Mitsubishy Heavy Industry	•	•	
NEC	•		
Northrop Grumman	•	•	
OneWeb	•		•
OHB System	•	•	
Planet			•
Rocket Lab	•	•	
RUAG	•		
RSCC			•
SES			•
SkyPerfect JSAT			•
SpaceX	•	•	•
Telesat			•
TELESPAZIO	•		
Thales Alenia Space	•		
ULA	•	•	
Viasat			•

Country

France

Core activity

Upstream - Manufacturer

Employees

> 10 000

Corporate developments

- Launched Open Innovation - Space Initiative in the UK.

Major announcements and achievements

- Completed the in-orbit tests of EDRS-C satellite (SpaceDataHighway)

Major contracts

- Awarded a 4-Year framework contract by EDA for the supply of satellite communications (EU SatCom Market contract).
- Signed an approx. £500 million contract with UK Ministry of Defence for the Skynet 6A military communications satellite, planned to launch in 2025.
- Signed an approx. €250 million contract with ESA to construct the 3rd European Service Module (ESM) for NASA's Orion spacecraft.
- Signed an annual renewal contract with ESA to continue ISS operations.
- Signed a €300 million contract with ESA to develop CRISTAL mission.
- Selected by ESA as a prime contractor for the Land Surface Temperature Monitoring (LSTM) mission in a contract worth €380 million.
- Selected by ESA as prime contractor for the Earth Return Orbiter (ERO) mission in a contract worth €491 million.
- Selected by ESA for the definition Phase A/B1 of the European Large Logistic Lander (EL3) mission.
- Signed a €380 million contract with ESA for the Copernicus LSTM mission.
- Selected by ESA for the TRUTHS mission, related to traceability of EO data.
- Signed a €190 million contract with the mission's Prime contractor Thales Alenia Space to build the advanced radar instrument for the ROSE-L mission.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Partnerships

- Concluded a reseller agreement to partner with Ovzon and included Ovzon's satellite communication services into its UK portfolio.
- Formed "Team Maier" to provide sovereign military communication satellite system in Australia.
- Formed a partnership with HawkEye 360 to deliver high-impact geospatial intelligence solutions across Europe.

Country

India

Core activity

Upstream – Launch Provider

Employees

10 – 50

Corporate developments

- Must pay a compensation of $1.2 billion ($562.5 million and the related interest rate) to Devas Multimedia Corporation for cancelling a satellite deal in 2005, as stated by a U.S. Court.

Major announcements and achievements

- Launched with PwC India a position paper titled "Preparing to scale new heights: Enhancing private participation in India's space sector" at Space Conclave 2020, Thiruvananthapuram.

arianeGROUP

Country

France

Core activity

Upstream - Manufacturer

Employees

5000 – 10 000

Corporate developments

- Added the 8th station to its GEOTracker network in Australia's Northern Territory; at the Centre for Appropriate Technology (CfAT).

Major announcements and achievements

- Announced that the European Commission and the European Investment Bank Group invested €100 million for the development of Ariane 6, an ESA programme with ArianeSpace as lead contractor.
- Announced that Ariane 6 rocket will not launch until the second half of 2021.
- Completed the 3rd and final static fire test of the P120C solid rocket motor which will be used on variants of the Ariane 6 and Vega C rockets.

Major contracts

- Signed a €33 million contract with ESA for the initial development phases of the Themis reusable rocket stage demonstrator.

Partnerships

- Partnered with ENGIE to develop renewable liquid hydrogen to speed up the decarbonisation of heavy-duty and long-distance transportation.

arianespace arianeGROUP

Country

France

Core activity

Upstream - Launch Provider

Employees

200 – 500

Corporate developments

- Listed among the creditors of OneWeb following the Chapter 11 filing in US Bankruptcy Court on March 27th.

Major announcements and achievements

- Suspended the Guiana Space Center (CSG) activities from March 16th to May 11st as decided by the French government for COVID-19.
- Orbited several satellites through 3 launches using Ariane 5 ECA launch vehicles from the Guiana Space Centre (EUTELSAT KONNECT; GSAT-30, JCSAT-17, GEO-KOMPSAT-2M; MEV-2, Galaxy 30 and BSAT-4b).
- Performed, along with Starsem, the second, third and fourth launch for OneWeb's global constellation, orbiting 104 satellites with the Soyuz medium-lift launcher.
- Performed the first Small Spacecraft Mission Service (SSMS) through VV16 flight, with 53 satellites for 21 customers onboard the Vega launcher.
- Announced the failure of Vega mission VV17 due to a malfunction in the upper stage.
- Orbited the UAE' Falcon Eye satellite in a Soyuz-2 mission.
- Orbited the French CSO-2 military EO satellite in a Soyuz-2 mission.
- Announced the fully booking of SSMS module that will fly on 2021 Vega VV18.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Signed a launch services contract with ESA for the Euclid dark universe exploration mission.
- Selected by ESA, on behalf of the EC DG Grow, for the pre-order of four more launches on the Ariane 6 rocket to launch Galileo satellites. The reservation will be confirmed after the vote of the MFF 2021-2027.
- Signed a contract with Airbus to launch a four-satellite optical EO (CO3D) constellation aboard a Vega C rocket in 2023.

ASIASAT

Country

Hong Kong

Core activity

Downstream - Satellite Operator

Employees

50 – 200

Corporate developments

- Appointed Tony Chung as Vice President, Data Services.
- Appointed Tammy Nam as Vice President, Finance.

Major announcements and achievements

- Accelerated efforts to guarantee stability of satellite operations and provide protection for C-band TT&C and Television receive-only (TVRO) antennas against potential interference due to the roll-out of 5G in Hong Kong.
- Published the "Technical Whitepaper - Gateway Network Rollout Methods for a Future VHTS System".
- Was awarded the ISO/IEC 27001:2013 certification, an international standard for Information Security Management System (ISMS) for its hosting service provided from the teleport in Hong Kong.

Astroscale

Country

Japan

Core activity

Upstream – Manufacturer

Downstream - Satellite Operator/IOS

Employees

50 – 200

Corporate developments

- Astroscale UK appointed Kumar Singarajah as Director of Government & Regulatory Affairs (UK & Europe).
- Raised $51 million through a Series E Funding Round, bringing the total capital to $191 Million.
- Astroscale U.S. appointed Carolyn Belle as Director, Advanced Systems.
- Astroscale UK appointed Sharon Parker-Lines as Operations Director.
- Acquired the IP Rights and certain staff members of the Israeli satellite life-extension and servicing company, named Effective Space Solutions R&D (ESS). Consequently, Astroscale entered the market for on-orbit services in GEO.

Major announcements and achievements

- Was awarded a grant of $4.5 million from the Tokyo Metropolitan Government's "Innovation Tokyo Project" to commercialise Active Debris Removal (ADR) services.

Major contracts

- Selected as commercial partner by JAXA for Phase I of the Commercial Removal of Debris Demonstration project (CRD2) .

Partnerships

- Signed a MoU with Northumbria University, Newcastle, to investigate on standards for End-of-Life practices in the satellite industry.

AVIO

Country

Italy

Core activity

Upstream - Manufacturer

Employees

500 – 1000

Corporate developments

- Appointed Giulio Ranzo as Chief Executive Officer.

Major announcements and achievements

- Completed the qualification test of the Zefiro 9 VT3 engine, an advanced version for the new Vega C launcher.
- Completed the final static test fire of the P120C rocket motor which will act as side boosters for Ariane 6 and as first stage for Vega C.
- Announced that the first launch of Vega C will occur in mid-2021.

Major contracts

- Selected as subcontractor of OHB Systeam AG within the framework of the ESA Hera mission.
- Signed an €167 million contract with ESA and Thales Alenia Space for the development of the Space Rider transportation system.

Partnerships

- Signed a MoU with UNOOSA to cooperate on "Access to Space 4 all" and provide institutions from UN Member States with the opportunity to access space using available slots in a Vega-C launcher.
- Signed a Letter of Intent with the Luxembourg company Made in Space to develop advanced robotic solutions for in-orbit servicing, including space debris removal.

BLUE ORIGIN

Country

United States

Core activity

Upstream - Manufacturer

Employees

1000 – 5000

Corporate developments

- Opened new headquarters and R&D facility in Kent, Washington.
- Opened a rocket engine production facility in Huntsville, AL, to conduct the production of BE-4 and BE-3U engines.

Major announcements and achievements

- Announced that BE-4 engine will power ULA's Vulcan launch vehicle in support of the Space Force's NSSL program.
- Delivered the first BE-4 engine to ULA to be used only for testing.
- Completed the first payload fairing of the New Glenn rocket.
- Blue Origin-led HLS National Team delivered an engineering mock-up for NASA evaluation.
- Blue Origin-led HLS National Team completed its System Requirements Review (SRR) receiving the NASA Certification Baseline Review, followed by the lower-level element SRRs, and the preliminary design phase.
- Launched its New Shepard rocket on an uncrewed test flight over West Texas.

Major contracts

- Selected by NASA as leader of the Blue Origin National Team which includes Lockheed Martin, Northrop Grumman, and Draper, to develop the HLS ($579 million)
- Was awarded a NASA Launch Services II (NLS II) contract, which allows Blue Origin to compete for missions through Launch Service Task Orders issued by NASA. Blue Origin's New Glenn launch vehicle was added to the NASA launch service catalog.

Partnerships

- Formed a partnership with Air Force Research Laboratory (AFRL) to develop a test facility for the BE-7 rocket engine at California's Edwards Air Force Base.

BOEING

Country

United States

Core activity

Upstream - Manufacturer

Employees

> 10 000

Corporate developments

- Appointed David L. Calhoun as President and CEO of the Boeing Company.
- Appointed Susan Doniz as Chief Information Officer and Senior Vice President of Information Technology & Data Analytics.
- Boeing HorizonX Ventures participated in a $11M Series B funding for Accion Systems and a $19.3 million Series B funding for Myriota.
- Appointed Marc Allen as Chief Strategy Officer and named Chris Raymond as Company's First Chief Sustainability Officer.

Major announcements and achievements

- Delivered to NASA the core stage of NASA's first Space Launch System (SLS) deep space exploration rocket.
- Withdrew DARPA's XS-1 programme, which led DARPA to abandon the programme.
- Started its U.S. Air Force X-37B spaceplane sixth mission with launch on the ULA Atlas V rocket.

Major contracts

- Signed a $916 million contract with NASA which extends its support to ISS operations until September 2024.
- Awarded, along with Northrop Grumman and Lockheed Martin, a $191 million contract by the U.S. Space Force to develop a cyber-secure communications payload under the Protected Tactical Satellite Communications (PTS) programme, for the Space and Missile Systems (SMC) Centre.
- Received orders for four more O3b mPower broadband satellites by SES.
- Selected by SES to manufacture two replacement satellites to comply with the FCC accelerated C-band spectrum clearing programme.
- Signed a $298 million contract with the U.S. Space Force, under the first phase of the Evolved Strategic SATCOM (ESS) programme, to build a satellite payload prototype and develop satellite communications architecture.

Partnerships

- Signed a Memorandum of Agreement with Andøya Space to expand Andøya Space's ability to provide medium launch services to customers in Europe.

中国长城工业集团有限公司
China Great Wall Industry Corporation

Country

China

Core activity

Upstream– Launch Provider

Employees

200 –500

Major announcements and achievements

- Launched JILIN-1KF01, NewSat-7, NewSat-8 and TIANQI-2-03 on the Long March 2D (LM-2D) launch vehicle.
- Launched APSTAR-6D communications satellite on LM-3B launch vehicle from Xichang Satellite Launch Center (XSLC), China.
- Launched ten NewSat satellites, and three additional satellites (MN50-3, TY20, BY70-3) on the Long March-6 launch vehicle from Taiyuan Satellite Launch Center (TSLC), China.
- Provided launch service for four satellites (HiSea-1 ,Yuanguang Satellite, TQ-08, and SS-01A), launched on the debut flight of the Long March-8 launch vehicle.

Major contracts

- Signed a contract for the APSTAR-6E satellite in-orbit delivery. CGWIC will establish a Joint Venture with APT Satellite, together with China Academy of Space Technology and China Academy of Launch Vehicle Technology. The overall contract price is $137.6 million.

ECHOSTAR

Country

United States

Core activity

Downstream - Satellite Operator

Employees

1000 – 5000

Corporate developments

Major announcements and achievements

- Hughes, a subsidiary of Echostar, launched HughesNet for Business, a satellite Internet service designed for MSMEs in Mexico.
- Hughes announced it will join the bidding consortium that acquired OneWeb out of bankruptcy with an investment of $50 million.
- Hughes released the newest set of features for the JUPITER System (7.4), the company's Very Small Aperture Terminal (VSAT) platform for broadband satellite services.
- Hughes announced the commercial availability of its AI for IT operations (AIOps) solution for Wide Area Networks (WANs) system.
- Hughes was awarded the status of approved provider by the Georgia Technology Authority (GTA) under the GTA Direct program.

Major contracts

- Hughes, along with ERT, was selected by the National Weather Service (NWS) to upgrade and expand managed satellite and wireless services at NWS locations in the U.S., Hawaii, Alaska, and the Pacific Region.
- Hughes was awarded a Data Link Modernization (DLM) contract by General Atomics Aeronautical Systems, Inc. to provide new advanced SATCOM systems for the U.S. Army's MQ-1C Gray Eagle Unmanned Aircraft System (UAS).
- Hughes was selected by the U.S. Naval Air Systems (NAVAIR) to provide SATCOM systems integration for the U.S. Coast Guard on its HC-27J aircraft.
- Hughes JUPITER System was selected by the Philippines satellite provider Cignal TV Inc. to enable satellite broadband service to its subscribers.
- Signed an approx. $250 million contract lasting three years with OneWeb to develop and manufacture ground system technology for OneWeb´s LEO constellation.

Partnerships

- Formed a partnership with Jersey Telecom to bring hybrid satellite/terrestrial capability to IoT and mobility customers across Europe.

eutelsat

Country

France

Core activity

Downstream - Satellite Operator

Employees

500 – 1000

Corporate developments

- Acquired the European satellite broadband activities of Bigblu Broadband in order to cover Hungary.
- Agreed on the disposal of its 51% stake in Euro Broadband Infrastructure (EBI) to Viasat.

Major announcements and achievements

- EUTELSAT´s KONNECT communication satellite was launched by Arianespace using an Ariane 5 rocket and it is now operational.
- EUTELSAT´s 7C satellite entered full commercial service, supporting broadcast customers across Africa, Europe, the Middle East and Turkey.
- Issued its revised transition plan announcing that they no longer intended to buy a satellite for the U.S. C-band transition plan.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Concluded an agreement with AfricaXP for Ku-band capacity on two Eutelsat satellites (16° and 7° East) to extend the DTH satellite services across Sub-Saharan Africa.
- Signed a contract with Telenor Maritime for Ku coverage in some sailing zone in Europe, Trans-Atlantic crossings, the Caribbean and Southeast Asia.
- Sold to Orange all available high-speed fixed broadband capacity on the KONNECT satellite to cover the French territory.
- Concluded an agreement with Strong Roots Ethiopia Broadcasting Service PLC for a Ku capacity on a 36 MHz transponder on EUTELSAT 8 West B satellite.
- Concluded an agreement with Sky Italia for the renewal of Sky's capacity contract at Eutelsat's HOTBIRD position.

Partnerships

- Concluded a distribution agreement with Paratus to bring network connectivity to South Africa.
- KONNECT Africa, a subsidiary of Eutelsat, signed an MoU with Schoolap and Flash Services to provide internet connectivity in the Democratic Republic of Congo schools.

GLAVKOSMOS

Country

Russia

Core activity

Upstream – Launch Provider

Employees

50 – 200

Corporate developments

- Celebrated the 35th anniversary since its foundation.

Major announcements and achievements

- Launched two batches of 34 OneWeb satellites aboard the Soyuz-2.1 b launch vehicle with the Fregat upper stage from the Baikonur Cosmodrome, under a contract between Glavkosmos and Arianespace.
- Launched 36 OneWeb satellites aboard the Soyuz-2.1 b launch vehicle with the Fregat upper stage from the Vostochny Cosmodrome, under a contract between Glavkosmos and Arianespace.
- Launched 15 spacecrafts as a rideshare payload during the launch of the 16th Russian Gonets-M communication spacecraft from the Plesetsk Cosmodrome, under contracts with several foreign customers.
- Began a 12-month training programme of Indian candidates for a spaceflight started at the Gagarin Research & Test Cosmonaut Training Center (GCTC), under a contract between Glavkosmos, JSC and the Human Spaceflight Centre of ISRO.

Partnerships

- Formed a partnership with ILS to promote commercial space travel programmes with the use of the Russian Soyuz spacecraft.
- Signed a Memorandum on Joint Participation with JSC Academician M.F. Reshetnev Information Satellite Systems (ISS-Reshetnev Company) in the implementation of the Full Innovation Cycle Global information satellite systems (GISS) programme.

Globalstar

Country

United States

Core activity

Downstream - Satellite Operator

Employees

50 – 200

Corporate developments

- Deployed a new ground station in Córdoba, Argentina, with second-generation technology (e.g., Sat-Fi2).

Major announcements and achievements

- Introduced the Satellite Transmitter ST100 which provides reliable connectivity that is powered by the Globalstar Satellite Network LEO constellation, providing SATCOM integration capability to any original equipment manufacturer product.
- Launched SPOT Gen4 Satellite GPS Messenger, SPOT X Jeep Edition 2-way Satellite Messenger and SPOT Gen4 Jeep Special Edition Satellite GPS Messenger.
- Obtained terrestrial authorisations in Canada, Brasil and Kenya, bringing the total coverage to approx. 700 million people.

Major contracts

- SPOT, a subsidiary of Globalstar, signed a licensing deal with the Jeep brand.

hispasat

Country

Spain

Core activity

Downstream - Satellite Operator

Employees

50 – 200

Corporate developments

- Appointed Jordi Hereu as new President.

Major announcements and achievements

- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Signed a contract with Thales Alenia Space for the construction of the GEO Amazonas Nexus High Throughput Satellite (HTS) which will replace Amazonas 2 satellite.
- Won a contract, alongside Artel, to embed Pathfinder 2 mission of the U.S. Space Force's Space and Missile Systems Center on its Amazonas Nexus Satellite.
- Signed an agreement with Claro Argentina to provide internet connectivity to rural communities in Argentina.
- Signed an agreement with the Mexican Altán La Red Compartida to provide transmission services in remote areas of Mexico.
- Signed an agreement with Telefónica in Spain for a multi-year renewal of the satellite service that Hispasat offers through its H30W-6 satellite.
- Renewed the agreement with SYNTELIX until 2022 to offer satellite connectivity to the maritime sector in the Mediterranean and Latin America.
- Signed an agreement with PLD Space to define the technical conditions and analyse the compatibility to launch services on board MIURA 5 launcher.

Partnerships

- Joined the 3rd Generation Partnership Project (3GPP) group for the standardisation of 5G technology for mobile communications, and the integration of satellites into the 5G ecosystem.
- Formed a partnership with EasyTV to bring internet service in regions in Brasil that lack connectivity through HISPASAT's Amazonas 5 satellite.

ILS

Country

United States

Core activity

Upstream - Launch Provider

Employees

50 – 100

Corporate developments

- Appointed Tiphaine Louradour as new President.

Major announcements and achievements

- Received U.S. State Department approval to promote commercial launch services of the Russian Soyuz launch vehicle in conjunction with GK Launch Services.
- Announced that Angara-A5 rocket was launched from Russia's Plesetsk Cosmodrome, and it has completed its second test flight.

Partnerships

- Formed a partnership with Glavkosmos to promote commercial space travel.

inmarsat

Country

United Kingdom

Core activity

Downstream - Satellite Operator

Employees

1000 – 5000

Major announcements and achievements

- Launched, along with Cobham SATCOM, a Broadband Global Area Network (BGAN) push-to-talk (PTT) communication solution to connect remote workers.
- Launched the Rail Telemetry and Communications Solution to enhance transfer of telemetry data from trains to control centre.
- Secured spectrum licences to deliver both L-band and Ka-band, Global Xpress (GX), services in Saudi Arabia.
- Announced that the GX5 launched in November 2019 entered into service.

Major contracts

- Signed a contract with Crowley Maritime to install Inmarsat's Fleet in many Crowley Maritime vessels.
- Signed a €22.4 million 3-year contract with ESA to develop government satcoms platform (INVISON — International Virtual Satellite Operators Network – programme)
- Concluded an agreement with Speedcast on the sale of Speedcast's primary Fleet Xpress, Fleet Broadband and Fleet One service contracts.

Partnerships

- Teamed up with three other UK-based companies (Serco, CGI UK and Lockheed Martin UK) to develop Athena and create additional UK space capabilities.
- Team up with Hughes for the development of a new Inflight connectivity solution.
- Concluded a partnership agreement with L3Harris to deliver L-TAC and GX services into the government market.

INTELSAT

Country

United States

Core activity

Downstream - Satellite Operator

Employees

1000 – 5000

Corporate developments

- Filed for Chapter 11 bankruptcy protection and gained bankruptcy court approval to access a $1 billion in debtor-in-possession financing.
- Acquired Gogo´s Commercial Aviation (CA) division for $400 million.

Major announcements and achievements

- Announced that Intelsat-901 resumed service after that Northrop Grumman's Mission Extension Vehicle MEV-1 docked and operated on the Intelsat satellite.
- Announced that it will not replace Intelsat-29e with another satellite and relied on a borrowed satellite from Hispasat and the upcoming Intelsat-40e.
- Launched Galaxy 30, a GEO communications satellite that will provide television distribution service to Intelsat's North American customers.

Major contracts

- Signed a contract with Maxar Technologies to manufacture five satellites (Galaxy 31, Galaxy 32, Galaxy 35 and Galaxy 36, Galaxy 37) to accommodate FCC C-Band Spectrum transition.
- Selected Northrop Grumman to manufacture two satellites (Galaxy 33 and Galaxy 34) to accommodate FCC C-Band Spectrum transition.
- Selected Maxar Technologies to manufacture its next-generation Intelsat 40e GEO communication satellite.
- Signed a contract with SpaceX and Arianespace to launch the satellites for the FCC C-Band Spectrum transition, beginning in 2022.

Partnerships

- Formed a partnership with Andesat to bring end-to-end mobile broadband (3G) service to remote communities across Peru.
- Formed the HAPS Alliance together with other global industry leaders, to support the use of high-altitude vehicles in the stratosphere.
- Formed a partnership with Inland Cellular to bring 4G LTE broadband coverage in rural areas of Washington State.

Iridium

Country

United States

Core activity

Downstream - Satellite Operator

Employees

500 – 1000

Major announcements and achievements

- Announced the commercial availability of Iridium Certus 700 service which provides fast L-band connectivity.
- Announced Iridium CloudConnect, the new service that combines Iridium IoT capabilities with Amazon Web Services (AWS) IoT and cloud services.

Major contracts

- Signed a contract with Relativity Space to launch six spare satellites.

Partnerships

- Formed a beta partnership with six companies (CLS Telemetry, Everywhere Communications, Marlink, M2M Connectivity, Rock Seven, and Tesacom) to test Iridium Edge Solar, a new satellite IoT device.
- Formed a partnership with Kobelco to integrate its satellite communications into Kobelco´s KMC equipment and provide global coverage.

Lockheed Martin

Country

United States

Core activity

Upstream - Manufacturer

Employees

> 10 000

Corporate developments

- Appointed James D. Taiclet as President and CEO.
- Acquired the Vector´s GalacticSky satellite technology for $4.25 million.
- Acquired the Hypersonics portfolio of Integration Innovation.

Major announcements and achievements

- Completed, along with NASA and Northrop Grumman, the final qualification test of the Attitude Control Motor (ACM) for Orion spacecraft Launch Abort System.
- Announced that the Lockheed Martin-built JCSAT-17 was launched into orbit to provide communications services in Japan, under the Sky Perfect management.
- Announced that the 6th Advanced Extremely High Frequency (AEHF-6) communications satellite was launched through ULA Atlas V 551 rocket in March and completed its On-Orbit Test (OOT) period in September.
- Announced that its experimental nanosat Pony Express 1 payload hosted on Tyvak-0129 spacecraft has started performing.
- Announced that GPS III Space Vehicle 03 and GPS III Space Vehicle 04 were delivered to the U.S. Space Force and then successfully launched.
- Announced that SBIRS GEO-5 satellite is completed and ready for launch in 2021.

Major contracts

- Signed a $31.9 million contract with DARPA for the Operational Fires (OpFires) Phase 3 Weapon System Integration program.
- Signed a $5.8 million contract with DARPA for satellite integration for the Blackjack program.
- Signed a $187.5 million contract with Space Development Agency (SDA) to develop 10 satellites for the SDA communications constellation.
- Selected by NASA alongside the University of Colorado Boulder to lead the Janus mission and study binary asteroids, under the NASA's SIMPLEx program.
- Signed a $240 million contract with the U.S. Space Force's Space and Missile Systems Centre (SMC) to develop a prototype payload for the Protected Tactical SATCOM (PTS) system.

MAXAR

Country

United States

Core activity

Upstream - Manufacturer

Employees

5000 – 10 000

Corporate developments

- Acquired the 3D data and analytics firm Vricon for approx. $140 million.

Major announcements and achievements

- Announced that the Defence Geographic Agency (DGeo) of The Netherlands Ministry of Defence signed a multi-million dollars, multi-year subscription to SecureWatch, the Maxar's cloud-based geospatial intelligence (GEOINT) platform.
- Announced the launch of BSAT-4b satellite, built by MAXAR for Broadcasting Satellite System Corporation (B-SAT) expanding its 4K/8K service in Japan.
- Announced that the Maxar-built Siriusxm's SXM-7 satellite was launched by SpaceX.

Major contracts

- Signed a $142 million contract with NASA to perform an in-space assembly demonstration using the SPIDER robotic arm in NASA's Restore-L spacecraft.
- Selected by Intelsat to manufacture six GEO communications satellites (Galaxy 31, Galaxy 32, Galaxy 35 and Galaxy 36, Galaxy 37, and Intelsat 40e).
- Signed a $5 million contract with NASA to deliver the Sample Acquisition, Morphology Filtering and Probing of Lunar Regolith (SAMPLR) robotic arm.
- Selected to support Dynetics in designing and building the HLS programme to compete with Blue Origin and SpaceX.
- Signed up to $49 million eight-year contract with the U.S. Army Geospatial Centre to deliver multiple portable satellite imagery ground system-
- Signed a $8.5 million contract with the U.S. Space Force to develop data processing applications for the Future Operationally Resilient Ground Evolution Mission Data Processing (FORGE MDP) programme.

Partnerships

- Extended the agreement with Esri to license data for the ArcGIS Living Atlas of the World through to 2023.

measat

Country

Malaysia

Core activity

Downstream - Satellite Operator

Employees

50 – 200

Major announcements and achievements

- Announced that CONNECTme NOW, its Malaysia's first prepaid satellite broadband WiFi Hotspot service, was installed at Data Kakus, Malaysia.

Partnerships

- Continues to collaborate with iKOMG which will offer Kazakh TV distribution service in HD over the MEASAT-3a satellite.

MITSUBISHI ELECTRIC

Country

Japan

Core activity

Upstream - Manufacturer

Employees

> 10 000

Corporate developments

- Opened a facility for the production of satellites at company's Kamakura Works in Japan.

Major contracts

- Selected by JAXA as the contractor of the Martian Moons eXploration (MMX) space probe.
- Selected by JAXA as the contractor of the Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW).

MITSUBISHI HEAVY INDUSTRIES

Country

Japan

Core activity

Upstream – Manufacturer

Launch Provider

Employees

> 10 000

Major announcements and achievements

- Launched the Mars Mission HOPE spacecraft, developed by the Mohammed Bin Rashid Space Centre (MBRSC) in the UAE, with the H-IIA Launch Vehicle No.42 (H-IIA F42).

Orchestrating a brighter world
NEC

Country

Japan

Core activity

Upstream - Manufacturer

Employees

> 10 000

Corporate developments

- Appointed Takayuki Morita as the new President and CEO.

Major announcements and achievements

- Announced that the Japanese Hayabusa2 asteroid-sample return mission uses a thermal infrared (TIR) imager camera designed by NEC.

Major contracts

- Signed a contract with Sumitomo Corporation to manufacture and launch the EO LOTUSat-1 for the Vietnam National Space Center (VNSC), which is scheduled for launch in 2023.
- Selected by AST SpaceMobile to manufacture AST SpaceMobile satellite modules.

NORTHROP GRUMMAN

Country

United States

Core activity

Upstream – Manufacturer

Upstream – Launch Provider

Employees

> 10 000

Corporate developments

- Appointed David F. Keffer as corporate Vice President and chief financial officer.

Major announcements and achievements

- Launched the Cygnus NG-13 spacecraft to the ISS for NASA.
- Completed its final qualification test of the Attitude Control Motor (ACM) for NASA's Orion spacecraft Launch Abort System (LAS).
- Ended its OmegA rocket programme, a solid fuel rocket designed to compete for a NSSL contract but failed to receive one.
- Launched its Minotaur IV space launch vehicle and placed a National Reconnaissance Office (NRO) spacecraft into orbit.
- Announced MEV-1 docking with Intelsat IS-901 in February, and the launching of MEV-2 on an Ariane 5 rocket. MEV-2 docked with Intelsat IS-1002 in 2021.

Major contracts

- Signed a $253 million contract, along with Boeing and Lockheed Martin, with the U.S. Space Force Space and Missile Systems Centre to develop payloads under the Protected Tactical Satellite Communications (PTS) programme.
- Signed a $2.37 billion contract with the U.S. Space Force to develop missile-warning satellites for Next-Gen Overhead Persistent Infrared Polar programme (Phase1).
- Orbital Science Corporation of Dulles, subsidiary of Northrop Grumman, was awarded a contract by NASA for the design and development of the Habitation and Logistics Outpost (HALO) for NASA´s Gateway.
- Selected by Intelsat and SES to build two C-band satellites each, as part of FCC accelerated C-band clearance plan.
- Awarded two missions with NASA to deliver cargo to the ISS in 2023 under the Commercial Resupply Services contract-2 (CRS-2).

Partnerships

- SpaceLogistics, a subsidiary of Northrop Grumman, was selected by DARPA as its commercial partner for the agency's Robotic Servicing of Geosynchronous Satellites (RSGS) programme.
- Signed a MoU with Gilmour Space Technologies to support the development of Australian sovereign space capabilities.

OneWeb

Country

United Kingdom

Core activity

Upstream – Manufacturer

Downstream - Satellite Operator

Employees

200 – 500

Corporate developments

- Filed for relief under Chapter 11 of the Bankruptcy Code in the U.S. Bankruptcy Court for the Southern District of New York.
- Entered into an agreement with a consortium led by UK Government and Bharti Global limited for the acquisition of the OneWeb business ($1 billion).
- Resumed full business operations after the approval of the plan of reorganisation by the Bankruptcy Court for the Southern District of New York.
- Announced that FCC approved the transfer of OneWeb's satellite and ground station licenses to the British government and Bharti Global.
- Appointed Neil Masterson as new CEO.
- Announced Hughes $50 million investment in the consortium led by the UK Government and Bharti Enterprises.

Major announcements and achievements

- Announced the launch of 34 satellites in February and of 34 satellites in March from the Baikonur Cosmodrome, Kazakhstan. It also announced the launch of 36 satellites from the Vostochny Cosmodrome in December.
- Announced that FCC granted OneWeb market access for 2,000 satellites to expand its Non-Geostationary Orbit (NGSO) satellite constellation.

Major contracts

- Amended the agreement with Arianespace to provide 16 launches placing 34-36 satellites per launch starting from the launch in December 2020.
- Signed a three-year contract valued at approx. $250 million with Hughes to develop and manufacture ground system technology for its LEO constellation.

Partnerships

- Formed a distributor partnership with Pacific Dataport to supply satellite communication systems in Alaska.
- Signed an MoU with JSC Silknet to bring satellite broadband services to Georgia.
- Signed an MoU with Astana International Financial Centre to accelerate broadband connectivity in Kazakhstan.
- Formed a global distribution partnership for LEO satellite service with Hughes.

OHB

Country

Germany

Core activity

Upstream – Manufacturer

Upstream – Launch Provider

Employees

1000 – 5000

Major announcements and achievements

- MT Mechatronics, a subsidiary of OHB, began work on assembling the first test antenna (out of five) for the Heinrich Hertz satellite communications mission.
- Announced that ESAIL, a commercial microsatellite built by LuxSpace (a subsidiary of OHB) and developed under ESA's SAT-AIS programme, was launched from French Guiana.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.
- Rocket Factory Augsburg (RFA), a participation of OHB SE, concluded the largest part of a phase 0/A project with CNES/CSG European Spaceport for the implementation of a launch site for the RFA-ONE launch system in Kourou, French Guiana.

Major contracts

- OHB System, a subsidiary of OHB SE, selected by ESA as the prime contractor for the Copernicus CO2M Monitoring Mission (€445 million contract).
- OHB Cosmos International Launch Service, a division of OHB Group, procured a contract with Rocket Lab to launch a communication satellite in 2021.
- OHB System AG, a subsidiary of OHB SE signed a €129 million contract with ESA to be the prime industrial contractor for the HERA asteroid mission.
- OHB Italia, a subsidiary of OHB SE, was selected by ESA as one of the two prime contractors to perform a study of the Comet Interceptor mission.
- OHB System was selected by Thales Alenia Space as subcontract to develop the payload for the two satellites of the Copernicus CHIME mission (total value for OHB contract is of €259 million).
- OHB Sweden, a subsidiary of OHB, was selected by ClearSpace as a partner for the ESA ClearSpace-1 mission.

Partnerships

- RFA signed a Letter of Intent with Andøya Space for establishing a launch site for a micro launcher in the Andøya Space Centre from 2022 onwards.
- Formed a global distribution partnership for LEO satellite service with OneWeb.

planet.

Country

United States

Core activity

Downstream - Satellite Operator/Product

Employees

200 – 500

Corporate developments

- Appointed Ashley Johnson as Chief Finance Officer.
- Appointed Rosanne Saccone as Chief Marketing Officer.

Major announcements and achievements

- Announced that Planet's RapidEye constellation was retired at the end of March 2020.
- Announced that 26 SuperDoves were launched on Arianespace's VV16 flight in September, and 9 SuperDoves were launched by Rocket Lab Electron in October.
- Announced that SkySats 16-18 were launched in June, and SkySats 19-21 were launched in August aboard the SpaceX's Falcon 9, completing the SkySat Constellation.

Major contracts

- Signed a contract with Norway's Ministry of Climate and Environment, along with KSAT and Airbus, to deliver satellite-based optical imagery, as part of the Norway's International Climate and Forest Initiative (NICFI).
- Signed a $7 million contract with NASA to expand subscription with Planet and provides PlanetScope data to NASA-funded research programs.

Partnerships

- Formed a partnership with Seisan, a custom software solutions and systems integration company specializing in leveraging geospatial technologies.
- Formed a partnership with Esri UK, enabling the latter to resell EO imagery on Esri ArcGIS tools.
- Formed a partnership with Everbridge, to use remote sensing data for critical event management.
- Formed a partnership with the NASA Resources for the Future (RFF) for the Valuation of Applications Benefits Linked with Earth Science (VALUABLES) consortium.

ROCKET LAB

Country

United States

Core activity

Upstream – Manufacturer

Upstream – Launch Provider

Employees

200 – 500

Corporate developments

- Opened a new facility in Long Beach, which serves as corporate headquarters and bring Mission Control Centre capabilities to California.
- Acquired Sinclair Interplanetary, a leading provider of high-quality, flight-proven satellite hardware.

Major announcements and achievements

- Completed 7 launches in 2020, deploying satellites for the National Reconnaissance Office, Capella Space, Planet, Canon Electronics, Synspective etc. Among them, it launched its first in-house built Photon satellite, namely First Light.
- Completed the its first plane change in orbit, demonstrating the Kick Stage's ability to customize orbits for smallsats.
- Was granted a 5-year FAA Launch Operator License for Electron missions from Rocket Lab Launch Complex 2.
- Announced that NASA has certified Rocket Lab's Electron launch vehicle, enabling NASA to launch small satellites on Electron.

Major contracts

- Selected by NASA as the launch provider for a small satellite mission, namely Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE) CubeSat.
- Signed a contract with OHB to launch a communications satellite on an Electron rocket early 2021.

Country

Switzerland

Core activity

Upstream - Manufacturer

Employees

1000 – 5000

Corporate developments

- Was divided into two companies by mutual agreement: RUAG International (Space, Aerostructures, MRO International and Ammotec) and RUAG (Swiss part). RUAS Space is part of RUAG International.
- Appointed André Wall as the new CEO of RUAG International.
- Ruag Space concentrated its activities in a new single location near Dresden.

Major announcements and achievements

- Provided the satellite container for the transport and integration on Earth of the Maxar-built broadcast satellite BSAT-4b.
- Supplied the PODRIX GNSS receiver for the Copernicus Sentinel-6 satellite.
- Built the satellite mega dispenser for the Airbus OneWeb satellites.
- Delivered the first flight model of a thermal insulation for Ariane 6 rocket.

Major contracts

- Concluded a long-term purchase agreement with GK Launch Services to supply payload adapters and separation systems for the Soyuz-2 launchers.

Country

Russia

Core activity

Downstream - Satellite Operator

Employees

500 – 1000

Corporate developments

- Re-elected Ksenia Drozdova, Deputy Director General for Business Development at RSCC, as Chair of Operations Committee of Intersputnik International Organization of Space Communications.

Major announcements and achievements

- Arranged the transfer of the central station satellite broadband access network in Ka-band from Express-AM6 satellite to Express-AMU1 satellite (36 degrees E).
- Launched its ordered Express-80 and Express-103 spacecrafts from the Baikonur Cosmodrome, Kazakhstan.
- Announced that Yuri Prokhorov, acting Director General of RSCC, presented a project on multifunctional satellite communication system, Express-RV, at the International Conference Satellite Russia & CIS 2020.

Major contracts

- Ordered four Express-RVs elliptical orbit satellites, to provide Ku-band coverage to Russia's Far North.

SES your satellite company

Country

Luxembourg

Core activity

Downstream - Satellite Operator

Employees

1000 – 5000

Corporate developments

- Appointed Sandeep Jalan as Chief Financial Officer.

Major announcements and achievements

- Announced the adoption of the Software-Defined Wide Area Network (SD-WAN) built on SES Networks' SD-WAN service by RCS Communication.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Selected Northrop Grumman and Boeing to deliver four new satellites as part of the company's accelerated C-band clearing plan.
- Selected SpaceX and ULA for the launch of up to 3 and 2 of its C-band satellites respectively over two launches as part of the company's accelerated C-band clearing plan.
- Signed a contract with Orange to integrate O3b mPOWER communications system in the Orange network, to support the demand for connectivity in Africa.
- SES Government Solutions and Isotropic Systems signed a two-phased antenna contract with the U.S. Air Force Research Laboratory to test the Isotropic Systems' multi-beam terminal over SES's O3b MEO constellation.
- Signed a contract with SpaceX to launch four newly-ordered O3b mPOWER spacecrafts.
- SES Government Solutions was awarded an Advanced Battle Management System tests contract to provide the U.S. Air Force with SATCOM capabilities.
- Signed an agreement with Pivotel to build a satellite ground station at the Pivotel teleport in Dubbo, New South Wales.

Partnerships

- Formed a partnership with the Belgian Development Agency Enabel to deliver satellite-based communications for aid projects in Africa.
- Concluded an agreement with Microsoft to become an Azure Orbital partner.
- SES Government Solutions and Artel teamed with Leidos to deliver connectivity solutions in Antarctica, operated by the National Science Foundation.

SKYPerfect JSAT Corporation

Country

Japan

Core activity

Downstream - Satellite Operator

Employees

500 – 1000

Major announcements and achievements

- Launched the JCSAT-17 communications satellite aboard Ariane-5ECA launch vehicle from Guiana Space Centre.

Partnerships

- Formed a partnership with RIKEN, Nagoya University and Kyushu University, to develop a satellite that uses a laser to remove space debris. In early-phases of the study JSAT has been supported by JAXA.
- Formed a partnership with ZENRIN and NIPPON KOEI to develop and provide Satellite Anti-Disaster Management Service.

Country

United States

Core activity

Upstream – Manufacturer

Upstream –Launch Provider

Downstream - Satellite Operator

Employees

1000 – 5000

Major announcements and achievements

- Obtained FCC license for up to one million ground terminals for Starlink constellation.
- Announced that Falcon 9 lifted off more than 25 times in 2020, carrying spacecraft into orbit for NASA, U.S. Space Force, Planet, USSF etc. Among them, SpaceX Crew-1 mission to the ISS was launched, successfully docking with the ISS and becoming the first operational commercial crew flight.
- Deployed 955 Starlink satellites into orbit since May 2019.
- Performed its fourth static fire test on the Starship SN8 prototype.
- Performed the first high-altitude test flight of a Starship prototype.

Major contracts

- Signed a $80.4 million contract with NASA to launch an Earth science mission, namely Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) spacecraft in 2022.
- Selected by NASA as the first U.S. contractor to provide commercial cargo services to the Lunar Gateway (Gateway Logistics Services programme).
- Signed a $316 million contract with U.S. Air Force Space and Missile Systems Centre for the Phase 2 contract for NSSL, with one launch planned for 2022.
- Signed a contract with Intelsat to launch satellites, beginning in 2022, to comply with the FCC accelerated C-band spectrum clearing plan.
- Signed a contract with the U.S. Space Force to reuse Falcon 9 boosters for upcoming GPS-III launches, the first of its kind for NSSL missions.
- Signed a contract with Axiom Space for a Crew Dragon mission to the ISS planned for 2021.
- Awarded by NASA for the launch of the IMAP mission, as part of a $109.4 million contract.
- Awarded $885.5 million in funding by the FCC under its Rural Digital Opportunity Fund (RDOF) Phase 1 auction.

Partnerships

- Concluded an agreement with Space Adventures to fly a Crew Dragon mission with four tourists in late 2021/mid-2022.

Country

Canada

Core activity

Downstream - Satellite Operator

Employees

200 – 500

Corporate developments

- Announced it would merge with Loral Space & Communications and become publicly listed on the Nasdaq stock market.

Major announcements and achievements

- Completed, along with Telefónica International Wholesale Services (TIWS), the on-orbit testing, demonstrating that Telesat's LEO Phase 1 satellite could be an option for wireless backhaul.
- Proposed the reallocation of the C-band spectrum for 5G services to the Canadian Government.

Major contracts

- Telesat U.S. Services selected by DARPA to develop and demonstrate different Blackjack Phase 2/3 Track B technology for the Blackjack constellation. Telesat received $18.3 million in Phase 2.

Partnerships

- Joined the Rural Broadband Consortium, to bring broadband access to rural areas.
- Formed a partnership with Lockheed Martin team on the SDA Space Transport Layer constellation to demonstrate interoperability between the OISLs of the SDA constellation and Telesat's future LEO constellation.

Country

Italy

Core activity

Upstream - Manufacturer

Employees

1000 – 5000

Corporate developments

- Telespazio UK appointed Mark Hewer as CEO.
- Spaceopal, a join venture between DLR GfR and Telespazio, appointed Marco Folino as Managing Director and CEO.

Major announcements and achievements

- Telespazio Brasil and Codemar signed an agreement to develop a satellite teleport for telecommunications applications in Maricá, Brasil.
- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Telespazio UK was selected by ESA as a leader of a team to develop 3 space-enabled services to predict and detect clean water leakage in pipelines.
- e-GEOS was selected by EC to lead a European consortium for the PEONEER project which is part of the European Defence Industrial Development Programme (EDIDP).
- e-GEOS was awarded a contract by the EC Joint Research Centre which is related to the Risk and Recovery mapping of the Copernicus EMS Service.
- Telespazio UK signed a €25M contract with ESA to work together with a pan-European team to mainly manage quality control operations .
- e-GEOS, along with ASI, won an ESA contract to develop a solution to monitor the economic recovery following COVID-19.
- Signed a contract, together with TAS, the Italian Ministry of Defence and ASI to develop two additional COSMO-SkyMed Second Generation satellites.
- Signed, together with ALTEC, a contract with ESA for the management of the ground segment and operations of the Space Rider mission.

Partnerships

- Formed a partnership with Campania Aerospace District for the MISTRAL project, funded by the Region of Campania.
- Concluded a partnership agreement with the UAE company, Thuraya, for the distribution of Thuraya's mobile satellite solutions worldwide.

Country

France

Core activity

Upstream - Manufacturer

Employees

5000 – 10 000

Corporate developments

- Appointed Massimo Comparini as Deputy CEO of TAS and as CEO of TAS Italia.

Major announcements and achievements

- Selected by the European Commission as part of a European Consortium to study the development of an EU´s satellite-based connectivity system.

Major contracts

- Signed contract with Hispasat to develop the Amazonas Nexus satellite.
- Signed a €88 million contract with Airbus to develop the advanced Interferometric Radar Altimeter for Ice and Snow (IRIS) of the CRISTAL mission.
- Selected by ESA and the prime contractor OHB to provide the communications system and the Power Conditioning and Distribution Unit (PCDU) of the HERA spacecraft, under a €129.4 million contract.
- Selected by SES for the final two GEO communications satellites (SES-22 and SES-23), for the accelerated C-band clearance plan.
- Selected by NASA and the prime contractor Dynetics as part of a consortium of more than 25 companies for NASA´s HLS programme.
- Signed €327 million contract with ESA to develop two modules for the Lunar Gateway.
- Signed €455 million contract with ESA to develop the Copernicus CHIME mission.
- Signed €495 million with ESA to develop the CIMR mission.
- Signed a contract, together with Telespazio, with the Italian Ministry of Defence and ASI to develop two COSMO-SkyMed Second Generation satellites and upgrade ground segments.
- Signed, together with Avio, a €167 million contract with ESA to develop the Space Rider transportation system.
- Selected by ESA to lead one of the two studies for the Comet Interceptor mission.

Partnerships

- Thales Alenia in Spain lead the consortium for the PROMISE (PROgrammable MIxed Signal Electronics) project, funded by H2020 programme.
- Selected by Airbus to supply the communication system, design the OIM and conduct AIT of ERO for ESA-NASA Mars Sample Return mission

ULA

Country

United States

Core activity

Upstream – Manufacturer

Upstream – Launch Provider

Employees

1000 – 5000

Major announcements and achievements

- Completed 6 launches. Among them, it deployed payloads such as the Solar Orbiter, a cooperative mission between ESA and NASA; the 6th Advanced Extremely High Frequency (AEHF) communications satellite for the U.S. Space Force (first NSSL mission under the U.S. Space Force); the Perseverance rover for NASA´s Mars 2020 mission; and the NROL-101 for the national Reconnaissance Office (NRO).
- Received from Blue Origin the first BE-4 pathfinder engine which will be used for testing by ULA.

Major contracts

- Signed a $337 million contract with the U.S. Air Force for the NSSL Phase 2 procurement.
- Selected by SES to launch two replacement satellites in 2022 to accelerate the company´s C-band clearing plan to meet FCC objectives.

Viasat

Country

United States

Core activity

Downstream - Satellite Operator

Employees

5000 – 10 000

Corporate developments

- Appointed Krishna Nathan as Chief Information Officer .
- Acquired Eutelsat Euro Broadband Infrastructure (EBI) share of 51%, including Eutelsat's KA-SAT satellite platform, the related ground infrastructure and the wholesale business for a total amount of €140 million.
- Acquired RigNet for approx. $222 million.

Major announcements and achievements

- Received Supplemental Type Certificate from FAA for its Ka-band business aviation in-flight connectivity (IFC) system on the Gulfstream G650 and Gulfstream G650ER business jets.
- Announced the expansion of its internet service to 14 additional states in Brazil, now offering service to more than 93% of the country's population.
- Integrated Azure Orbital with its ground service solution, Viasat Real-Time Earth (RTE), to enable Microsoft Azure customers to have access.
- Qualified to bid for a share of $20.4 billion made available by the FCC under the Rural Digital Opportunity Fund (RDOF).

Major contracts

- Signed a contract worth a maximum of $90 million with U.S. Air Force to expand capabilities through Viasat's BATS-D Device.
- Viasat UK, a subsidiary of Viasat, was awarded a contract to provide Ultra High Frequency (UHF) satellite communications for the Royal Navy's Type 31 vessels.

Partnerships

- Expanded its partnership with Visiontec to bring reliable internet service to residential homes across Brazil.
- Formed a partnership with Honeywell to add Viasat's VR-12T shipset to Honeywell's Maintenance Service Plan (MSP).
- Formed a partnership with Infostellar for Real-Time Earth ground station network.

3 Economy & Business

3.1 Global Space Economy

3.1.1 Overview and main indicators

Each year, the Satellite Industry Association (SIA), the trade association of the American satellite industry, and the Space Foundation, an American not-for-profit organisation advocating for the sector, release reports that detail the breakdown of the global space economy.

In 2019, SIA estimated the global space economy to be worth $366 billion,[607] whereas the Space Foundation estimated it in the order of $424 billion.[608]

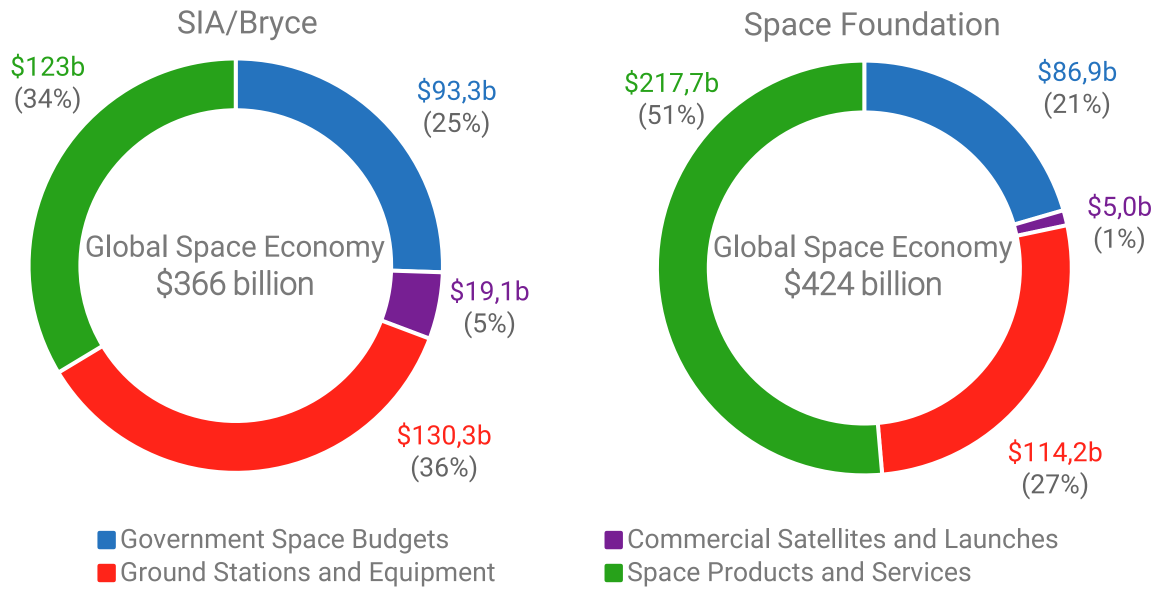


Figure 9: Global space economy estimations by SIA/Bryce (left) and the Space Foundation (right)

These two estimations can be broken down into four major segments:

- Government space budgets correspond to the economic activity directly related to government spending. It covers in particular public space programmes and other activities of governmental space organisations (i.e., space agencies, development agencies, military organisations and bodies, etc.).
- Commercial satellites and launches correspond to the economic activity of satellite manufacturers and launch service providers outside public markets (i.e. commercial space). It covers in particular the provision of commercial satellites and launch services to private operators.
- Ground stations and equipment correspond to the economic activity related to the ground segment of space infrastructures including ground stations, teleports, networks and user equipment.
- Space products and services correspond to the economic activity of companies selling space-enabled products and services such as Direct-to-Home services or satellite imagery products. This part of the space economy is usually referred to as downstream and is the most complex to delineate.

[607] Satellite Industry Association, "2020 State of the Satellite Industry Report (prepared by Bryce Space and Technology). Summary", (2020), :https://sia.org/news-resources/state-of-the-satellite-industry-report/.
[608] Space Foundation, "The Space Report 2020 (Q2 and Q3)", (2020)

The following table provides a more detailed overview of global space economy estimations by SIA/Bryce and the Space Foundation, for each segment:

Global Space Economy	SIA/Bryce			Space Foundation		
	$366 billion			$424 billion		
Government Space Budgets	$93.5B	U.S. budget	$57.9B	$86.9B	U.S. budget	$47.2B
		Non-U.S. budget	$35.6B		Non-U.S. budget	$39.7B
Commercial Satellites and Launches	$19.1B	Satellites	$12.5B	$5.0B	Satellites	$3.8B
		Launches	$4.9B		Launches	$1.2B
		Human Spaceflight	$1.7B		Human Spaceflight	$0.0B
Ground Stations and Equipment	$130.3B	GNSS[1]	$97.4B	$112.4B	GNSS	$78.4B
		Others[2]	$32.9B		Others	$34B
Space Products and Services	$123.0B	Television	$92.0B	$217.7B	Television	$91.5B
		Communications[3]	$22.5B		Communications	$23.7B
		Remote Sensing	$2.3B		Remote Sensing	$3.6B
		Satellite Radio	$6.2B		Satellite Radio	$7.8B
		PNT[4]	$0.0B		PNT	$91.1B
Others	-	-	-	$1.7B	Insurance Premiums	$0.5B
					SSA	$1.2B

1 Includes GNSS chipsets and navigation devices
2 includes network stations and user equipment such as satellite TV dishes or satellite mobile phones
3 includes Fixed Satellite Services (FSS), Mobile Satellite Services (MSS) and Broadband services
4 Positioning, Navigation and Timing services, enabled by GNSS and augmentation system

Table 13: Detailed comparison of space economy estimations by the SIA/Bryce and the Space Foundation

The two reports estimate the global space economy by recording government space budgets as well as space-related commercial revenues, but methodological differences lead to some significant discrepancies in the estimation of the various segments and of the total space economy value.

The two reports broadly agree on the size of government space budgets, with SIA reporting $93.5 billion and the Space Foundation reporting $86.9 billion, a difference of $6.6 billion, or less than 8%. However, the SIA estimate the U.S. government budget to be over $10 billion larger than the Space Foundation estimate. At the same time, it estimates the non-U.S. budget to be $4.1 billion lower than the Space Foundation, offsetting the difference and resulting in comparable estimates for the total.

On the other hand, **the reports adopt different approaches to assess the size of the commercial satellite and launch markets, which leads to significantly different estimations for this segment**. As a result of this divergence, SIA estimates $19.1 billion in revenues for commercial satellite manufacturing, launches, and Human spaceflight, whereas the Space Foundation estimates that the revenues stemming from this segment are in the order of $5 billion. One notable example of their dissimilar approach can be seen in the estimation of the value of the Human spaceflight segment. The SIA includes a revenue of $2 billion which probably corresponds to the value of crew and cargo transportation services to the ISS provided by SpaceX and other U.S. companies. The Space Foundation on the other hand does not include any revenue since it defines commercial Human spaceflight as suborbital flight services, such as those soon to be offered by Virgin Galactic and Blue Origin.

In the ground stations and equipment segment, the SIA and Space Foundation estimate the revenues from network stations and user equipment (included in the other category) between $32.9 and $35.2 billion. However, their estimations of the revenue from GNSS chipsets and navigation devices differ substantially, with the SIA estimating $97.4 billion of revenues and the Space Foundation estimating them around $78.4 billion, a difference of $19.0 billion. In 2018, the SIA had estimated revenue from GNSS chipsets and navigation devices to be almost $30 billion higher than the estimation of the Space Foundation, so the difference between the two estimates was actually reduced. Overall, the total estimation of the ground stations and equipment segments represents $130.3 and $113.6 billion for the SIA and the Space Foundation respectively, thus representing a reduction compared to the data collected in for 2018 with GNSS still being the main factor explaining the difference.

Space products and services represents the overall valuation of the applications enabled by space systems, typically known as the 'downstream' segment, and corresponds to the largest segment of the space economy representing 34% and 51% of the total according to the SIA and the Space Foundation respectively. The largest portion of this is direct-to-home television, which is estimated at just over $90 billion by both reports (the Space Foundation uses the SIA as its primary source here). However, the SIA does not include positioning, navigation and timing (PNT) services enabled by GNSS, whereas the Space Foundation lists this as worth $91.5 billion, similar in size to satellite television. Other categories in this segment include satellite communications, valued at over $20 billion by both reports, remote sensing ($2.3 billion and $3.6 billion by SIA and Space Foundation respectively), and satellite radio ($6.2 billion and $7.8 billion).

Furthermore, the Space Foundation also includes the value of insurance premiums at $0.5 billion, using data from AXA XL, an insurer. A new segment for 2020 is Space Situational Awareness (SSA), which the Space Foundation estimates at $1.2 billion using data from Markets and Markets.

According to the SIA and Space Foundation, the global space economy year-on-year growth stood between 1.7% and 2.2% in 2018-2019. This is significantly lower than in 2017-2018 (between 3.4% - 8.1%).

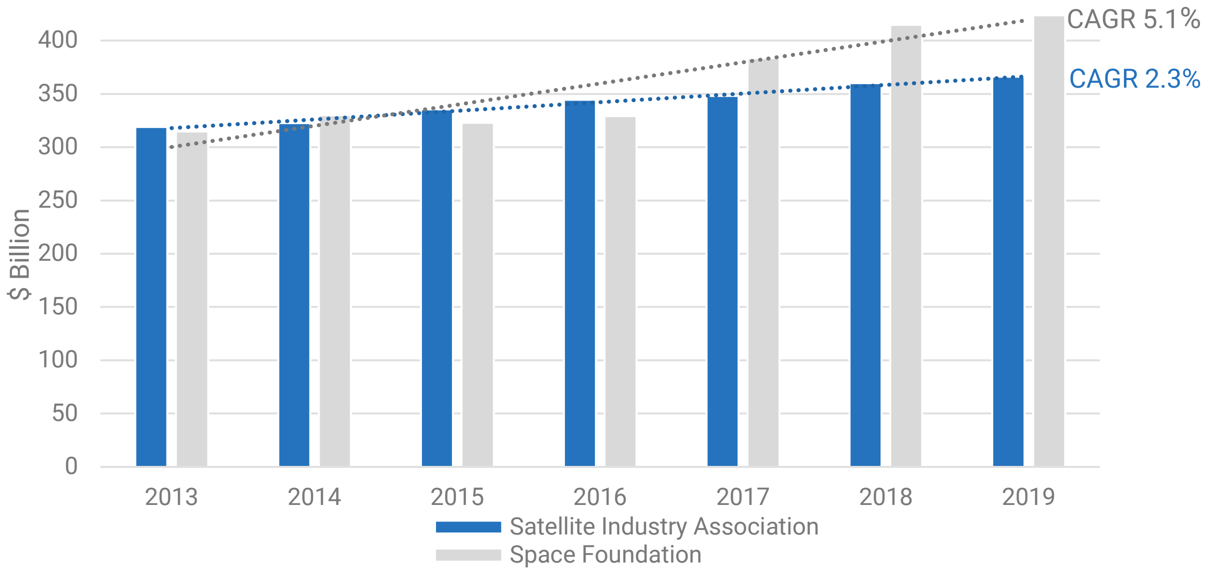


Figure 10: Global space economy evolution (Source: SIA, Space Foundation, ESPI)

Whilst the SIA and Space Foundation had broadly similar figures from 2013 to 2016, the Space Foundation started including PNT services for the first time in 2017, boosting the global economy value by $85 billion and widening the gap with SIA estimation. This also results in a difference in the compound annual growth rate (CAGR) from 2013 to 2019 - with 5.1% for the Space Foundation but only 2.3% for the SIA.

Assessing the space economy: limits and pitfalls

Several organizations have forecasted that the space economy could be worth up to $1 trillion by 2040. While discussions about a trillion-dollar space economy can attract a lot of positive attention on the sector, the spotlight put on space economics raises questions about the methodologies used to estimate the size and growth of the space economy.

Perimeter of the space economy: where does the space economy start, where does it end?

By definition, the value of the space economy corresponds to the value of all final goods and services produced by the space sector. While the inclusion of the value of satellites and launch services in the space economy is straightforward, setting the limits of the space economy becomes increasingly difficult going down the space value chain and reaching "space-related" or "space-enabled" goods and services (e.g. navigation services, data analytics, TV broadcast contents). Definitions of the space economy perimeter vary greatly, and methodologies applied to estimate the economic value of downstream products may be contested. Yet, this peripheral part of the space economy accounts for a large share of the overall value as currently estimated.

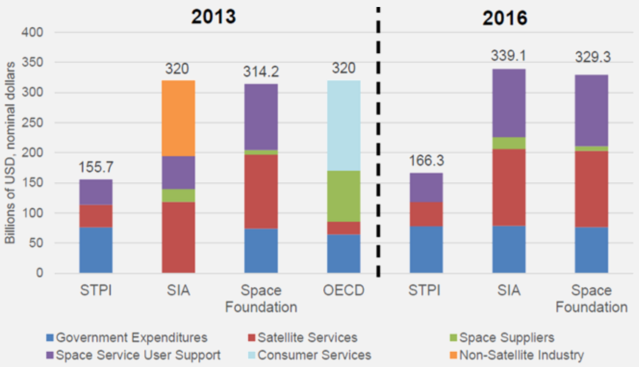
Measuring the space economy: budgets, revenues, gross value added… what is measured and how?

The measurement of the economic value of the goods and services produced by the space sector is another major challenge. Space economy assessments use a mix of data to estimate the value of space goods and services including public budgets and expenditures, company revenues, price estimates and other indicators to assess the value of "space-enabled" goods and services. Methodologies are rarely disclosed which does not allow to verify their soundness and validity. An issue often underlined is the risk of double-counting (i.e. counting both expenditures to buy goods and services and revenues from selling those goods and services) which can lead to an overestimation of the size of the space economy.

Macro-economic conditions: how to consider inflation or exchange rates?

The estimation of the global space economy over time also raises issues to account for macro-economic factors such as inflation or exchange rates fluctuation. Available estimations are provided in current prices (i.e. not corrected for changes in prices) which creates a bias in the perception of the space economy growth. Estimations are provided in US Dollars which also creates a bias related to the fluctuation of currency exchange rates over time. A direct conversion into US Dollars does not allow either to account for the major differences in purchasing power between different countries.

A study by the Science and Technology Policy Institute (STPI) addressed some of these pitfalls and found that existing estimations may be overestimating the size of the economy by twice their measured amount. This significant variation highlights the increasing need to elaborate a consistent estimate for space economy indicators as initiated recently by the U.S. Bureau of Economic Analysis.



STPI Measuring the Space Economy: Estimating the Value of Economic Activities in and for Space

3.1.2 Commercial satellites and launches

The market for commercial satellites and launches was worth $19.1 billion according to the SIA and $5.0 billion according to the Space Foundation; almost four times smaller. The discrepancy is primarily due to different definitions of "commercial" satellite manufacturing and "commercial" launch. Furthermore, the SIA includes flights to the International Space Station (ISS) as commercial human spaceflight, accounting for $1.7 billion or 9% of its total figure, whereas the Space Foundation does not include it.

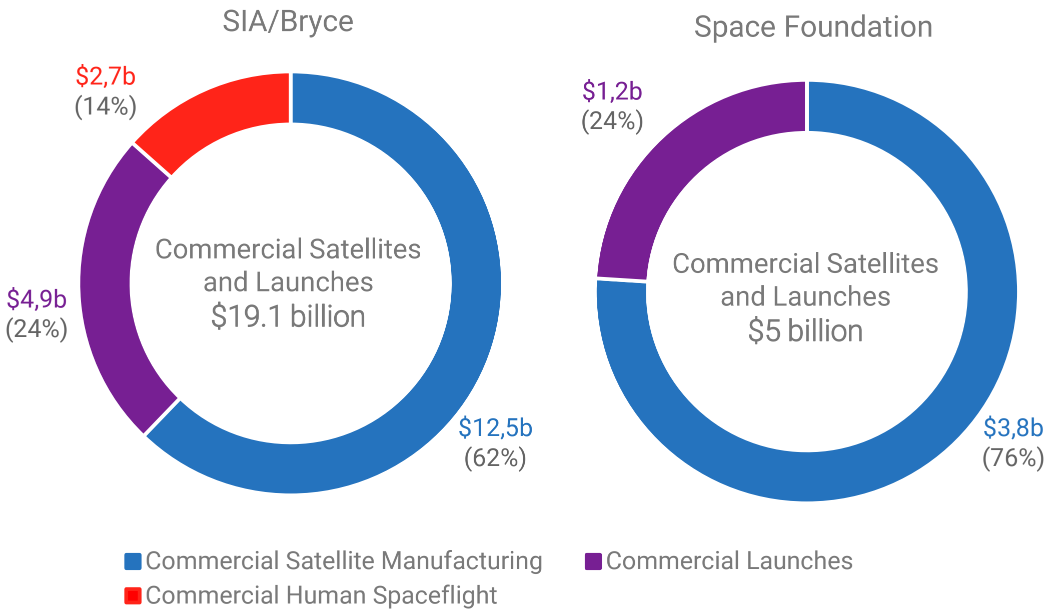


Figure 11 : Commercial satellite and launch industry revenues (Source: SIA, Space Foundation)

Revenues from commercial satellite manufacturing and launches have seen a reduction in 2019 compared to 2018 in both analyses. The SIA reports a reduction of over 30%, from $27.5 billion to $19.1 billion, and the Space Foundation reports a drop of 26%, from $6.8 billion to $5 billion. The reduction in revenue represents a continued trend in the Space Foundation's estimation with 2019 being the third consecutive year of decline in revenues in this segment, whereas the drop in the SIA's estimations represents a return to pre-2018 levels.

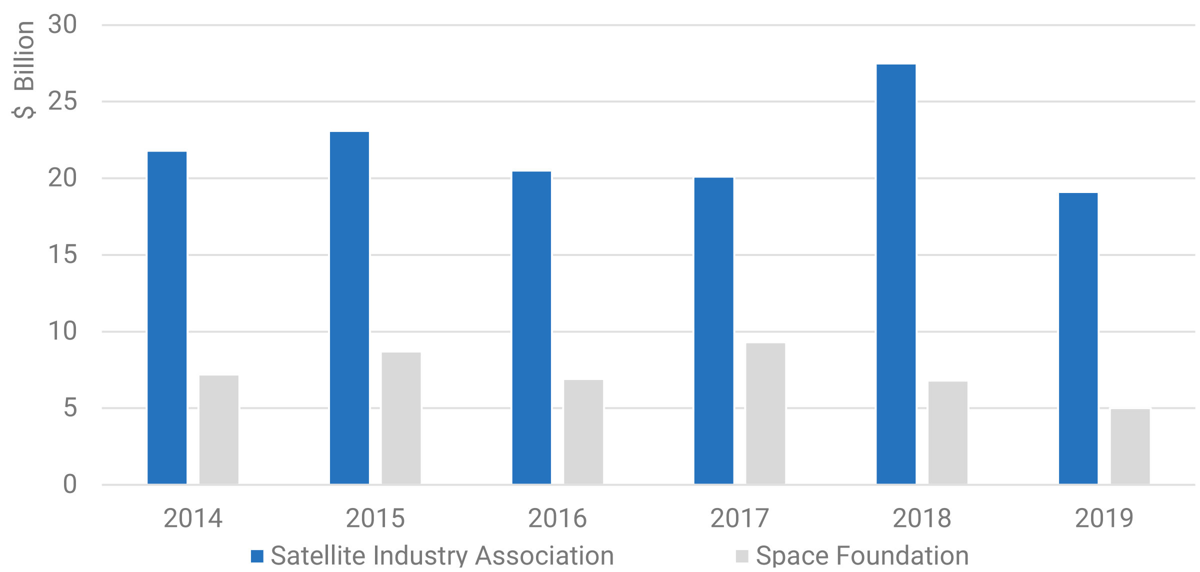


Figure 12: Commercial satellite and launch industry revenue evolution (Source: SIA, Space Foundation)

Commercial launches

To estimate the economic activity related to commercial launches, both SIA and the Space Foundation rely on a market valuation of launches operated during the year that they qualify as “commercial”.

In 2019, ESPI recorded 102 launches, including seven failures or partial failures. The SIA and the Space Foundation differ in their methodology for counting commercial launches.

- The SIA considers that 78 of 102 launches were “commercial”, with an estimation of the total value of these launches at $4.9 billion.
- The Space Foundation considers that 27 out of 97 launches were “commercial”, with an estimation of the total value of these launches at $1.2 billion. The divergence in number of total launches stems from the Space Foundation only considering the number of successful launches.

The Space Foundation defines commercial launches as launches carried out for non-government customers, representing 27.1% of successful launches. The economic value of launches for government customers should be covered by the government space budget segment according to Space Foundation’s methodology. The Space Foundation estimates the value of governmental launches in the order of $5.7 billion.

On the other hand, the SIA seems to define “commercial launches” as those involving a financial transaction, including for governmental payloads possibly. This corresponds to 76.5% of 102 launches in 2019. Just over one third (35%) of this revenue was captured by U.S. industry.

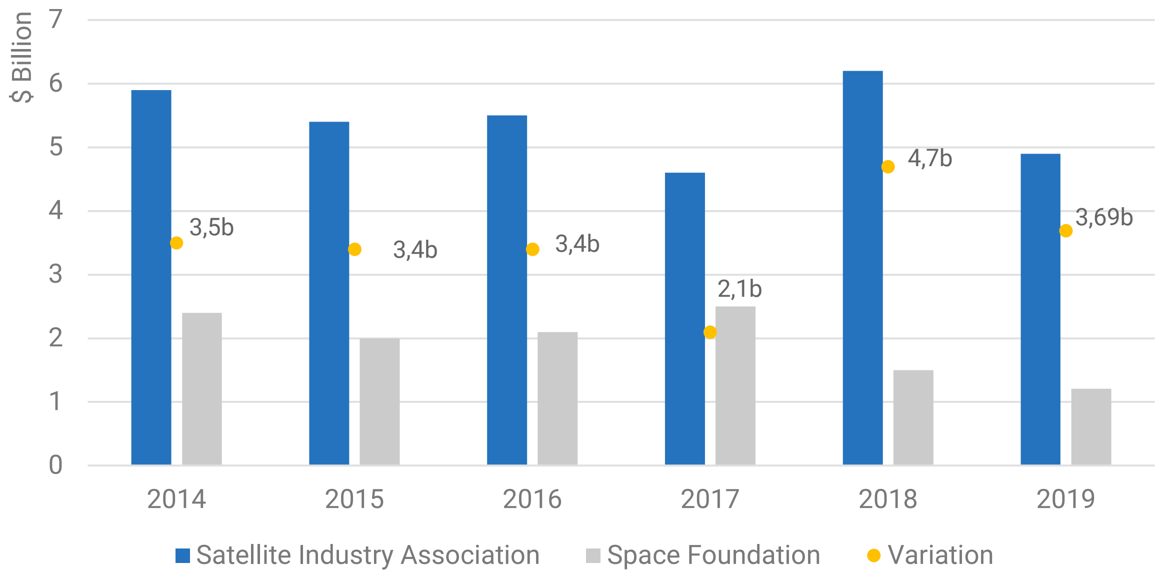


Figure 13: Commercial launch revenues evolution (Source: SIA, Space Foundation)

The difference in estimations between SIA and the Space foundation has been stable in the last few years, with an average variation of approx. $3.4 billion. The largest difference was in 2018 with a divergence in estimation of $4.7 billion, while the lowest difference was measure in 2017 with only $2.1 billion between the two estimates. Overall, both the data collected by the SIA and the Space Foundation remains consistent within the measured period, with a standard deviation of $0.59 billion and $0.50 billion respectively. The highest revenues from commercial launches were measured in 2018 for the SIA at $6.2 billion, with the 2017 having the lowest at $4.6 billion. On the other hand, the Space Foundation estimates that the higher commercial launch revenues were in 2017 at $2.5 billion, with revenues in 2018 being the lowest at $1.5 billion.

Commercial Satellite manufacturing

According to SIA, revenues of the commercial spacecraft manufacturing industry were down to $12.5 billion in 2019. This represents a decline of 36% compared to 2018 when revenues were estimated to be worth $19.5 billion. On the other hand, the Space Foundation estimated the commercial spacecraft manufacturing industry to be worth $3.8 billion in 2019 which represents a 28% decrease compared to the $5.3 billion revenues recorded in 2018.

Here again, SIA and the Space Foundation's estimations of the global economic activity related to commercial satellite manufacturing seem to rely on a valuation of "commercial satellites" launched during the year, with different definitions of what is considered a "commercial satellite".

In 2019, ESPI recorded a total of 489 spacecraft put in orbit, including 274 commercial spacecraft (i.e. spacecraft primarily intended to serve a commercial market and to make profit). SIA estimated that 386 of satellites launched over the year were commercial. Out of these 386 commercial satellites, 27% were used for remote sensing and 45% for telecommunication.

The Space Foundation, on the other hand, considered that only 255 spacecraft put in orbit in 2019 were commercial, corresponding to 55% of the 466 total spacecraft recorded by the Space Foundation. The Space Foundation estimates that commercial spacecraft manufacturing accounts for less than 10% of the overall spacecraft manufacturing economic activity.

These discrepancies lead to a $8.7 billion gap between the two estimations.

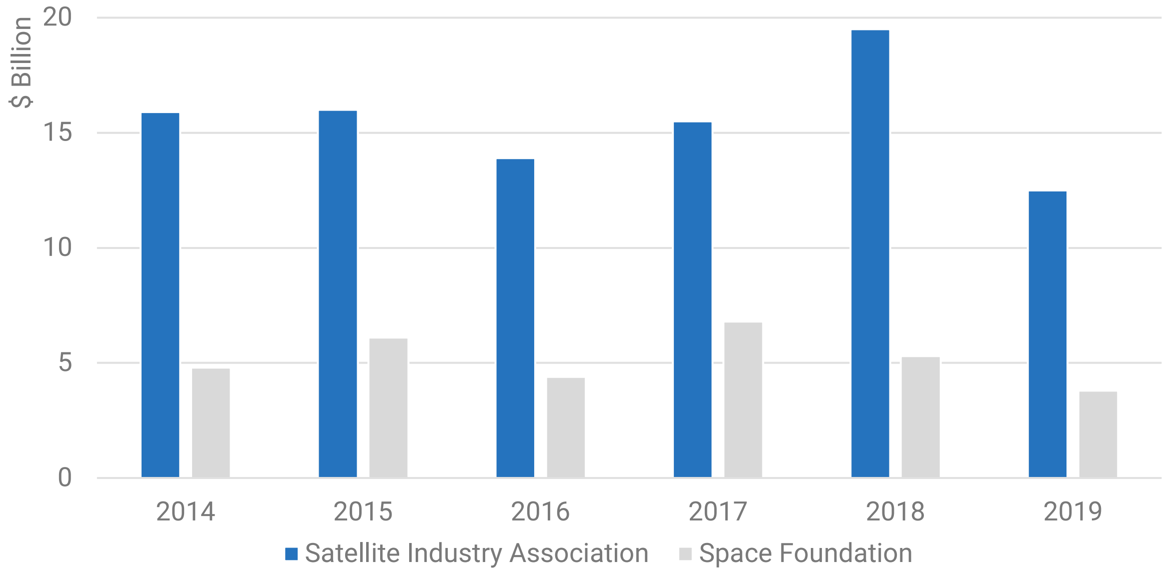


Figure 14: Commercial satellite manufacturing revenues evolution (Source: SIA, Space Foundation)

3.1.3 Ground stations and equipment

The SIA and the Space Foundation estimate the total value of ground stations and equipment revenue in 2019 to be $130.3 billion and $112.5 billion respectively. The main difference between these two estimations is related to the value of GNSS chipsets, with a difference of $17.5 billion.

In this segment, $78.4 billion, or 70.0% of the $112.5 billion reported by the Space Foundation, correspond to revenues from navigation chipsets and software. The SIA reports a similar proportion, at 61.0% of $130 billion total revenues. The rest of the segment includes network stations and user equipment such as satellite TV dishes or satellite mobile phones. These are estimated at $32.8 billion by the SIA and $35.2 billion by the Space Foundation.

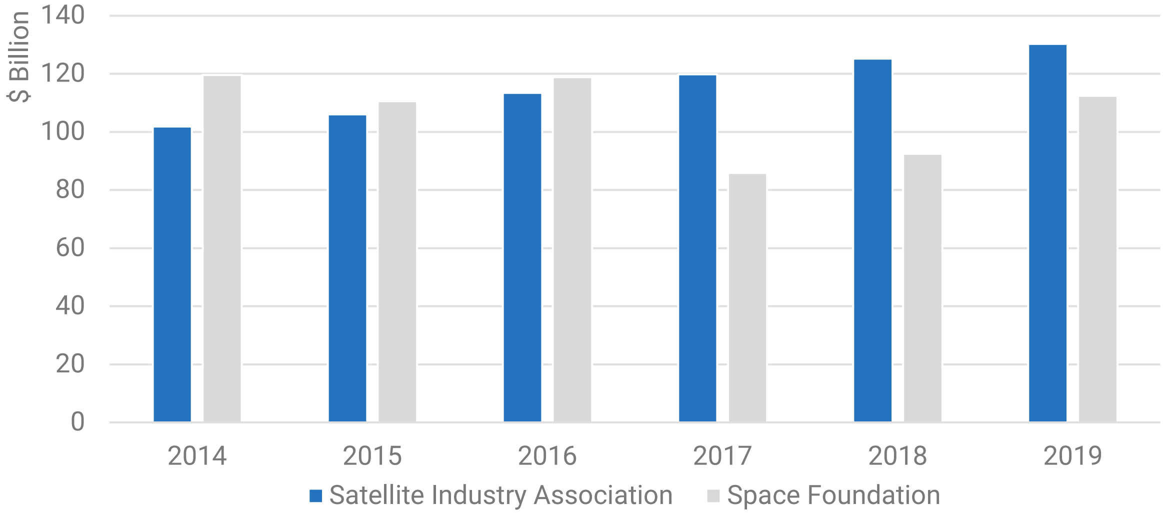


Figure 15: Ground stations and equipment revenues evolution (Source: SIA, Space Foundation)

The SIA data show a continuous growth with a year-on-year increase from 2018 to 2019 of 4%. The Space Foundation data show a large drop between 2016 and 2017. However, after this the segment continues to grow, with a large year on year increase of 22% between 2018 and 2019.

3.1.4 Space products and services

The segment of space products and services, corresponding roughly to the downstream sector, comprises the sales of a variety of space-based solutions to end-users including governments, businesses and individuals. Categories of space products and services include:

- Television: TV broadcast and Direct-to-Home services
- Communications: Services ranging from texting and telephony to broadband internet.
- Remote Sensing: Wide variety of solutions enabled by optical and radar satellite imagery, from sales of raw data to turnkey analytics services.
- Satellite Radio: Radio services via satellites, usually for personal vehicles (mainly XM Sirius revenues).
- PNT value-added services: Wide variety of solutions enabled by GNSS signals (not included by the SIA in their assessment).

The space products and services segment are estimated to be $123.0 billion by the SIA and $217.7 billion by the Space Foundation. This large discrepancy is due to the inclusion of PNT services by the Space Foundation, which account for nearly half of the segment. Estimations for other space products and services are very similar between the two sources with direct-to-home television taking up the largest portion, $92.0 billion for SIA and $91.5 for the Space Foundation.

The PNT value-added services category includes in-vehicle navigation systems, fleet management services, and revenues from smartphone applications that use location-based services. The Space Foundation estimated this economic activity to be worth $91.1 billion in 2019.

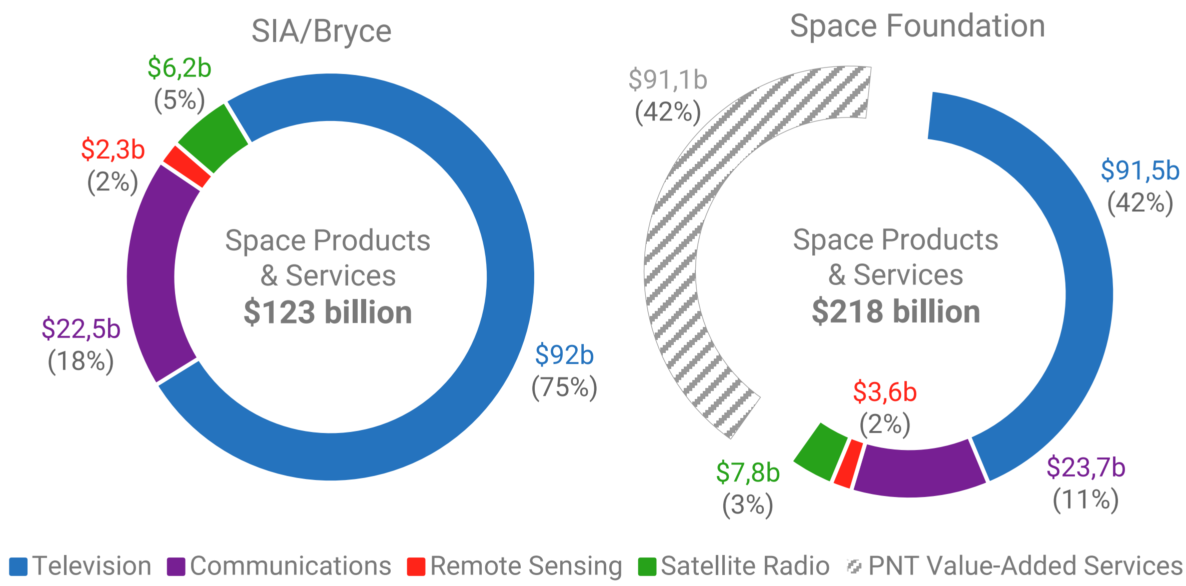


Figure 16: Commercial space products and services revenues (Source: SIA, Space Foundation)

For the SIA, revenues from space products and services segment decreased in 2019 compared to 2018, from $127 billion to $123 billion. The Space Foundation's estimate, on the other hand continued its year per year increase, going from a revenue of $214.2 billion in 2018 to $218 billion in 2019. It is important to note here that the data collected by the Space Foundation for 2018 was significantly revised in the last year, going from an estimated $229 billion in revenues from this segment to the current figure of $214.18 billion.

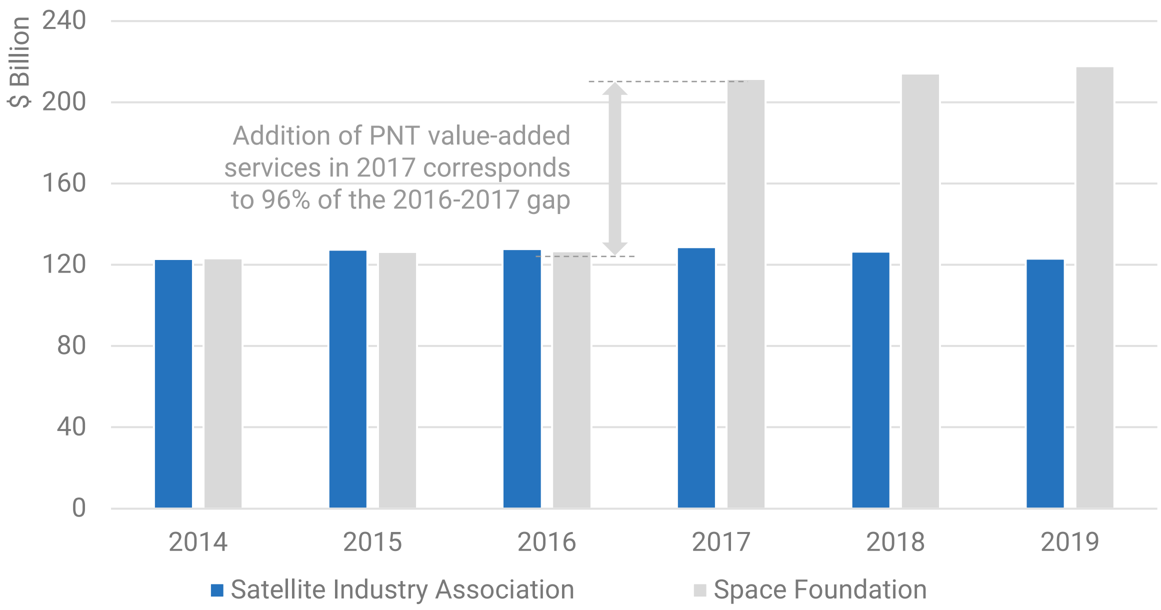


Figure 17: Commercial space products and services evolution (Source: SIA, Space Foundation, ESPI)

The Space Foundation saw an 1.7% increase compared to 2018 while SIA estimated that revenues decreased by approx. 3.3%. A general analysis shows that the estimates for the market size comparison in the period going from 2014 and 2017 were very similar between the SIA and the Space Foundation. However, the decision by the Space Foundation to also include revenues stemming from PNT activities in their perimeter of analysis in 2017 has led to a growing divergence in estimates with the SIA.

The total revenues estimated by the Space Foundation for this sector jumped by almost $85 billion between 2017 and 2018 due to the PNT activities. PNT activities are also the main drivers behind the increase in revenues from 2018 to 2019 according to the Space Foundation, with an increase in revenues stemming from these activities estimated at approx.5.3%. Based on data form the GSA, the Space Foundation expects the PNT value added services segment to grow significantly over the next 10 years.

3.1.5 Insurance sector

Space insurance landscape

Space activities involve inherently risky operations and the insurance sector provides space actors with solutions to help mitigate financial setbacks that can arise from activities undertaken in the phases ranging from pre-launch to in-orbit operations. Insurers usually compete on coverage terms, capacity and most often on premium prices. While they are typically packaged together in most insurance solutions, there is a distinction between property insurance (first party) and liability insurance (third party). While the property insurance insures against the failure of a satellite during launch or operation and will typically cover the cost of the satellite, the liability insurance of a satellite insures against damage caused to a third-party by the launch or satellite operator.

First party liability covers the riskiest phase of the satellite's life cycle, with 34% of GEO satellite losses since 2000 occurring during launch,[609] and usually represents the third-largest expenditure of commercial satellite ventures after launch and manufacturing. The liability insurance, on the other hand, may be mandatory in some countries for the obtention of a license having drafted national legislations to this end.[610]

There are currently approximately 30 insurers operating in the space industry across the world.[611] In 2019, around 50% launches worldwide had undertaken property insurance,[612] with only 30% of commercial satellites insured and institutional satellites rarely being insured for first party liability. Overall, GEO satellites are more often insured, with 45% of GEO satellites holding insurance in 2019. In contrast, the number of LEO satellites having been insured is just 3%.[613] This is in line with recent trends in the sector, as only approx. 2% of non-geostationary satellites have carried insurance on orbit since 2017.[614]

The decision to insure a spacecraft is often taken in relation to the overall costs and risks associated with the mission. The price of insurance premiums for a single satellite, launch vehicle or spacecraft may vary depending on its size, cost, and the type of mission it will carry. GEO satellites thus often incur higher premium prices, as they are in many cases the most expensive private commercial satellites to produce, assemble and launch. The high costs associated with these types of satellites throughout their development stage and operational lifespan is typically the main reason driving customers and operators to be more risk-averse than with other types of satellites such as those in LEO and CubeSats.

Therefore, whereas a large telecommunications satellite operator may choose a more comprehensive insurance to cover the risk of loss of their investment, operators of smaller satellites may seek more basic insurance packages to reduce costs.

Operators of satellite constellations such a SpaceX with Starlink therefore tend to be less risk averse and launch and operate their constellations without property insurance, basing their risk reduction strategy on the launch of more satellites than needed. These operators are likely to view the entire constellation as the asset rather than a single satellite.[615]

[609] AXA XL, "Space Insurance Update", (2019): https://iuai.org/IUAI/Study_Groups/Space_Risks/Public/Study_Groups/Space_Risk.aspx.
[610] Mathieu Luinaud, Virgile Salmon, " Third Party Liability and Insurance Innovation in the Smallsat Era", (December 2020):
[611] Space Foundation, "The Space Report 2020 (Q3)", (October 2020)
[612] *Ibid.*
[613] *Ibid.*
[614] Space Intel Report, "Space insurers book 3rd straight money-losing year. Market volatility may mean 100% premium hike in 2019 is not enough", (December 2020)
[615] Space Intel Report, "Space insurance premiums rose by 2x-3x in late 2019 and the increase is holding — so far", (March 2020)

2020 underlines a steady increase in claims

In recent years a number of factors have put pressure on the space insurance business. One of these factors is that claims have outsized premiums in the past three years. 2018 saw five major failures, resulting in estimated claims of over $515 million. In 2019, two high profile failures resulted in claims of over $800 million against premiums of $502 million. The consecutive years of losses have resulted in underwriters raising the price of premiums in 2019 and 2020, which has brought prices to early 2010s levels but still not as high as those in the early 2000s.[616] The year 2020 therefore marked the third consecutive year of losses for insurance companies as claims ($500.3 million) again outsized premiums ($460.5 million).

2018	Reported claims	Cause
WorldView-4	$183 million	In-orbit failure
Angosat-1	$121 million	In-orbit failure
Al Yah 3	$115 million	Partial launch failure
Soyuz MS-10	$71 million	Launch failure
Turksat-4b	$25 to $60 million	Partial launch failure
2019	**Reported claims**	**Cause**
Falcon Eye-1	$415 million	Launch failure
ChinaSat-18	$250 million	Post-launch anomaly
Eutelsat 5 West B	$192 million	Partial failure
2020	**Reported claims**	**Cause**
Thaicom 5	$26 million	On-orbit anomaly
Express AM-6	$39 million	Payload failure
Palapa-N1	$252 million	Launch failure

Table 14: Major insurance claims in the space sector 2018-2020 (Various sources)

There have been three notable insured failures in 2020, and with the occurrence of high profile failures such as that of the Sirius-XM-7 GEO satellite in January 2021 and the Vega failure in 2020 (although in this case the satellites on board were not insured), underwriters have led to believe that there would be a continued increase in the price of premiums in the next years in order to compensate for the higher estimated risks of space activities as well as for the recent years of losses attributed to the steady fall of premiums prices.[617]

The three years of consecutive losses can thus be attributed to a mix of factors. With the space insurance sector only failing to make yearly profits 6 times so far, a series of new underwriters entered the market seeking profit and steadily driving down the price of premiums. In addition to this phenomenon, recent years have seen a reduction in the number of geostationary satellites insured as well as a decrease in launch prices[618] and a higher risk of collision due to the higher the multiplication of satellite constellations

[616]SpaceNews, "Space insurers hoping to break even after recent losses", (November 2020)
[617] Space Intel Report, "Space insurers book 3rd straight money-losing year. Market volatility may mean 100% premium hike in 2019 is not enough", (December 2020)
[618] Space Intel Report, "Space insurance premiums rose by 2x-3x in late 2019 and the increase is holding — so far", (March 2020)

and debris in LEO. These factors have led some companies such as Swiss Re (which represented 5% of the market capacity in the space insurance industry)[619] and American International Group (AIG) to exit the market or limit their exposure.[620]

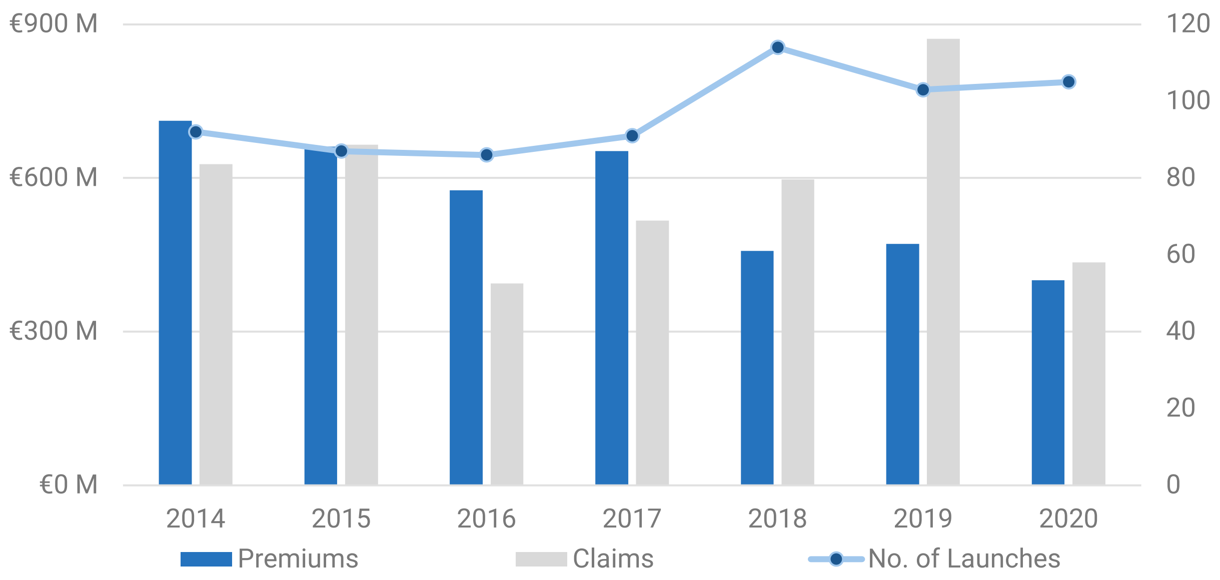


Figure 18: Insurance premiums and claims 2014-2020 (Seradata, AXA XL, ESPI)

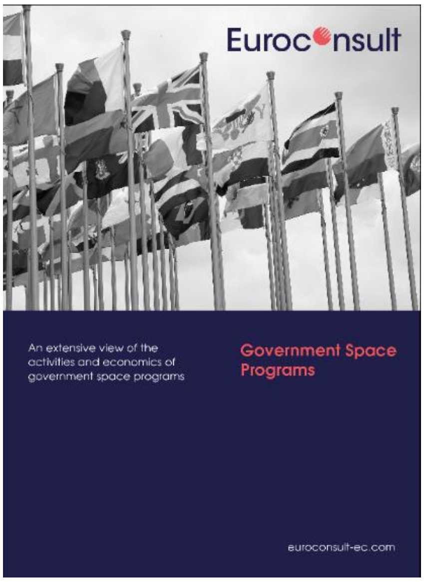
While the increase in insurance premiums can be seen as a way for underwriters to return to profitability, the potential uptake of commercial space represents both new opportunities and risks for the insurance market, with members of the industry calling for space insurance to find a new level of flexibility and innovation in their services in order to provide affordable insurance to the space sector to deal with the new challenges posed by the space economy.[621]

[619] Seradata, "Swiss Re pulls out of space insurance causing shock across the market", (August 2019)
[620] Insurance Insider, "AIG withdraws from loss-hit space insurance market", (November 2020)
[621] Insurance Business, "The new space race", (January 2021)

3.2 Institutional Space Budgets

The following section makes use of Euroconsult data for national space budgets with their permission.

Data are extracted from the Euroconsult Government Space Programs report which provides a comprehensive assessment of 87 countries with a detailed analysis of their space programs and space budgets. Various sources of information are collected by Euroconsult on government space programs and budgets from government agencies' primary information, public sources, and estimates. This information is harmonized and processed to form a coherent set of data.



The report provides an in-depth profile for each country, including:

- Country factsheet: high-level key figures on that country's space program, including top 3 applications, high-profile space missions, total space budget, world ranking, space spending per capita, 5-year CAGR, etc
- Analysis of government space strategy and space policy documents, including key stakeholders
- Assessment of government budgets, split by application, civil/defense, and 10-year historical data and 10-year forecast
- Breakdown and analysis of government space program by application (satcom, satnav, EO, exploration, etc.)
- Roadmap of all satellites and space missions launched by that country (10-year historical and 10-year forecast)

Euroconsult complete report is available here.

3.2.1 Global overview and evolution

As of 2019, at least 88 countries have invested in space programmes. Of these, 14 have a launch capacity and 10 have a space programme with a budget of over $1 billion per year: USA, China, Russia, India, Japan, France, Italy and the United Kingdom. Three new space agencies were founded in 2019 including Portugal Space, the Philippine Space Agency and the Hellenic Space Centre (Greece), with the El Salvador Aerospace Institute and the Latin America and Caribbean Space Agency founded in 2020. This trend underpins that an increasing number of countries are raising their level of ambitions in the space sector.

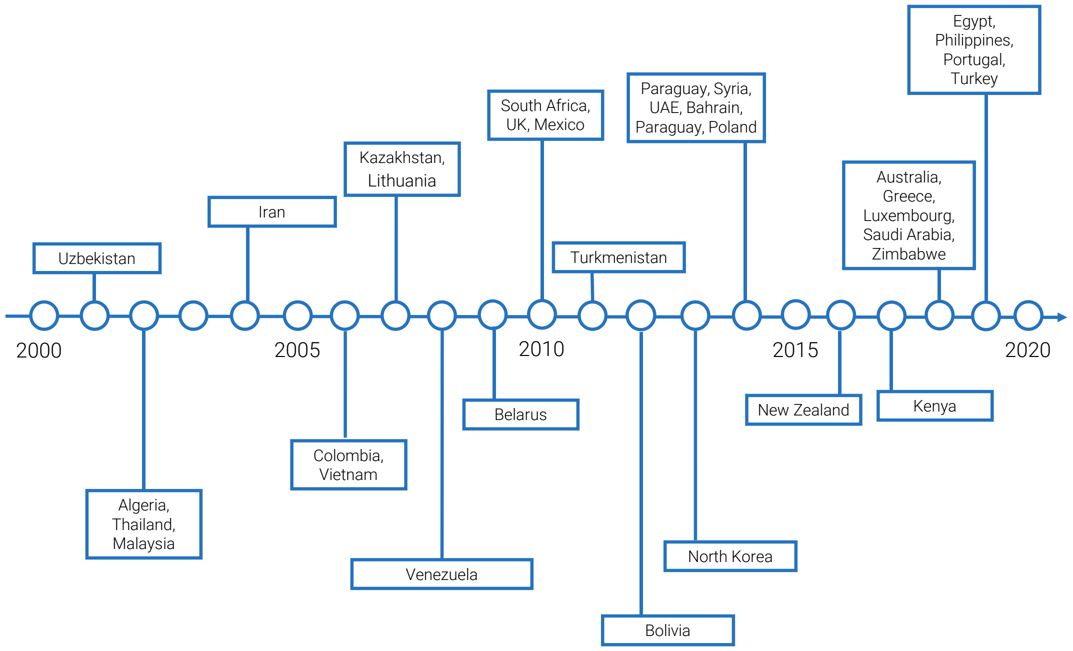


Figure 19: Creation of space agencies since 2000 (ESPI database)

The total institutional budget for space programmes in 2019, including intergovernmental organisations, is estimated to be $93.5 billion by the SIA/Bryce, $86.9 billion by the Space Foundation, and $74.8 billion by Euroconsult. The variation between estimates in institutional budgets is notable, mainly due to the difference in the definition and the perimeter selected in the scope of each study. In terms of year-on-year evolution, while the Space Foundation records an increase of only $1 billion (1.2%) in 2019, Bryce reported an increase of $12.8 billion (16%). Euroconsult reports an increase of $4 billion (5.6%).

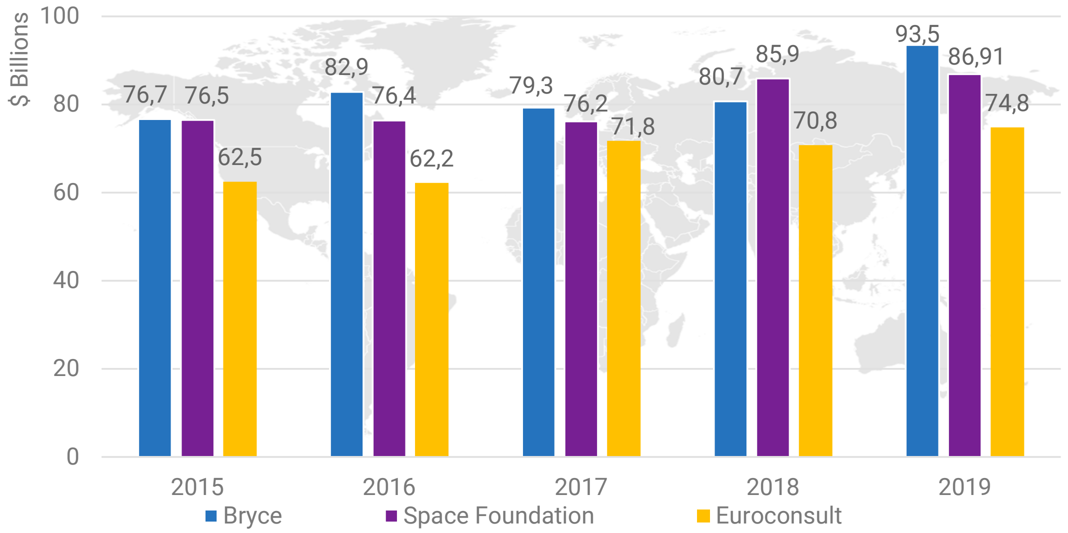


Figure 20: Global institutional space budget evolution (Source: SIA, Space Foundation, Euroconsult)

While the global government budget remained relatively steady over the past 5 years, a recent study by Euroconsult has forecasted that the global institutional spending in space could increase by almost 20% over the next 5 years as a result of renewed exploratory space programs (Artemis, Lunar Gateway).[622]

It is important to note that institutional budgets provide an incomplete perspective on governments' investment in the space sector and cannot be directly compared. The influence of currency exchange rates and purchase power differences should not be overlooked. Governments may also invest in the space sector through classified military spending or programmes in adjacent sectors.

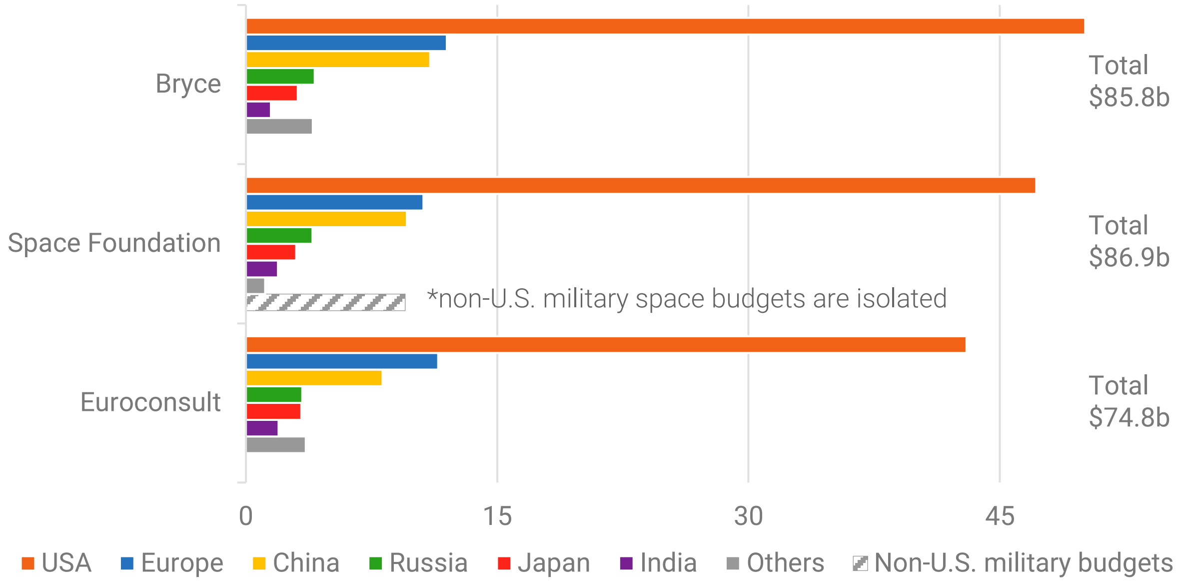


Figure 21: Institutional space budgets in 2019 (Source: SIA, Space Foundation, Euroconsult)

Overall, the similarity between the SIA/Bryce and the Space Foundation estimates is noteworthy, with the Space Foundation's being only $1.1 billion higher. In contrast, Euroconsult estimates institutional space budgets to be much lower, with their figures having a difference of over $10 billion compared to both SIA's and the Space Foundation's. In addition, Euroconsult also diverges in its estimation of Japan and Russia's institutional budgets, considering them to be on a similar scale with Russia's being only slightly larger. This divergence with the Space Foundation is also visible in its estimation of institutional budgets for the rest of the world, labelled in "others", which is significantly higher and similar to that of the SIA.

With regards to the world military space budget, the Space Foundation indicates a decrease from $34.1 billion to $32.6 billion between 2018 and 2019. At the same time, the world civil budget increased by 5.0% from $51.8 billion to $54.4 billion. Euroconsult have slightly lower figures, with a 2019 world military budget of $28.3 billion and a civil budget of $46.5 billion.

Another interesting comparison is to look at civil and military space budgets. Looking at SF data, while in 2018 the global military budget was of $34.1 billion, in 2019 this total decreased to $32.6 billion or a $1.5 billion decrease coming in large majority from the US military budget ($20.6 billion in 2019). In terms of global civil budget, the SF points out a $2.6 billion increase in total (from $51.8 billion in 2018 to $54.44 billion in 2019). This increase in civil budget is a result of increased civil expenditure in other countries going from $28 billion in 2018 to $30.3 billion in 2019.

[622] Euroconsult, "Euroconsult predicts 10-year growth cycle for government space programs", (2019)

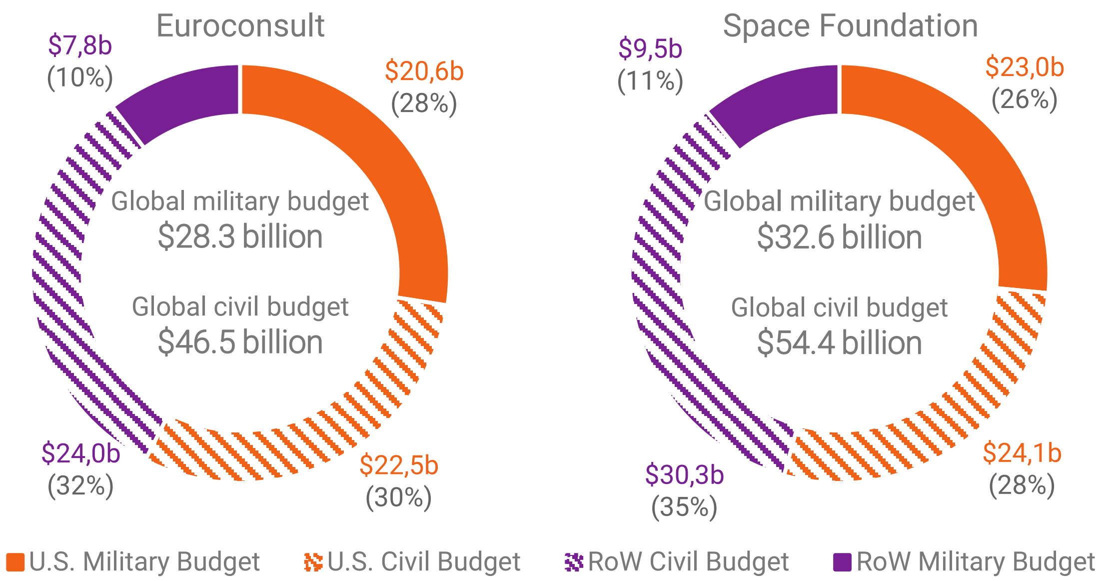


Figure 22: Civil vs Military budgets in the U.S. and Rest of the World in 2019 (Source: Space Foundation and Euroconsult)

In 2019, the United States accounted for approx. 54% to 58% of expenditures on global space programmes, with a gradual decrease observed in the last few years. The U.S. budget represented roughly 75% of global space budgets in the early 2000s. This can be explained by the growth rate of budgets for other nations, which has increased at a faster rate over the last two decades.

The prominence of the United States in the space sector is boosted by its military budget. The U.S. military budget is estimated by the Space Foundation to be $23.0 billion, just lower than the civil budget of $24.1 billion. This represents a slight decline compared to the military budget of 2018, which was $24.5 billion. Half (49%) of the U.S. space budget goes to military departments. In contrast, only one quarter (24%) of the space budget for the rest of the world goes to military budgets, at $9.5 billion. This makes the U.S. military budget approx. 2.4 times larger than that of the rest of the world. In addition, $30.2 billion is spent on civil programmes outside the United States.

Euroconsult reports similar proportions, although the overall budget is reportedly smaller. The U.S. military budget was recorded as $20.6 billion in 2019, with the rest of the world spending $7.8 billion. This means the U.S. spends 2.6 times more than the rest of the world on military space. The U.S. spends $22.5 billion on civil programmes, with the rest of the world spending $24.0 billion.

3.2.2 Space budget per country

Similar to 2018, the United States continues to spend more than all other governments combined. After the United States, China spends the most on its space programmes, estimated at $8.16 billion in 2019. In recent years there has been a large growth in China's space budget, though the growth in 2019 was smaller. However, it is important to mention that information regarding Chinese space budgets are not based on official figures and are more speculative due to China's policy of opacity regarding information on its space programme. Chinese space budget estimations do not necessarily reflect the level and growth of space activity in the country (China was the first launching country in 2020 with 39 launches). The top 5 largest space budgets, including Russia, France and Japan, correspond to over three quarters of the world total government spending on space.

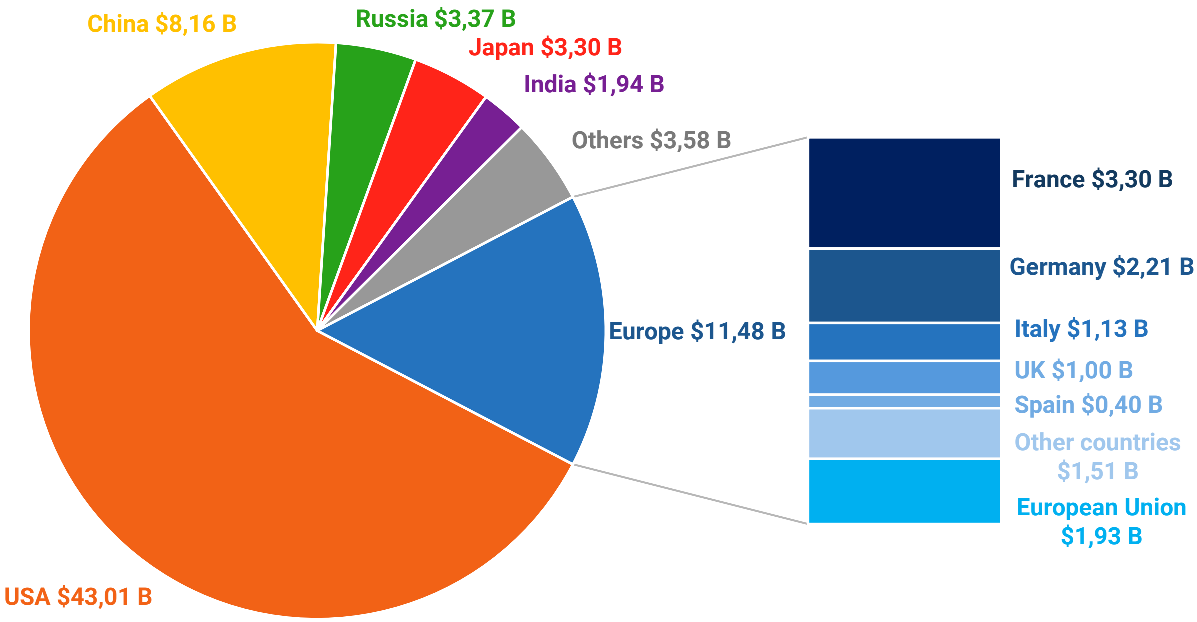


Figure 23: Institutional space budget per country in 2019 in USD (Source: Euroconsult)

As in other years, the United States remains the country with the largest institutional space budget, which reached $43.0 billion in 2019. This represents an approximately $2 billion (4.8%) increase compared their 2018 valuation.

China also retains its position, with the country having an institutional space budget of approx. $8.2 billion according to the data collected by Euroconsult. Bryce's estimates remain higher with a provided value of $11 billion. Here is once more important to mention that the estimation of the Chinese space budget is subject to debate given the limited official information available and the difficulty to account for purchase power parity of the Yuan.

Russia's budget on the other hand is estimated between $3.37 billion and $.4.1 billion by Euroconsult and Bryce respectively. Both valuations thus estimate Russia as the country with the third largest institutional space budget globally.

Japan's budget is estimated between $3.1 billion and $3.3 billion by Bryce and Euroconsult respectively. This is notable as it represents the only estimation for which Euroconsult's valuation is higher as compared to the one provided by Bryce.

If counted collectively, Europe has an institutional space budget between $11.48 billion and $12 billion according to Euroconsult and Budget respectively. According to Euroconsult data, France's budget of $3.30 billion is the largest within Europe and represents 29% of the total European budget. Germany's is the second country with the largest space institutional budget in Europe and represents 19% of the total European budget, at $2.21 billion. This includes their contribution to ESA and EUMETSAT budgets but does not include their contribution to the EU space budget which represents around 17% of the total European budget ($1.93 billion in 2019 according to Euroconsult).

The Space foundation on the other hand estimates the U.S. budget in 2019 to be $47.2 billion, including military spending. The next largest budget in their data belongs to China at $9.6 billion, followed by Russia and Japan with an estimated space budget of $4.0 billion and $3.0 billion respectively. With regards to the consolidated European budget, the Space Foundation estimates its value at $10.6 billion, including national government budgets, ESA budget, EU space programme and EUMETSAT.

In addition to comparing data on institutional space budgets for each country, a comparative analysis of the value of space budget as a proportion of Gross Domestic Product (GDP) is also useful to gain a better understanding of the weight of each budget in the overall domestic economy. When considering this method of analysis, the reduction in differences between countries is noteworthy. For instance, although the U.S. maintains its relative position as the country with the highest ratio between space institutional budget and GDP (0.202% of GDP), this ratio is only slightly larger to Russia's (0.198%). These figures show that, although the U.S.'s overall space budget is significantly larger to that of Russia, its proportion to the national GDP is similar to Russia's.

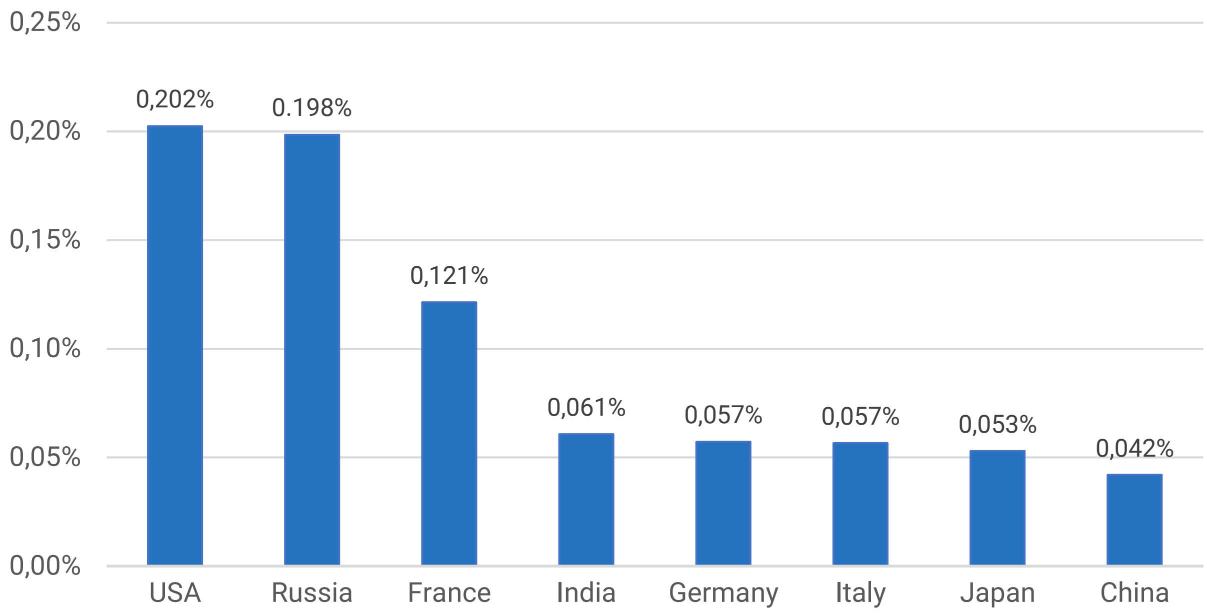


Figure 24: Space budget as a % of GDP in 2019 (Source: Euroconsult, IMF, ESPI)

Following the U.S. and Russia, France has the third largest space budget in proportion to its GDP followed by Germany, India, Italy, and Japan. Interestingly, China is the country with the lowest ratio between institutional space budget and GDP out of the countries analysed when considering this method of comparison.

It is also interesting to compare the same ratio while also making a Purchasing Power Parity (PPP) adjustment to the values of GDP. GDP based on PPP is defined by the World Bank as the "gross domestic product converted to international dollars using purchasing power parity rates".[623] It thus takes into account the relative price of items in different countries so that an international dollar will have the "same purchasing power over GDP as the U.S. dollar".[624]

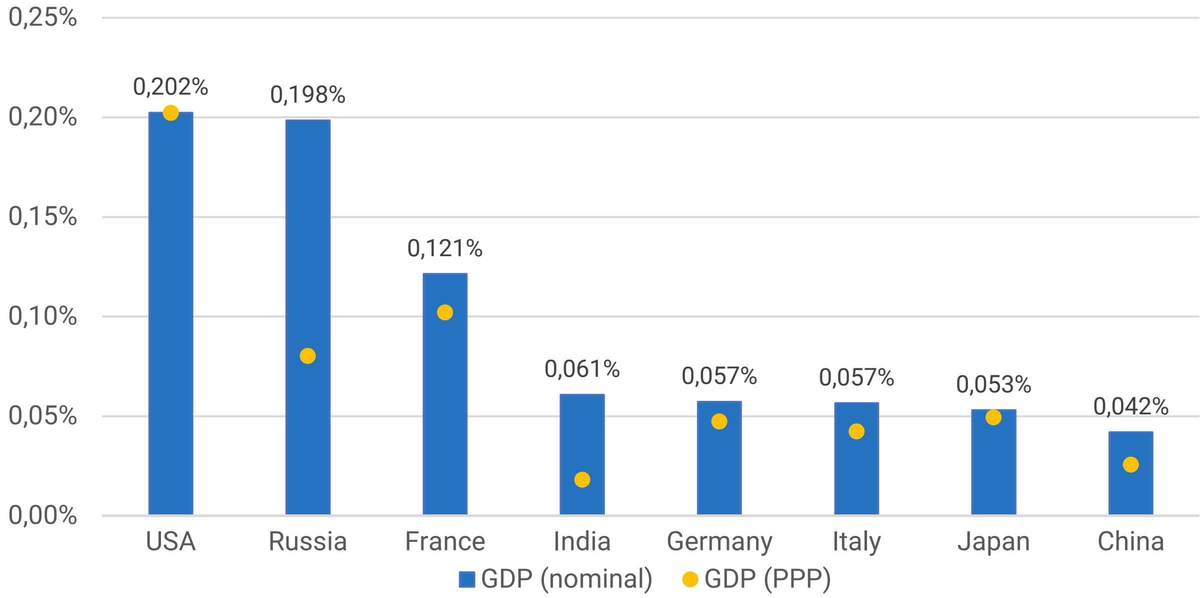


Figure 25: Space budget as a % of real and PPP adjusted GDP in 2019 (Source: Euroconsult, IMF, ESPI)

Using this method of comparison, it is interesting to note that the Russian GDP adjusted for PPP is over twice as large as its nominal GDP. Therefore, the proportion of its space budget compared to its GDP is much smaller when adjusting for PPP. A similar effect occurs in all the other analysed countries except for the U.S. and Japan, which have a similar ratio. However, the disparity between GDP and GDP(PPP) in European countries is noticeably smaller than in Russian and India and there is thus a smaller change in the ratio of institutional space budgets to GDP(PPP).

Measuring the value of space budgets per capita for each country is also an interesting method to gain a better perspective on its weight in each national economy. When considering this approach, the U.S. is the country that has the largest space budget per capita ($132) followed by France and Germany. The difference between this value and that of the second country in this metric is considerably, with France having a per capita space budget of $49. The U.S.'s space budget per capita in 2019 represents an increase compared to the $125 measured in 2018.

Germany has the third largest budget per capita in this sample at $27 with a population of approx. 83 million, followed by Russia ($23 per person) and China ($4). Finally, India has the smallest space budget per capita with approx. $1 spent on space per each of its 1.37 billion inhabitants.

It is important to note that only countries with a budget of over $1 Billion are included here as countries with small populations and relatively sizeable space budgets will tend to distort this metric. For instance, Luxembourg has a space budget of over $108 million and a population of just over 610,000, resulting in a space budget per capita of $176, which would result in it becoming the highest of all countries.

623 World Bank, "Metadata Glossary", (2011): https://bit.ly/3vKZCsl
624 Ibid.

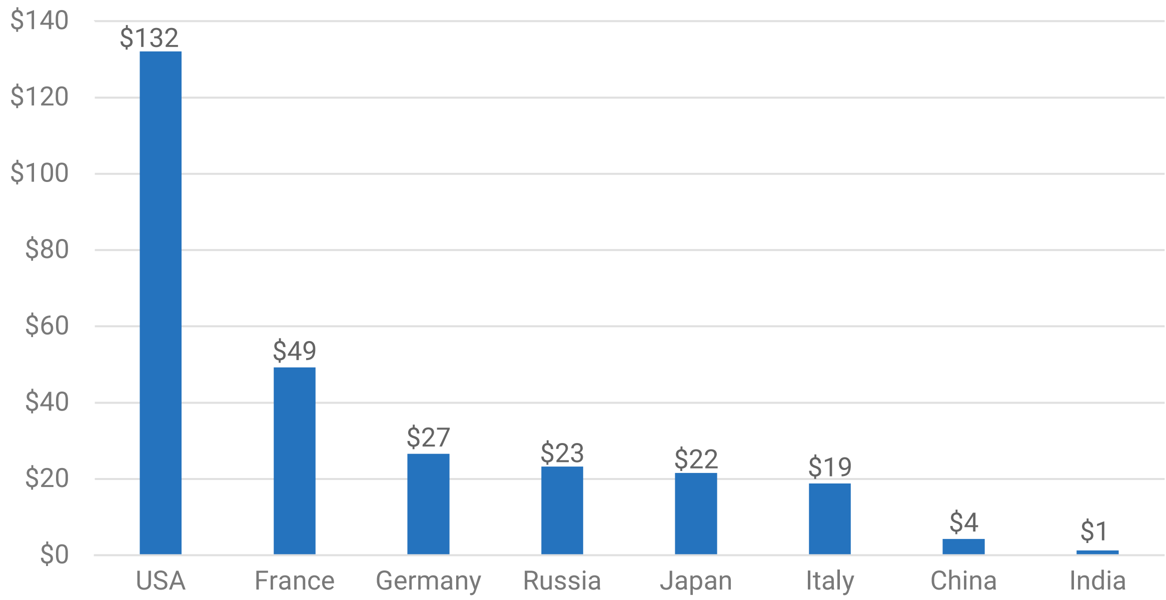


Figure 26: Space budget per capita in 2019 (Source: Euroconsult, IMF, ESPI)

An additional comparison can be made by evaluating the proportion of each national space budget relative to the total government expenditure. The World Bank defines total government expenditure as the "total expense of each government including the net acquisition of non-financial assets".[625] Figures for country GDPs and the relative government budgets in percentage of GDP provided by the IMF in its World Economic Outlook were used in this analysis.

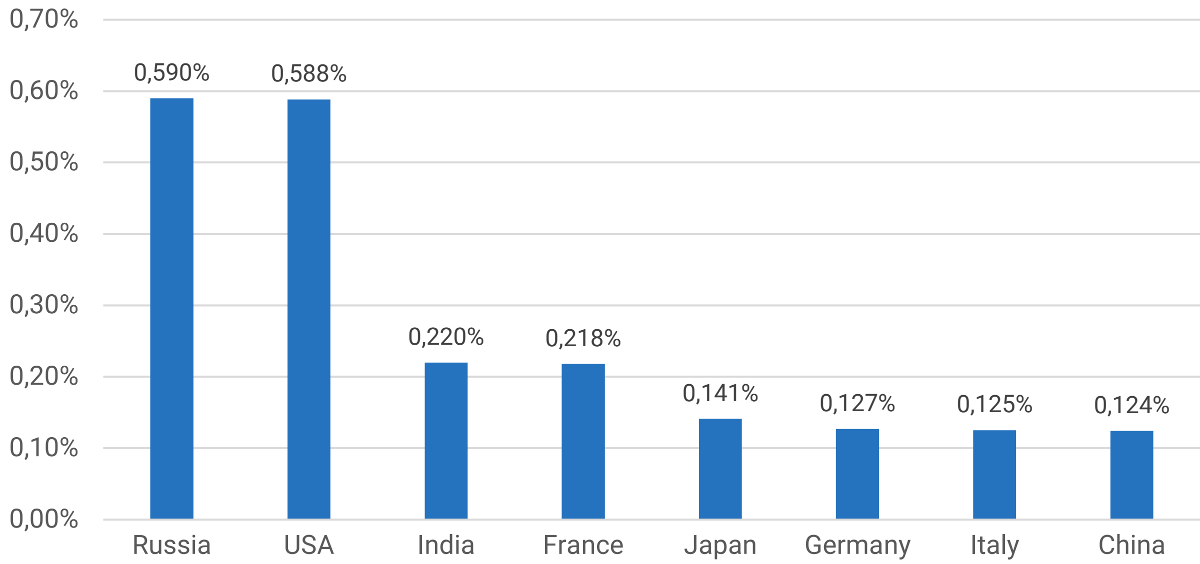


Figure 27: Space budgets as % of total government expenditure

Interestingly, Russia is the country with the largest ratio between its space budget and its total government expenditure at 0.590%, which is slightly higher than the U. S's. Thus, this method of comparison shows that although the two countries have significantly different space budgets ($43.4 billion vs $3.4 billion) and total government expenditure (approx. 7.3 trillion vs $568 billion) they attribute a similar weight to their institutional space budgets.

[625] World Bank, "General government total expenditure", https://bit.ly/2RXfzO3

India and France are the third and fourth countries with the highest space budget to public spending ratio, with 0.220% and 0.218% respectively, followed by Japan, Germany and Italy. Notably, China is also last when using this method of comparison, with its space budget accounting for 0.124% of its total government spending. On average, countries with a space budget over $1 billion thus attribute a budget representing roughly 0.267% of their total government expenditure to space.

3.2.3 European space budgets

Consolidated European space budget

Space budgets in Europe are intertwined with a variety of budget transfers (delegations, contributions) between different national, intergovernmental and supranational actors. Overall, and after consolidation, ESPI estimates the consolidated European space budget was around €10.3 billion in 2019.

This includes two main sources of public funding:

- National space budgets are the primary source of public funding in Europe. In 2019, the total space budget of European countries (ESA and EU Member States) was around €8.5 billion
- This budget includes:
  - Contributions to ESA budget for €4.18 billion
  - Contributions to EUMETSAT budget for €559.5 million
  - Budget remaining with national bodies for the management of national space programmes and other space projects outside ESA and EUMETSAT
- The European Union space budget is the second source of public funding in Europe. This budget is financed through Member States contributions to the budget of the Union but managed as a supranational budget complementing national budgets. In 2019, the EU space budget represented an additional public investment of €1.73 billion.

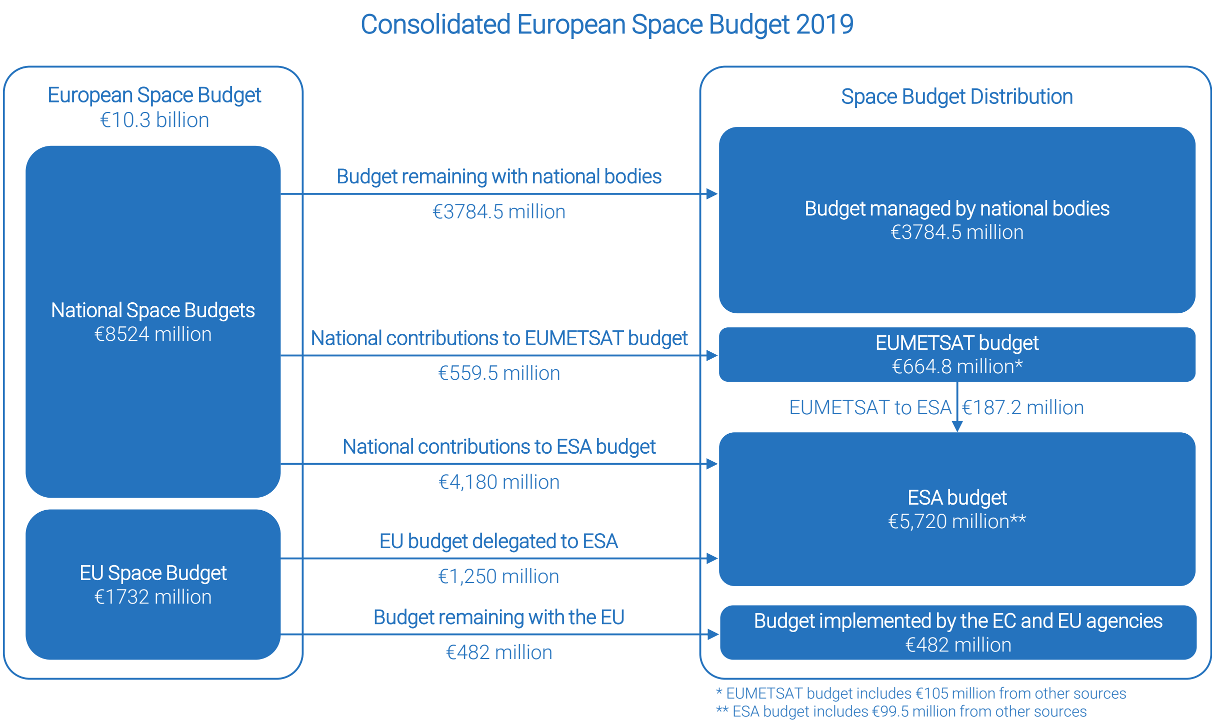


Figure 28: Consolidated European space budget 2019 (multiple sources, ESPI consolidation)

In 2019, the budget of the European Space Agency was €5.72 billion, including national contributions (€4.18 billion) and the implementation of institutional programmes for the EU (€1.25 billion) and EUMETSAT (€187.2 million).

National space budgets

European countries delegate more than half of their national space budget to ESA (and EUMETSAT to a lesser extent) and therefore contribute primarily to European space programmes. For some countries, a vast majority of the national space budget is implemented through ESA and EUMETSAT. The table below shows the estimated national space budget (civil and military) for ESA Member States in 2019.

European countries	National space budget 2019	ESA contribution	National activities
Austria	€77.2 M	€57.0 M	€20.2 M
Belgium	€230.2 M	€191.4 M	€38.8 M
Czech Republic	€53.0 M	€11.8 M	€41.2 M
Denmark	€45.8 M	€31.5 M	€14.3 M
Estonia	€5.4 M	€2.7 M	€2.7 M
Finland	€51.7 M	€19.5 M	€32.2 M
France	€2,948.5 M	€1,174.4 M	€1,774.1 M
Germany	€1,973.7 M	€927.1 M	€1,046.6 M
Greece	€19.8 M	€10.5 M	€9.3 M
Hungary	€9.1 M	€5.2 M	€3.9 M
Ireland	€27.1 M	€19.5 M	€7.6 M
Italy	€1,011.6 M	€420.2 M	€591.4 M
Luxembourg	€96.7 M	€29.9 M	€66.8 M
Netherlands	€132.4 M	€77.7 M	€54.7 M
Norway	€102.5 M	€64.4 M	€38.1 M
Poland	€72.4 M	€34.6 M	€37.8 M
Portugal	€28.7 M	€18.0 M	€10.7 M
Romania	€59.7 M	€45.4 M	€14.3 M
Slovenia	€13.2 M	€2.4 M	€10.8 M
Spain	€356.8 M	€201.8 M	€155.0 M
Sweden	€110.3 M	€74.4 M	€35.9 M
Switzerland	€199.1 M	€158.4 M	€40.7 M
United Kingdom	€894.3 M	€369.6 M	€524.7 M

Table 15: National space budgets of European countries (Source: Euroconsult, ESA, ESPI)

European Space Agency

The ESA budget has continued to increase in recent years. In 2020, the budget was €6.68 billion, an increase of 17% from €5.72 in 2019. Earth Observation programmes remain the largest budget allocation, accounting for €1.54 billion or 23% of the total budget, up from €1.39 in 2019. Space transportation has continued to increase, now also representing €1.54 billion or 23% of the total budget. This is an increase of 19% over 2019, and 38% since 2018. These two programmes account for nearly half of ESA's budget in 2020. Funds devoted to the Navigation programme also greatly increased in 2020, from €749 billion in 2018 to €1.10 billion in 2020, an increase of 47%. Navigation represents 17% of ESA budget, followed by Human Spaceflight amounting to €645 million, or 10% of the total budget.

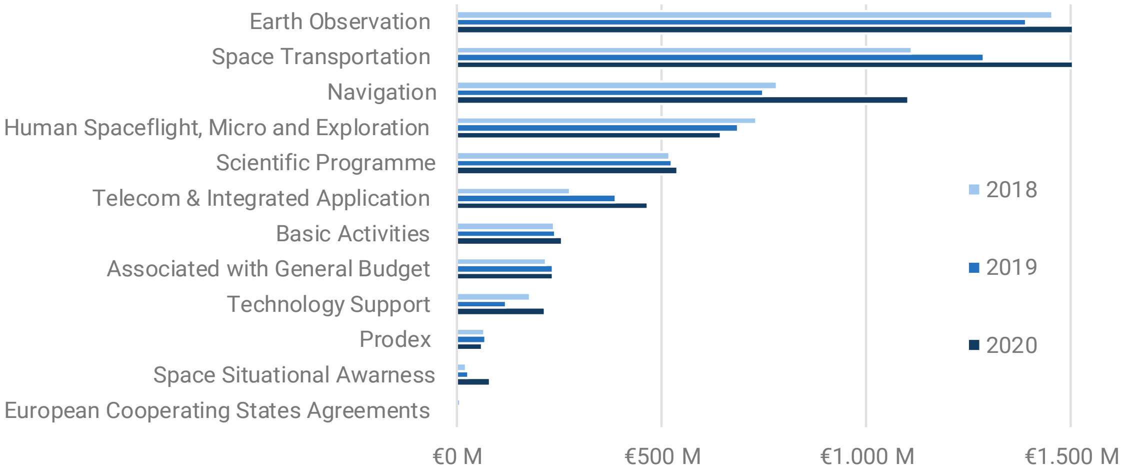


Figure 29: ESA programmatic budget allocations from 2018 to 2020 (Source: ESA)

Following the ESA Space19+ ministerial meeting in 2019, member state contributions to ESA have increased. National contributions to ESA increased from €4.18 billion in 2019 to €4.87 in 2020, an increase of 17%. Apart from Austria and Romania, all countries increased their ESA contribution in 2020 in comparison to 2019.

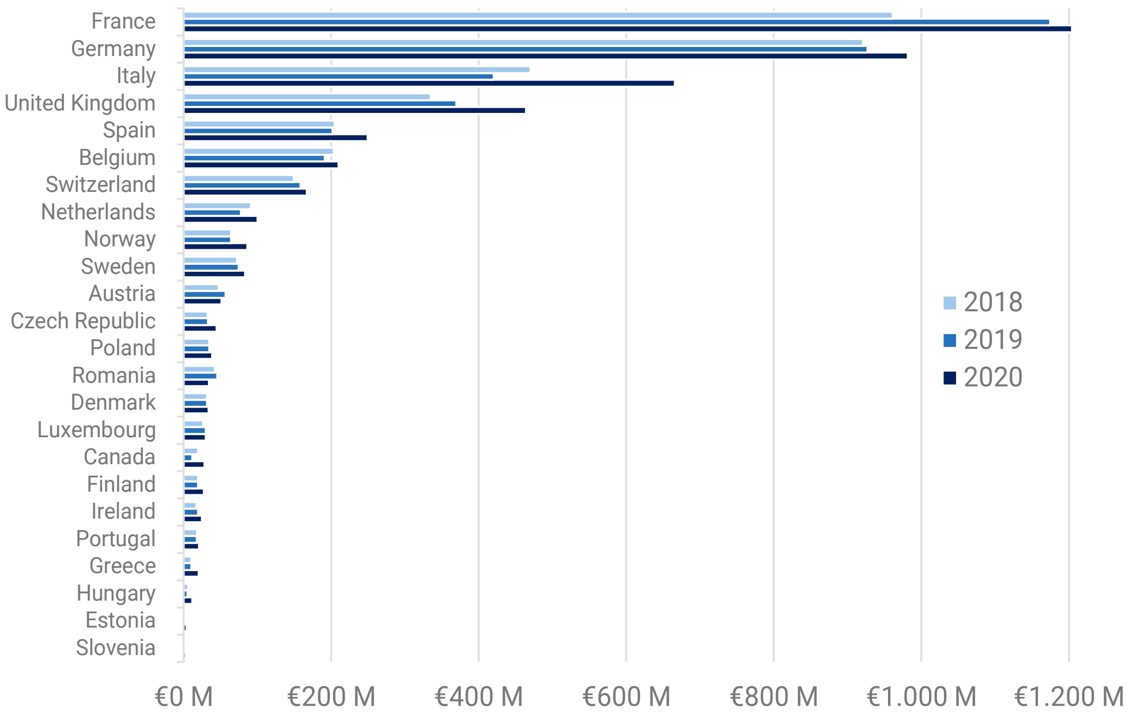


Figure 30: Member States contributions to ESA's budget from 2018 to 2020 (Source: ESA)

In 2020, France continues to be the largest contributor to ESA, accounting for €1.31 billion, or 27% of the total member states contributions. Germany's contribution to ESA increased to €982 million in 2020, from €927 million in 2019. Notable are the increases in contribution from Italy and the United Kingdom. Italy's contribution to ESA increased by 58% to €666 million in 2020, and the United Kingdom increased its contribution by 26% to €464 billion.

Other countries with ESA contributions larger than €100 million include Spain, Belgium Switzerland and now the Netherlands, all of which increased their contribution in 2020.

The following figure illustrates the distribution between national budgets and the national contributions to the ESA budget. Only a few countries keep more than 50% of their national space budget under national management. The largest space economies, France, Germany, Italy and the UK, all spend around 40% of their total budgets on ESA contributions. Belgium spends the largest proportion of its space budget on ESA contributions, at over 80%.

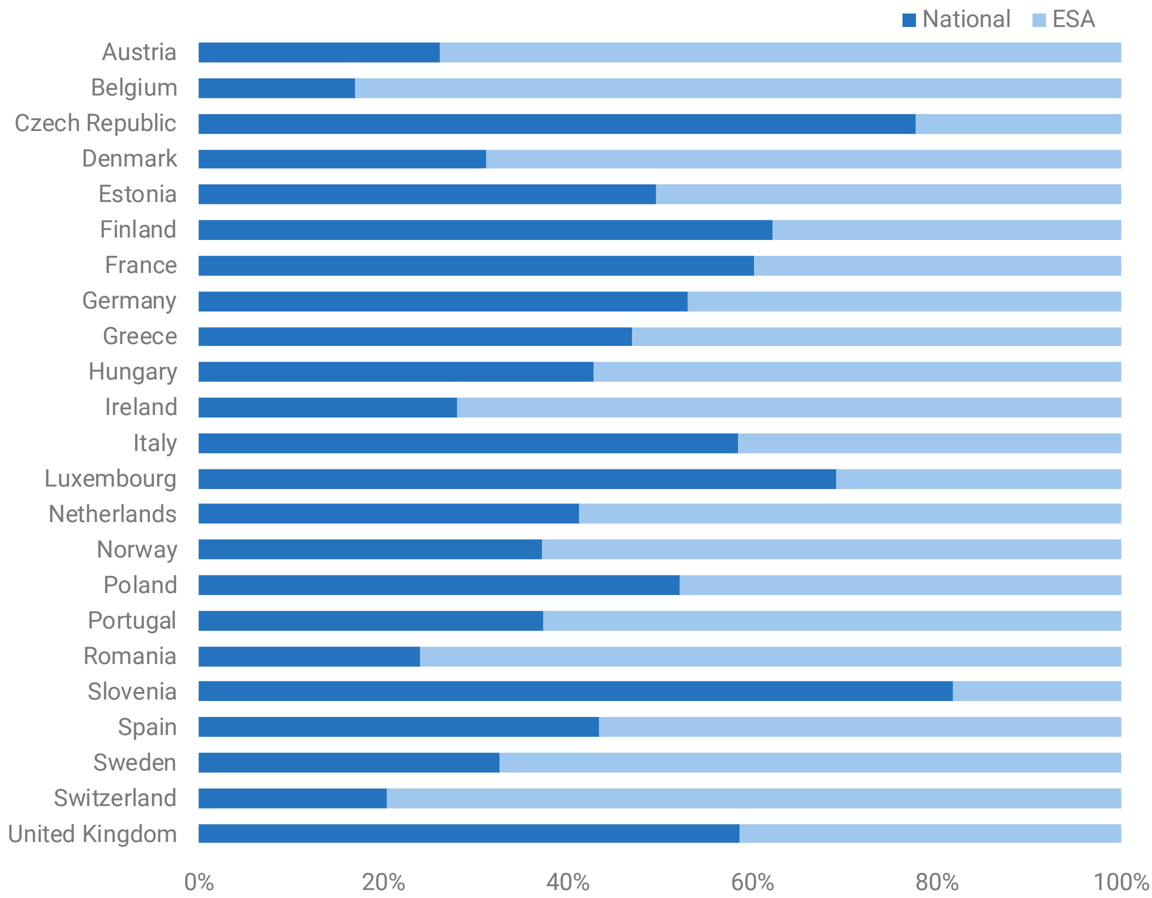


Figure 31: Member States Budget Allocation Comparison in 2019 (Source: ESA, ESPI)

EUMETSAT

EUMETSAT is an intergovernmental organisation supplying climate and weather satellite data to European Member States national meteorological services since 1986.

EUMETSAT activities are primarily funded through Member States contributions, which represented 84% of its total revenue in 2019 compared to 85% in 2018 and 83% in 2017. More specifically, Member States contributions in 2019 were reduced by 5,6% compared to 2018. They went from €594.7 million in 2018 to €559.5 million in 2019.

Member States contributions are calculated on the basis of their Gross National Income (GNI)

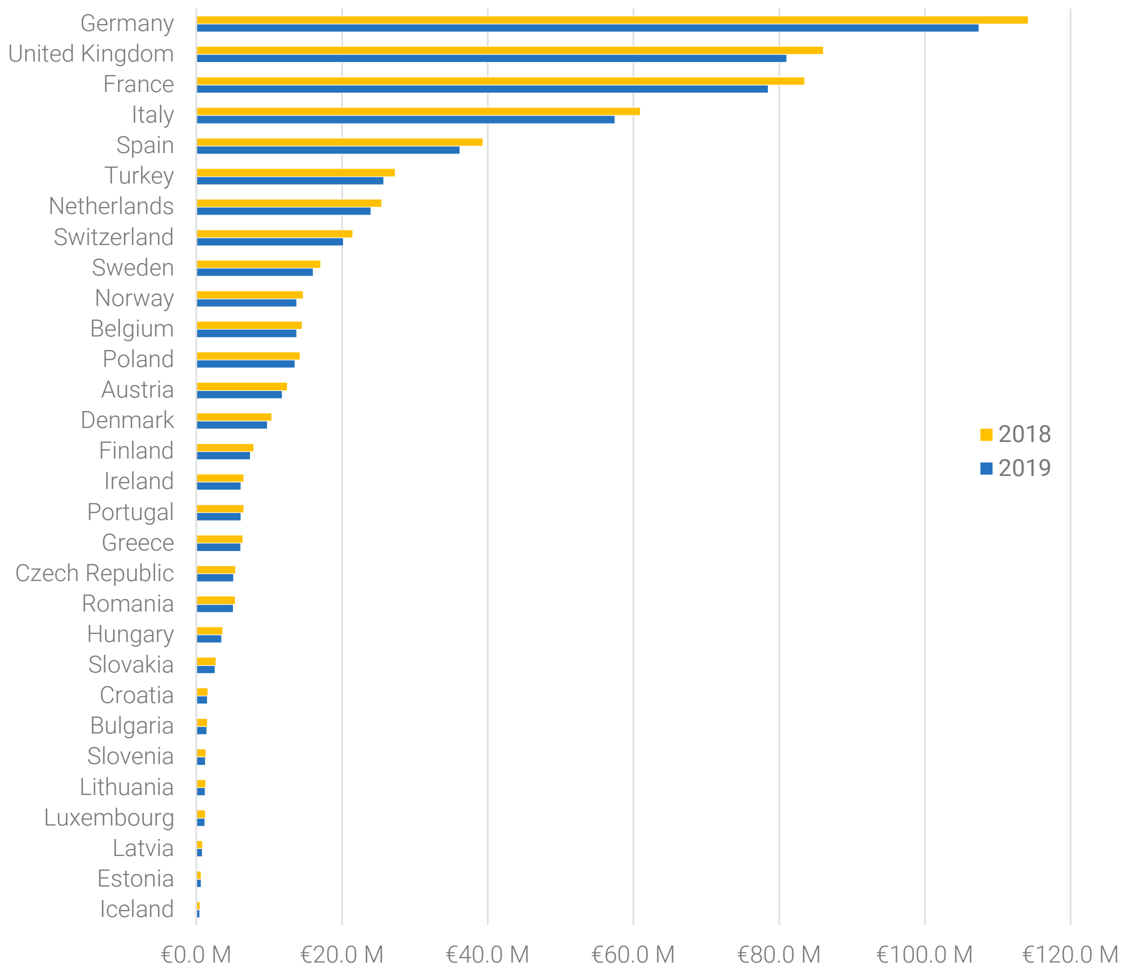


Figure 32: Member states contributions comparison for 2018/2019 (Source: EUMETSAT, ESPI)

Germany remained the largest contributor to the EUMETSAT budget with €107.4 million, which is however a 5.92% decrease from the €114.2 million it funded in 2018. The United Kingdom remained the second biggest contributor in 2019 after surpassing France in 2018 following a 22.1% increase in its contribution. The UK's total contribution in 2019 amounts to €81 million, a 5.8% decrease compared to is 2018 contribution. The third and fourth contributors to the EUMETSAT budget are France and Italy with an endowment of €78.5 and €57.5 million respectively.

Beyond Member States contributions, other sources of revenues for EUMETSAT originated from products sales and other contributions totaling €105 million of its income or 15.8% of its total revenue.

Following the contraction in Member States contributions in 2019 compared to 2018, EUMETSAT's overall revenue decreased by 5.2% going from €702 million to €664.8 million.

European Union

The European Union conducts various space activities that are implemented and managed by different executive bodies and agencies including in particular the European Commission, the GSA (which has officially transformed into the European Union Agency for the Space Programme - EUSPA) and the European Space Agency.

In 2019, the European Union space budget stood at €1732 million. Major EU space activities and cost items include:

- Galileo and EGNOS are Europe's GNSS and SBAS programmes providing improved positioning and timing information.
- Copernicus is the European Union Earth Observation flagship programme.
- Horizon 2020/Horizon Europe is the EU Research and Innovation programme for the period 2014-2020 and includes a component for "Leadership in Enabling and Industrial Technologies - Space".
- GSA budget to manage various space programmes and activities of the European Union.
- Other space activities implemented by the European Commission, the European External Action Service, the EU Satellite Centre, the EU Joint Research Centre and other European bodies.

Galileo and EGNOS

The European Commission Navigation and Positioning flagship programme entered its operational phase on the 15th of December 2016, following the European Commission's Declaration of Initial Service and is on track to enter its full operational capacity in the next few years. Its GNSS constellation Galileo currently has all planned 24 satellites in orbit, with the full operational capacity currently projected at 30 satellites consisting of 24 operational satellites and 6 additional provided as spares.

In 2019, the European Commission dedicated about €720.3 million to Galileo and EGNOS, an increase of roughly 14% compared to the €630 million committed 2018. As part of the budget dedicated to the two elements, approx. €562.7 million were committed specifically to Galileo. Following technical difficulties earlier in the year, an important milestone was achieved on 10 September 2019 as Galileo officially reached 1 billion smartphone users,[626] and is currently serving more than 2 billion phones and 15 million cars.[627] Galileo is also now supported by all European produced car models and is expected to be used by 95% of all European smartphone users.

On the other hand, the European Union dedicated about €125 million of its Navigation and Positioning flagship programme to EGNOS in 2019. EGNOS is used to improve the performance of GNSS, such as the U.S. GPS and relies on 3 payloads hosted on GEO satellites to provide Safety-of-Life (SoL) services to aviation, maritime and land-based users. The EGNOS programme made several major steps towards the completion of Version 3, with the GSA awarding a contract to Eutelsat in 2021 for the development and operation of the EGNOS Geo-4 service. The payload is expected to be launched on board a Hotbird 13G satellite in 2021[628] and follows that of the Eutelsat 5 West B, which carried an EGNOS payload in October 2019.

The 2021-2027 Multiannual Financial Framework defines the budget of the EU for the next 7 years, including for the EU space programme. In 2020 the European Union approved its space programme for

---

[626] European Commission, "Space: EU's satellite navigation system Galileo reaches 1 billion smartphone users", (September 2019)
[627] European GSA, (February 2021): https://bit.ly/3fQYIVa
[628] European GSA, "Global Navigation Satellite Systems Agency, Eutelsat to host EGNOS GEO-4 payload", (February 2021)

the MFF 2021-2027, which significantly increased its space budget and navigated more towards security-related activities.

The EU has committed €9.01 billion to Galileo and EGNOS as part of the new MFF, which represents a 32.5% increase compared to the budget committed to the two components in the previous period. With the new budget, the EU mainly projects to provide additional resources for continuity in operations and infrastructure for the components. It also expects to enhance the current capabilities as well as the development of the next generation of Galileo and EGNOS services, and drive for a deeper integration of satellite navigation data in other policy areas and economic sectors. The procurement for 12 Galileo 2nd generation satellites have been conducted in 2020 and early 2021.

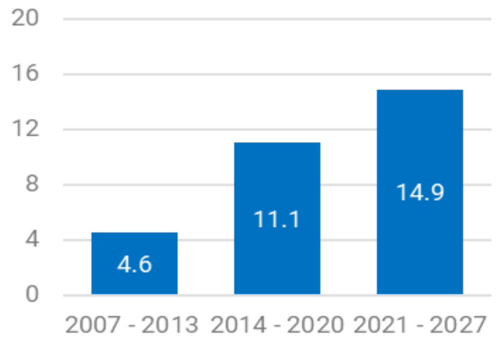


Figure 33: Evolution of Space budget in EU MFF (figures in € billion, current prices)

Copernicus

The Copernicus programme relies on a fleet of EO satellites named Sentinels, which display a variety of capabilities and address various applications from land to sea level monitoring. The Copernicus programme develops a global, continuous and autonomous high accuracy observation of Earth systems offering European countries scientific precision and autonomy in questions related to the global environment. In 2019, the European Union dedicated about €858.6 million to Copernicus, which represents an increase of approx. 34% compared to the €640 million committed in 2018.

Currently, the Sentinel 1A-1B, 2A-2B, 3A-3B, 5P and the Sentinel-6A Michael Freilich have been deployed in orbit. Notably, the Sentinel 3 mission reached full operational capacity in 2019 with the launch of the Sentinel 3B satellite in March, and the completion of the full spectrum of remote sensing satellite is expected to be finished in 2025 following the launch of Sentinel 4, 5, and 6B.

The overall cost of the programme over the period 2008-2020 could be estimated at about €8.2 billion according to the Copernicus Market Report[629], which is issued by the European Commission to provide an estimation of cost and benefits of the Copernicus programme on the European economy. Over the same time span the turnover of both manufacturers and service providers together would account for €11.5 billion, with total economic benefits ranging from €16.2 billion to €21.3 billion.

With regards to the 2018 to 2020 period, on the other hand, the benefits generated by the Copernicus programme for intermediate and end user ranges from €4.7 to €9.8 billion[630], with benefits stemming from the Programme estimated to range between €125 million to €150 million for the year 2018 alone, with an expected CAGR of 15% until 2020.

As part of the MFF 2021-2027, the EU has committed approx. €5.42 billion (current prices) to the Copernicus Earth Observation programme, an increase of roughly 26% compared to the €4.3 billion commitment under the previous MFF. The increased budget attributed to Copernicus in the new MFF will provide resources for the continuity of operations as well as for the enhancement of capabilities for the programme. The continued development of services and plans for a deeper integration of Earth Observation data in other policy areas and economic sectors are also planned, with the procurement of 6 new Copernicus missions having been conducted in 2020 and early 2021.

[629] PwC (for the European Commission), "Copernicus Market Report – February 2019", (February 2019): https://www.copernicus.eu/sites/default/files/2019-02/PwC_Copernicus_Market_Report_2019_PDF_version.pdf
[630] Ibid.

GOVSATCOM / SSA

The EU has also provided for an increase in budget for the development of its Space Situational Awareness and GOVSATCOM initiative as part of the EU Space Programme. As part of the new MFF, the EU has committed €442 million to SSA and GOVSATCOM, building from the budget committed for the Preparatory action leading to the new EU GOVSATCOM programme in 2019 that was roughly equal to €10 million.

Although the two components have a relatively smaller budget compared to both Galileo/EGNOS and Copernicus, the increased budget as well as their inclusion in the new MFF underlines the growing importance of the security and defence dimension of EU engagement in space. Both the SSA and GOVSATCOM will build on activities initiated during the MFF 2014-2020, as the new one attributes both lines of action greater political significance and a long-term vision.

The SSA component will build upon the work by several member states in the 2015-established EU Space Surveillance and Tracking (EUSST) Support Framework with the objective of monitoring and preventing space hazards and will also include an early-stage EU engagement in space weather and near-Earth objects. The GOVSATCOM initiative, on the other hand, is addressing the need for a secure, guaranteed and autonomous governmental satellite communications capability for the EU and its Member States. It will primarily rely on existing capacity until 2025, with some of the early programme developments having included major involvement of the European Defence Agency.

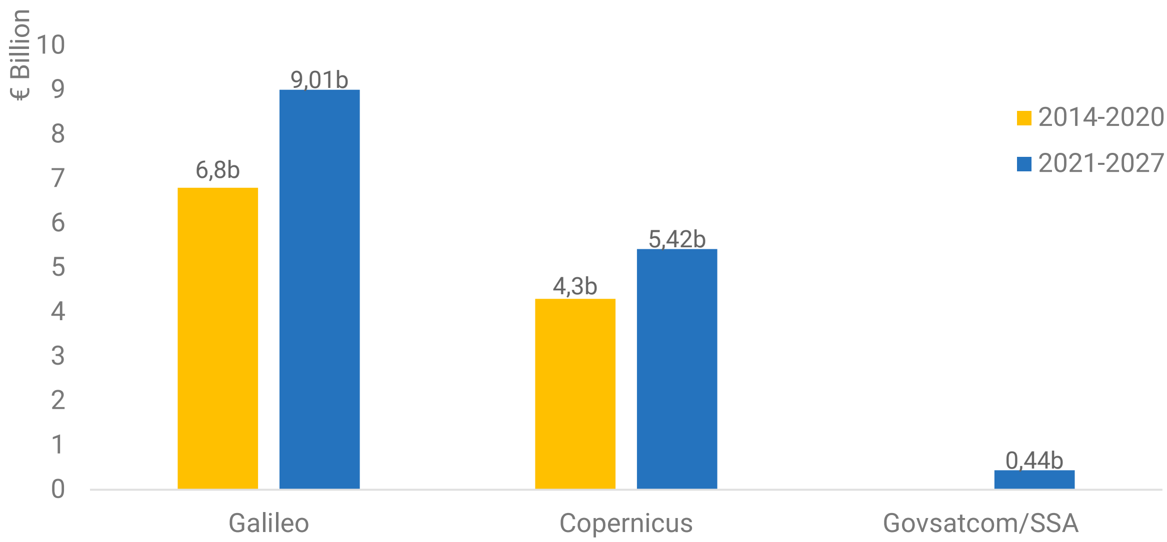


Figure 34: Evolution of budgets Galileo, Copernicus and Govsatcom/SSA between MFF 2014-2020 and MFF 2021-2027

Horizon 2020 / Horizon Europe

Horizon Europe will follow Horizon 2020 as the new EU Framework Programme for Research & Innovation. It represents the largest research and innovation programme in Europe and the overall financial envelope for Horizon Europe has been set to €95.5 billion in current prices.

Its support to space technologies and applications will be primarily undertaken under Pilar 2 “Global Challenges and European industrial competitiveness” within its Cluster 4 named “Digital, Industry and Space”. The support provided through Horizon Europe is thematically linked with the development of Copernicus and Galileo services, SSA and GOVSATCOM-related activities, as well as to other strategic innovation areas such as reusable launchers, European technology non-dependence and space science. It will thus be used in support of the overlining objectives set by the EU Space Programme.

In addition, the European Innovation Council has been established under Horizon Europe with a total budget of €10 billion (current prices) for the current MFF period, following the successful implementation of the EIC pilot under Horizon 2020. The EIC will support research and innovation on the continent through three main instruments, which include:

- The "Pathfinder", which aims to support research in breakthrough and highly disruptive technologies.
- The "Transition", which will have the specific objective of supporting the transition between research and real innovation opportunities.
- The "Accelerator", whose aim will be that of supporting European companies scale up and develop their disruptive, high risk and high impact technologies.

In order to enable the support of selected star-ups and SMEs, the European Commission and the EIB Group have established that approx. €3 billion will be attributed to the European Innovation Council Equity Fund. The EIC Fund is an innovative instrument through which the European Commission is able to make direct and quasi-direct equity investments in funded companies. Innovative start-ups and SMEs are also eligible for the EIC accelerator and for funding under the EIC Fund. The Dutch start-up Hiber is the first space company to have benefited from this mechanism since the establishment of the EIC as it closed a €26 million round in 2021 in a funding round led by the European Innovation Council, who invested in the company by means of blended finance.

New EU funding instruments

With New Space increasingly high in its space agenda, the EU is now openly and actively seeking to support entrepreneurship and investment in the European space sector and introduced new instruments for this purpose.

In addition to the support mechanisms foreseen under Horizon Europe, space companies will also be able to benefit from initiatives undertaken in the frame of other programmes established in the new MFF:

- The InvestEU programme and the InvestEU Fund are projected to have a key role in this regard as it now contains the European Fund for Strategic Investment (EFSI) that backed investments made in the scope of the unprecedented €100 million InnovFin Space Equity Pilot, which is expected to reach full deployment in Q1 2021. Within the new MFF, the EU provided the programme with a total EU budget guarantee of €26.2 billion for the purpose of attracting over €372 billion in additional investment over the 2021-2027 that will provide support to European start-ups and SMEs including in the space sector with the objective of "underpinning space entrepreneurship".
- The European Defence Fund, which has been established with a total budget of €7.9 billion, is also expected to play an important role in particular by underpinning the implementation of the EU's growing ambition in security and defence. In particular, the European commission outlined its plan to use "up to 8% of its budget to support disruptive technologies" in its Action Plan of synergies between the civil, defence and space industries". For this purpose, the European Commission also foresees the creation of an innovation incubator expected to be launched in 2022 "to support new technologies and shape dual-use innovation".

The European Commission also stepped up its collaboration with the European Investment Bank (EIB) and the European Investment Fund (EIF) to foster investment and entrepreneurship in the space sector in particular through:

- The framework of the aforementioned InnovFin Space Equity Pilot, which is part of the InnovFin equity initiative launched by the EU and the EIB Group under Horizon 2020. In this regard, the Commission announced €300 million in investments for the space sector following the joint investment by the European Commission and the EIF in Orbital Ventures and the Primo Space venture capital fund.

3.2.4 Investment and entrepreneurship in the European space sector

Every year, ESPI releases the report "Space Venture Europe", providing information about private investment and entrepreneurship trends in the European space sector based on two ESPI analysis tools:

- The ESPI investment database, recording available data on private investment in European space start-ups for the period 2014-2020.
- The ESPI space entrepreneurship survey, collecting the views of European space start-ups on their business and situation, on the European ecosystem, and on their expectations for the future.

This section provides an extract of Space Venture Europe 2020. More detailed information is available in the report on ESPI website.

Overview and evolution

The year 2020 represented a continuation in the evolution and development of private investment in European space startups that has been observed in the past years. The period ranging from 2014 to 2020 in particular has seen remarkable development in the sector, with 295 private investment deals concerning European space start-ups recorded for a total amount of €1,249 million.

The value counted in this estimation exclusively comprises of private investments in European space companies in the start-up phase, and thus does not include major investments or acquisitions in more mature space ventures that could significantly affect the total volume of investments.

While the period ranging from 2017 to 2019 saw steady growth in private investments with an average yearly volume of €207.5 million, 2020 was a particularly significant year as a total of 57 deals were recorded totaling €502 million. This is a conservative estimate of the total volume, as the value of 8 transactions were not disclosed.

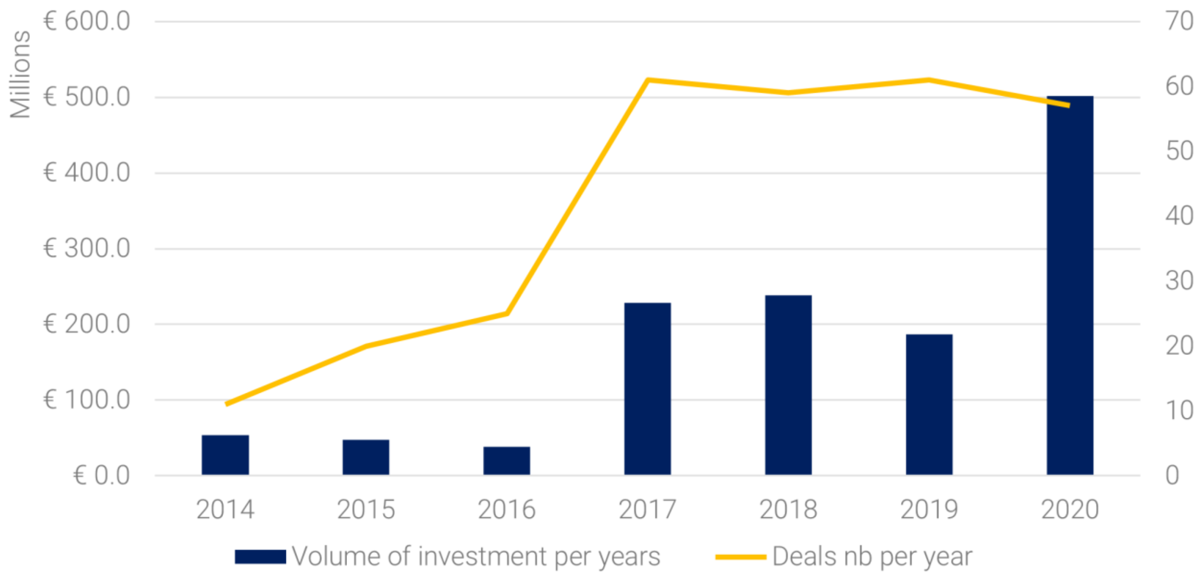


Figure 35: Private investment value and number of deals per year 2014-2020

Types of Investment

With regards to the types of investments made in European space start-ups, Venture Capital represents the vast majority (71%) of the total value of private investments over the period ranging from 2014 and 2020. The year 2020 is consistent with this trend as the 30 recorded Venture Capital deals hold a total value of €375 million, which accounts for 75% of total investments. Notably, this figure represents a 13% increase compared to 2019 where Venture Capital investments only constituted 62% of the total.

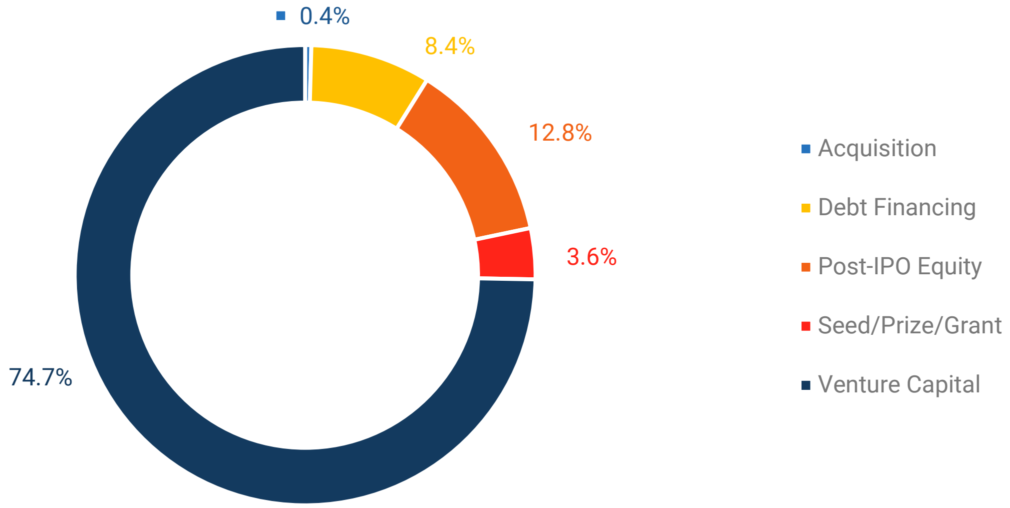


Figure 36: Distribution of investment by category in 2020

This was followed by Post-IPO equity and Debt Financing, accounting for 12.8% and 8.4% of total investments respectively in 2020.

When considering the investments made through Venture Capital in 2020, ESPI research notably points out that out the 30 recorded rounds, 52% of them were from a mixed consortium, meaning the funds originated from both public and private investors. The figure is significant, as it shows that public investment is often key to the financing of European space start-ups also in venture rounds. Overall, 2020 was also noteworthy as it shows continuity in the increasing value of Post-IPO Equity and Debt Financing as means of financing in the sector in the past four years.

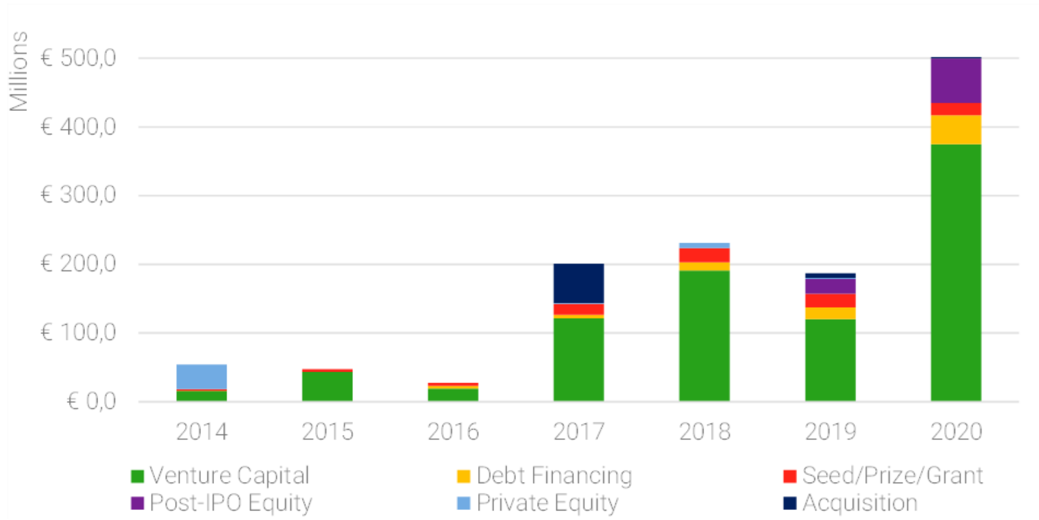


Figure 37: Value of investment type by category 2014-2020

Distribution of investment across of Europe

In 2020, a significant share of the private investment volume in European space start-ups was concentrated in its top 5 deals (€324 million), which accounted for 65% of the total. By comparison, this volume represented 37% in 2019, 62% in 2018 and 65% in 2017. The average value of investments outside of the top 5 amounted to €3.4 million in 2020, which also constitutes an increase compared to 2019 where it was equal to approx. €2.1 million.

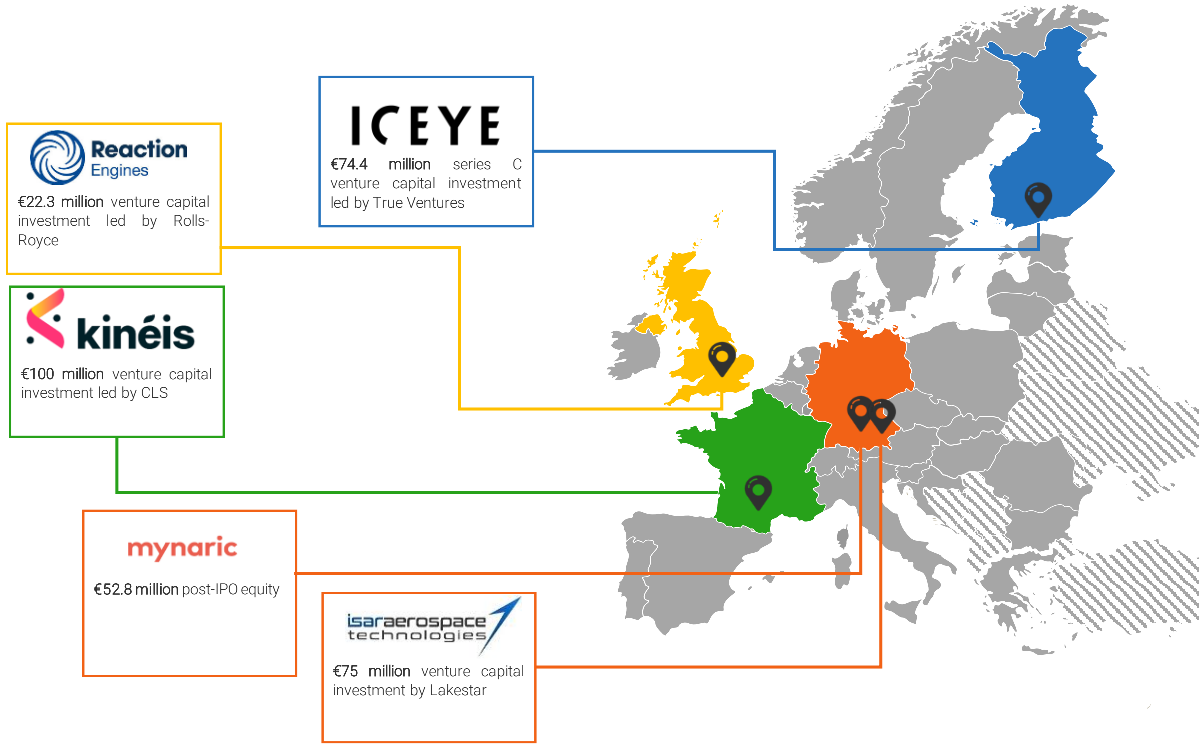


Figure 38: Top five European investment deals in 2020

Thus, although the value of the top 5 investments continues to represent a large share of the total volume of transactions occurring over the year, 2020 remains a very successful for European space start-ups and confirms that private investment is now well established in the continent as new public and private financing initiatives continue to emerge.

Interestingly, the pattern of distribution in 2020 contrasts with 2019. While 2019 showed that the majority of investments went to European countries with smaller budgets, it is not the case in 2020 as space start-ups headquartered in France, Germany and the UK attracted the bulk of private investments.

France leads in terms of deals in 2020 with a total value of €148 million invested into French space start-ups in 7 primary transactions. Notably, some of these investments include the €100 million invested into French IoT Kinéis, €20 million into the secure analytics company Preligens and finally, €11 million into micro-propulsion company Exotrail. German space start-ups have also performed at a record level in 2020, attracting €135 million in funds in total of 8 deals. Finally, with over 15 deals worth a total of over €80 million, the UK also continues to stand out, as does Finland with a €74.4 million investment in Iceye.

With regards to the origin of investments, the data collected on the 2014-2019 period shows that European space start-ups mainly attract funds domestically or from European investors (63%), with investments from the RoW and the U.S. constituting 7% and 5% respectively. This was also the case in 2020, as 76% of investments came from Europe and 12% from the U.S. which shows an increase in interest from American investors in 2020 relative to the 2014-2019 average.

European space start-ups views on business and COVID-19 crisis impacts

Key results of ESPI Space Venture Europe 2020

Investment trends	• Record investment in 2020 with €502 million invested in European space start-ups despite the COVID-19 crisis • Massive growth since 2014 with annual investment growing from €50 million to €500 million in just 6 years - CAGR (2014-2020): 45% • Number of investment deals is stable with 57 deals recorded in 2020 across 12 European countries including 12 deals above 10 million. • Record investment round for start-up Kinéis (€100 million) to finance IoT constellation. • Investment highly concentrated in a few large deals with the top 5 deals representing 65% of the total value of investments. • Venture Capital accounts for the largest share of investment value with 75% of the investment originating from Venture-Capital • Public institutions play a key role in investment with 60% of investment deals involving at least one public backer (e.g. public investment bank, regional development fund). • Important domestic dynamic with 76% of investment deals for European start-ups led by a European investor.
Start-up profiles & priorities	• European start-ups are mostly micro enterprises between 1-5 employees (48%). • Most start-ups address B2B markets (78%), only 14% address B2G markets and 8% address B2C markets. • Most start-ups already generate revenue (82%), with 63% generating a revenue <€1 million and 19% >€1 million. • Start-ups seek first and foremost to establish their business in terms of products and markets. Top priorities for start-ups are “Marketing and customer acquisition”, “Product development” and “Growing revenues on existing markets”. • Access to private and public funding is a secondary priority although it is the main area of action of European public institutions
COVID-19	• Mixed perception of COVID-19 crisis impact on business: Half start-ups estimate that COVID-19 had a significant impact on their business while the other half estimate the impact was limited or even negligible. • Impacts on the demand side (e.g., payment delays, loss of revenues) have been more significant than on the operation side (e.g. operation shutdown, supply chain disruption, productivity loss), leading to cashflow issues. • Overall deterioration of business situation and confidence: A smaller share (54%) of start-ups met or exceeded their expectations in 2020. A smaller share of start-ups (69%) except an improvement of their business situation in 2021.

3.3 European space economy statistics

3.3.1 European space manufacturing industry

Main indicators

ASD-Eurospace, the trade association of the European space industry, provides robust and detailed insights on the state of the industry in its authoritative *Facts & Figures* annual report.[631]

In 2019, the final sales of the European space manufacturing industry increased by 2.4% to stand around €8,756 million. Following a downturn in 2018, particularly in commercial and export sales, European activity increased marginally by 2.4% to just above 2017 levels This was mostly fuelled by growth in satellite applications systems sales. Space industry employment, on the other hand, grew largely to reach 47895 permanent staff (in Full-Time Equivalent - FTE), an increase of 6.4%. When including other personnel, not directly employed by space industry companies, the number of total staff increases by over 2000 to 50151.

Key figures employment (FTE) and sales (M€)	2017	2018	2019	Variation
Direct industry employment (FTE)	43910	44984	47895	+6.5%
Other personnel working on site (FTE)	2658	2940	2256	-23.3%
Total space industry employment (FTE)	46568	47924	50151	+ 4.6%
Final sales (M€ current e.c.)	8729	8525	8756	+2.4%

Table 16: Main industry facts

Industry sales by customer segments

The distribution of industry sales by customer segment shows that the European space industry addresses primarily domestic markets: in 2019, public and private European customers accounted for 83% of industry sales, the same proportion as in 2018. The European public sector (ESA, EUMETSAT, European Commission, national space agencies and other civil and military institutions) remains the principal source of revenues for the European space manufacturing industry, corresponding to 63% of final sales in 2019.

European public programmes have become increasingly important over the past decade in terms of share of industry revenues. Whilst commercial sales and export have grown only marginally since 2010, sales to European public entities have almost doubled going from approx. $3 billion in 2010 to roughly €5.5 billion in 2019. Following a noticeable 17.1% contraction in sales to commercial and export markets in 2018, 2019 saw a growth in this figure which almost regained its 2017 level. However, whilst sales to European commercial entities increased by 6.2% to €1.6 billion, commercial exports to the rest of the world decreased by 4.1%, to €777 million. 2019 is the 5th consecutive year that this segment has declined.

[631] ASD-Eurospace. "Facts & figures – The European space industry in 2019", (July 2020)

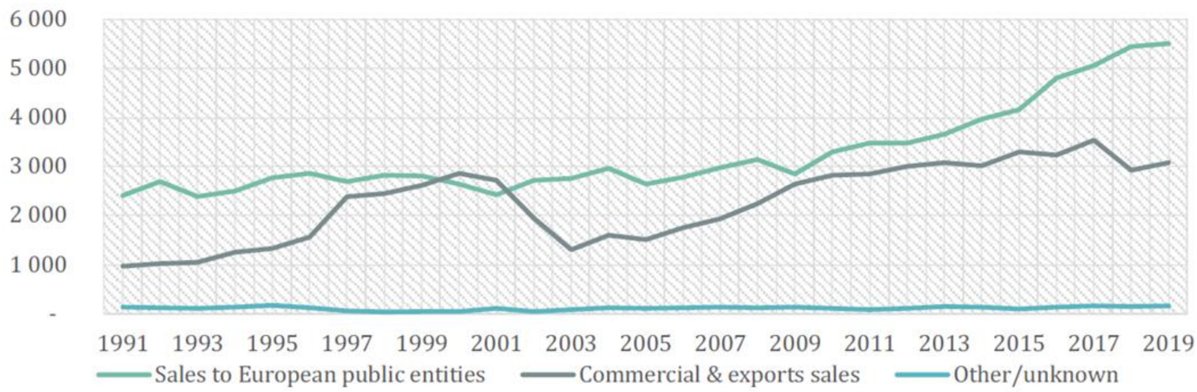


Figure 39: Sales by main market segment - European public entities vs Commercial and exports (M€)[632]

Final sales by main customer segment (M€)	2017	2018	2019	Variation
European public customers	5059	5446	5509	+1.2%
European private customers	1825	1520	1614	+6.2%
Other European customers	90	99	109	+10.6%
Public customers RoW	808	593	696	+17.4%
Private customers RoW	906	810	777	-4.1%
Other customers RoW	80	57	50	-12.6%

Table 17: Final sales by main customer segment (M€)

Industry sales by product segments

The distribution of industry sales by product segment shows that satellite application systems, including the development and production of telecommunication, Earth observation and navigation systems, is the main market of the European space industry, representing 48% of sales. This segment grew steadily until 2017, contracted slightly by 8.8% in 2018 and grew again by 9.5% in 2019 to reach €4.1 billion, just below the peak seen in 2017.

Launcher systems are the second source of revenue, representing 20% of industry sales. This market concerns mostly the design, development and production of European launchers Ariane and Vega. Eurospace reports that a small share of revenues is associated to the export of launcher sub-systems and equipment for foreign launchers, representing 4.2% of the total.

Ground systems and services, including electric and mechanical ground segment equipment (EGSE & MGSE) as well as engineering and other specialized services is the third market, representing 17.6% of the total sales by macro segment; and scientific systems, including human spaceflight, exploration, Earth and space science programmes is the fourth industry market, representing 15.1% of the total.

[632] Commercial and export sales include the sales to: Privately owned satellite operators worldwide (e.g. Eutelsat, Intelsat), public satellite operators outside Europe (e.g. Arabsat, RSCC, Chinasat), privately owned launch services operators worldwide (e.g. Arianespace), public space agencies outside Europe (e.g. NASA, KARI), military institutions outside Europe, space manufacturing companies outside Europe.

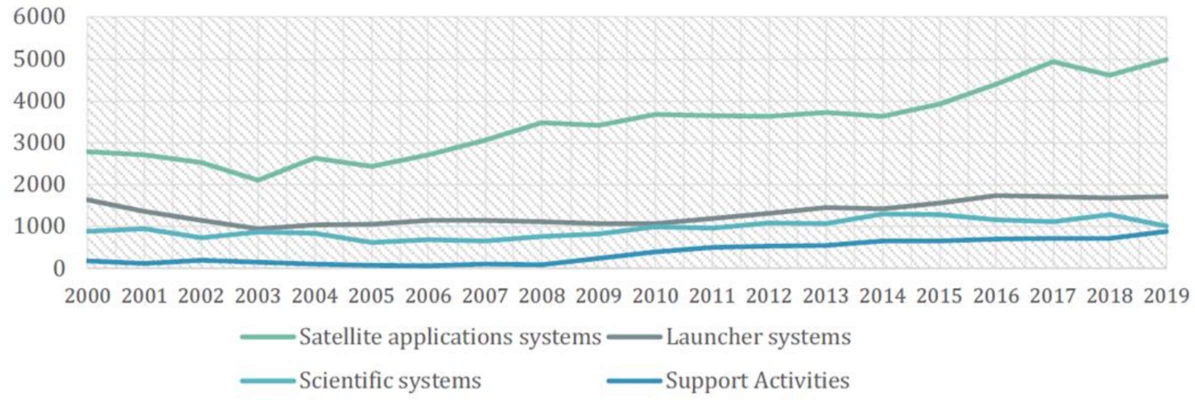


Figure 40: Sales by main market segment - type of system (M€)

(Copyright by Eurospace - all right reserved, used with permission, reproduction forbidden)

Final sales by main product segment (M€)	2017	2018	2019	Variation
Launcher systems	1709	1677	1712	2.1%
Satellite applications systems	4248	3813	4177	9.5%
Scientific systems	1117	1290	1006	-22.1%
Ground systems and services	1405	1509	1696	12.4%
Other & Unknown	290	236	166	-29.8%

Table 18: Final sales by main product segment (M€)

(Copyright by Eurospace - all right reserved, used with permission, reproduction forbidden)

Industry employment

Employment in the European space industry has been steadily growing since 2005. A total of 2227 jobs (FTE) were created in 2019 (+4.6%). The sector now employs a total of 50,151 workers (FTE). The space sector is a male-dominated industry where women count for only 22% of employment, a proportion that has not changed since 2019. The mean average age is 44 with a most common age (mode average) of 37. The industrial space workforce is also highly qualified with 73% of employees having attained a tertiary (university) level of education. The geographic distribution of industry employment within the European space sector is highly concentrated and generally proportional to national space budgets, with some exceptions in countries with smaller budgets and workforce. Comparably to public budgets, 85% of the direct space industry employment is located in 6 countries: France, Germany, Italy, the United Kingdom, Spain and Belgium.

Industry employment (FTE)	2017	2018	2019	Confidence level
Austria	420	420	416	68%
Belgium	1533	1554	1576	63%
Czech Republic	187	187	292	93%
Denmark	258	257	257	0%
Estonia	39	39	51	24%
Finland	160	168	227	57%
France	16994	17128	18186	85%
Germany	7901	8526	9071	86%
Hungary	97	97	130	25%
Ireland	61	61	46	43%
Italy	5140	5076	5215	75%
Luxembourg	34	36	24	0%
Netherlands	1155	1166	1240	32%
Norway	405	412	418	24%
Poland	250	266	290	27%
Portugal	161	165	239	46%
Spain	3551	3811	3803	70%
Sweden	995	1057	996	57%
Switzerland	805	806	842	80%
United Kingdom	3969	3973	4263	61%

Table 19: European space industry employment by country, 2019

(Copyright by Eurospace - all rights reserved, used with permission, reproduction forbidden)

3.3.2 European remote sensing industry insights

Every two years, the European Association of Remote Sensing Companies (EARSC) surveys the remote sensing industry to gain insights on the state of the industry. In 2020, EARSC began conducting the survey annually. The 5th survey occurred in 2020, with data from 2019, meaning the effects of COVID-19 are not covered in this survey.[633] This edition also included a closer look at start-ups and skills.

572 companies participated in the 2020 survey, from 32 countries. 70% had 10 or fewer employees, and 93% had 50 or fewer. The results included a new category for larger companies with EO services as a minority part of the business, accounting for 2% of the companies surveyed. The number of companies founded each year has grown largely since a low or 8 in 2009 and is currently around 40.

The UK has the most remote sensing companies, at over 80, followed by Germany and France. Despite having the most companies, the UK does not employ the most people in the remote sensing sector. France holds this title, at 1794 employees, followed by Germany (1434) and the UK (1049). This is partially explained by Airbus, which has many employees in France and Germany.

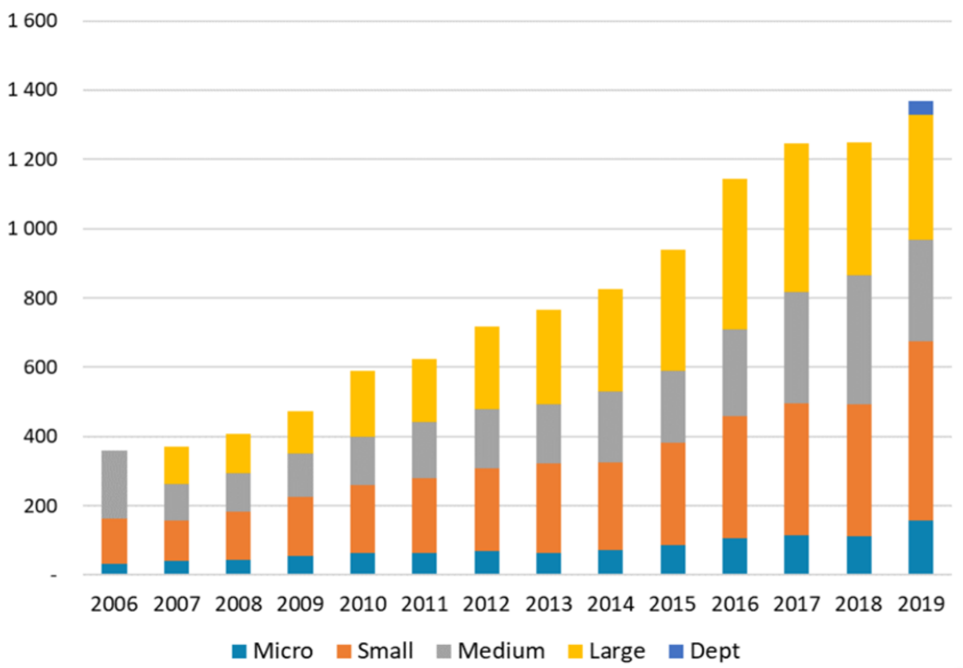


Figure 41: EARSC Survey 2020 evolution of revenues per company's class (Source: EARSC)

In total in 2019, 9876 people were employed in remote sensing in Europe. This is a large increase of over 17% since 2018. The employment figures have increased with a 5-year CAGR of 8%. 60% of job creation in the sector comes from companies formed 4 and 5 years ago, meaning they have secured revenue and investment and are able to expand. However, 80% of companies reported that it was not easy to fill open positions.

Total sector revenues in 2019 were €1.37 billion, growing by 9.7% since 2018. As the revenue growth rate between years is affected by single large contracts, CAGR is a more helpful measure. For the 5 years leading up to 2019, the CAGR was 10%.

[633] EARSC Secretariat, "EARSC Survey 2020", (2020): https://earsc.org/wp-content/uploads/2020/07/Industry-survey-2020-Final-version-1.pdf

4 Launches & Satellites

4.1 Global space activity evolution 2000-2020

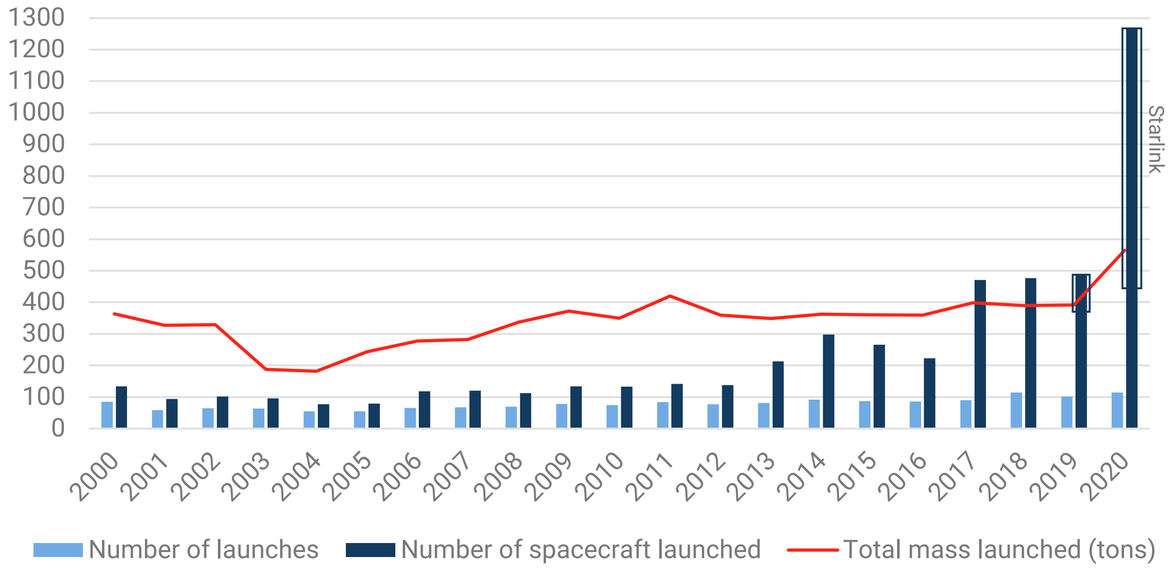


Figure 42: Evolution of launch activity over time (2000-2020)

Despite the COVID-19 pandemic, 114 launches were carried out in 2020, that is, 12 more than the year before and reaching the record high set in 2018. Moreover, 2020 is a milestone year starting a new era: for the first time, more than 1000 satellites were launched in a single year (1266 satellites in total), largely due to the launch of mega-constellations. As a result, the total mass launched also increased although not in the same proportion, reaching 564 tons (increase of 44.3% compared to 2019).

As mentioned above, the most important change concerns the number of spacecraft launched to orbit. While the period 2017-2019 already marked a major step compared to the years before, the year 2020 reaches another level: 2.6 times more spacecraft were launched than the record set in 2019. This stark increase is in large part due to the 833 Starlink satellites launched by SpaceX and, to a lesser extent, to the 104 satellites deployed for OneWeb, representing together 74% of all satellites launched worldwide. Indeed, in 2020, the routine deployment of mega-constellations actually started, and this trend is expected to continue in upcoming years. Involving heavier satellites than CubeSat constellations, these projects will also lead to an increase of the mass launched every year and of the total number of launches.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of launches	84	77	81	92	87	86	91	114	103	114
Spacecraft launched	142	138	213	298	266	223	471	477	490	1266
Mass launched (tons)	420	360	348	363	360	359	401	389	385	564

Table 20: Key space activity statistics (2011-2020)

4.1.1 Launch activity evolution by country

Figure 43: Evolution of the number of launches (left) and total mass launched (in tons, right) per country (2000-2020), with trendline

The evolution of the activity of World leading launch countries (United States, Russia, Europe, China) shows very different profiles:

- United States: after a decrease related to the retirement of the space shuttle and other factors, the U.S. activity is now experiencing a new growth, largely driven by new launch service providers, such as SpaceX, and the recovery of the capacity to service the ISS, for both cargo and crew missions. The role of SpaceX in the striking increase of 2020 is predominant, due to the rollout of the Starlink constellation as well as the launch of two crewed spacecraft to the ISS, on top of the cargo Dragons that the company usually delivers.

- China: the Chinese launch activity has skyrocketed since 2000 and China has now become one of the most active launch countries in terms of number of launches (e.g. 39 launches in 2018 and 2020, a record). Despite the pandemic, China carried out more launches in 2020 than in 2019, though several of them failed. However, the country is not yet a leader in terms of mass launched. The strong growth in institutional demand from Chinese authorities remains the main driver, as almost all payloads launched by China are domestic and more than 80% of the mass is launched for governmental actors (civil and military).
- Russia: along the rest of its space sector, the launch activity of the historical leader has experienced a sharp decrease over time, both in number of launches and mass launched. This decreasing trend accelerated in 2020 with only 15 launches (compared to 22 in 2019) and 58 tons put in orbit (83 tons in 2019). Today, the servicing of the ISS corresponds to a significant share of the Russian launch activity in terms of number of launches (one quarter of Russian launches in 2020) and of mass launched (half of the total mass put in orbit in 2020).
- Europe: the launch activity has remained rather stable around 10 launches and 50 tons put in orbit per year. The introduction of the new launchers Vega and Soyuz contributed to diversifying and expanding European launch capabilities. Nevertheless, a significant drop is visible in 2020 (the total mass launched represented only 70% of the mass launched in 2019), partly explained by the Guiana Space Centre's closure because of the COVID-19 pandemic.

Despite a strong domestic space sector, other countries such as India and Japan still have a comparatively limited launch activity.

4.1.2 Spacecraft orbit and mass

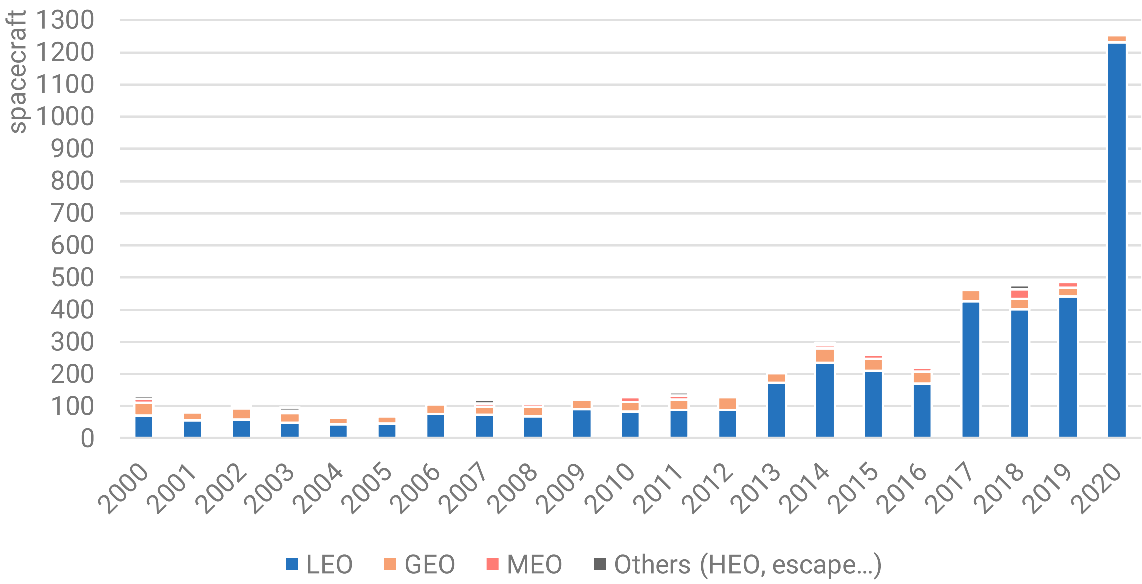


Figure 44: Evolution of the number of spacecrafts launched per orbit (2000-2020)

Over the past ten years, the number of satellites launched to GEO remained rather stable, between 30 and 40, with a maximum of 45 in 2014 and a minimum of 29 in 2019. However, this trend worsened in 2020, with only 24 satellites launched to geostationary orbit. An overwhelming majority of satellites is now deployed in LEO, mainly due to the launch of small spacecraft and CubeSats in the frame of (mega)constellations (for Earth observation or telecommunications) and technology/demonstration missions. During the period 2017-2019, LEO was the destination of 88% of all satellites launched but, in 2020, this rate reached 97%. This remarkable increase is mostly due to the launch of Starlink satellites; yet, even when excluding them, still 92% of all spacecraft launched in 2020 were for LEO.

The number of launches to MEO also increased over time but to a much lesser extent (5 in 2009, 16 in 2019, with a peak at 31 in 2018), due to the deployment of several GNSS systems (China's Beidou, Europe's Galileo), as well as the development of satcom systems in MEO (e.g., the O3b constellation and its 20 satellites that were launched between 2013 and 2019). Therefore, the (quasi-)completion of GNSS constellations (e.g., Galileo, Beidou) and the development of LEO satcom mega-constellations may explain the low number of satellites launched to MEO in 2020 (only 5).

Interestingly, in 2020, most of the mass was for the first time launched to LEO (while this orbit used to dominate "only" in terms of number of spacecraft). However, the gap between LEO and other orbits is less important when we focus on the mass launched. While spacecraft launched to LEO accounted for 97% of all spacecraft in 2020, they represented 69% of the total mass sent to orbit (excluding human spaceflight activities). In comparison, spacecraft launched to GEO (mostly telecommunication satellites) accounted for only 1.9% of all spacecraft launched but 21.9% of the total mass (when excluding human spaceflight activities).

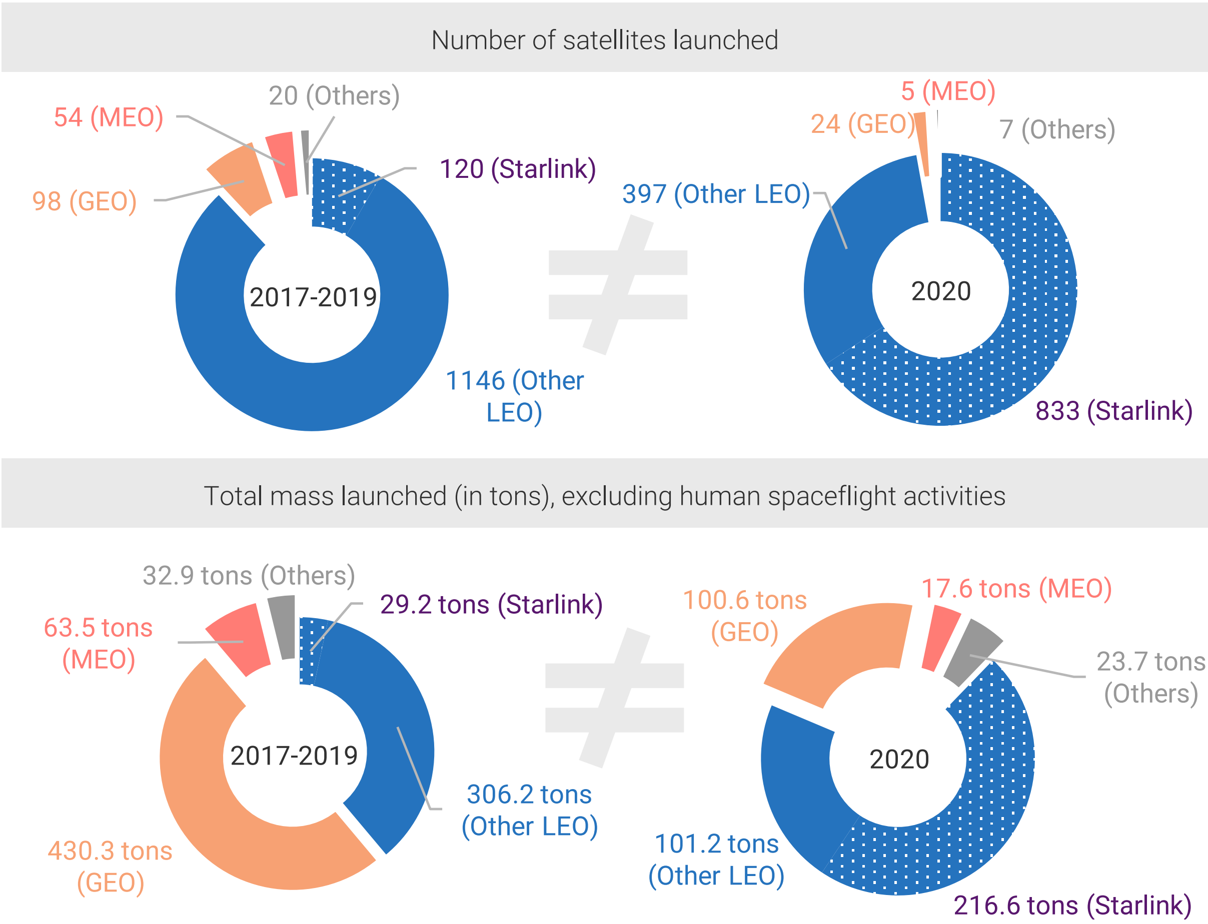


Figure 45: Comparison of the number of satellites and total mass launched by orbit between the period 2017-2019 (left) and the year 2020 (right)

The total mass launched to GEO has increased over time (+34% between 2009 and 2017), but this trend is starting to reverse. In the last three years, the mass drastically decreased due to difficulties in the satcom market (governmental satellites being included, 23 and 21 GEO satcoms were launched in 2018 and 2019, and only 15 in 2020, as compared to 30 in 2017). The average mass of GEO satcoms increased to reach 5 tons in 2019 (it was around 3 tons in the 2000s). The total mass launched to LEO (including human spaceflight) was around 200 tons per year over the past years, comparable to the years 2000s when the ISS was under construction. However, in 2020, this amount reached around 422 tons. The launch of mega-constellations for telecommunication purposes (in particular Starlink) is the main driver of this doubling.

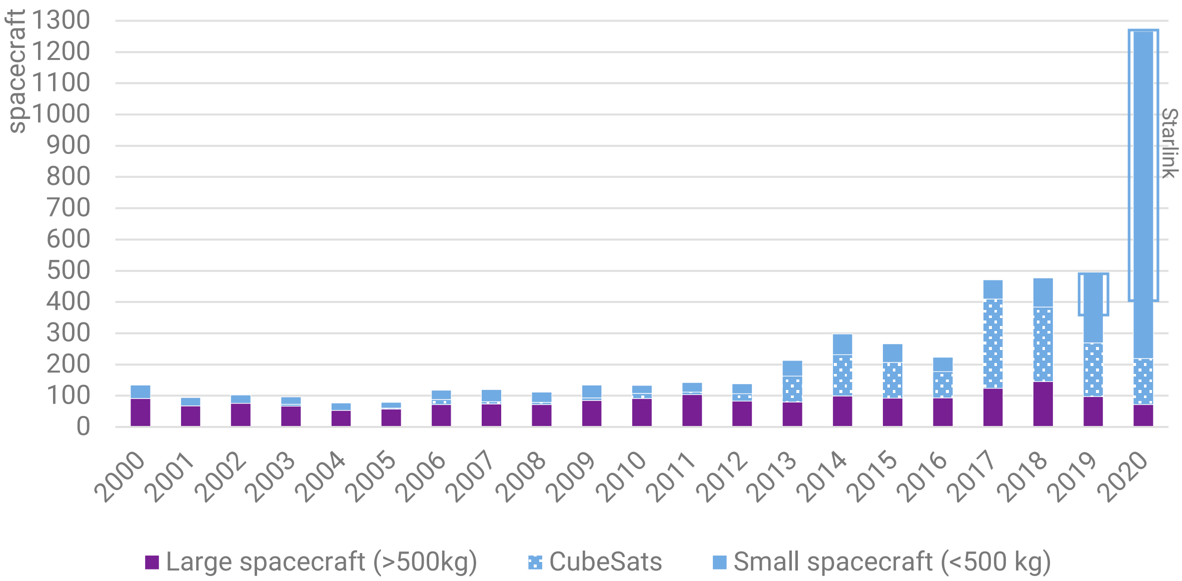


Figure 46: Evolution of the number of spacecraft launched per mass category (2000-2020)

Small spacecraft, including CubeSats, became the dominant category of payloads launched to orbit from 2013, but this preeminence decreased with time, in particular in 2019 and 2020 (where small spacecraft below 500 kg became the overwhelming category). Over the past two years, the number of small spacecraft (including CubeSats) launched reached an all-time high: in 2019, they were four times more numerous than large spacecraft (80% of all spacecraft launched); and in 2020, small spacecraft represented 16.5 times the number of large spacecrafts sent to orbit. This very high number is of course mostly linked to the 833 Starlink satellites launched. Yet, when they are discarded, 5 times as many small spacecrafts as large spacecraft were still launched in 2020, thus demonstrating a real trend towards the miniaturisation of satellites.

Despite the very high share of small spacecraft launched, large spacecraft still account for the majority of the mass put in orbit every year, even though this dominance is fading. While in the period 2017-2019, large spacecraft accounted for 94% of the total mass launched, this proportion was only of 56% in 2020. Since 2000, the number and total mass of large spacecraft have been highly variable ranging between 53 and 145 spacecraft for 180 to 420 tons. Since 2012, the total mass of large spacecraft has stabilised around 360 tons per year but has been following a slightly decreasing trend since 2017.

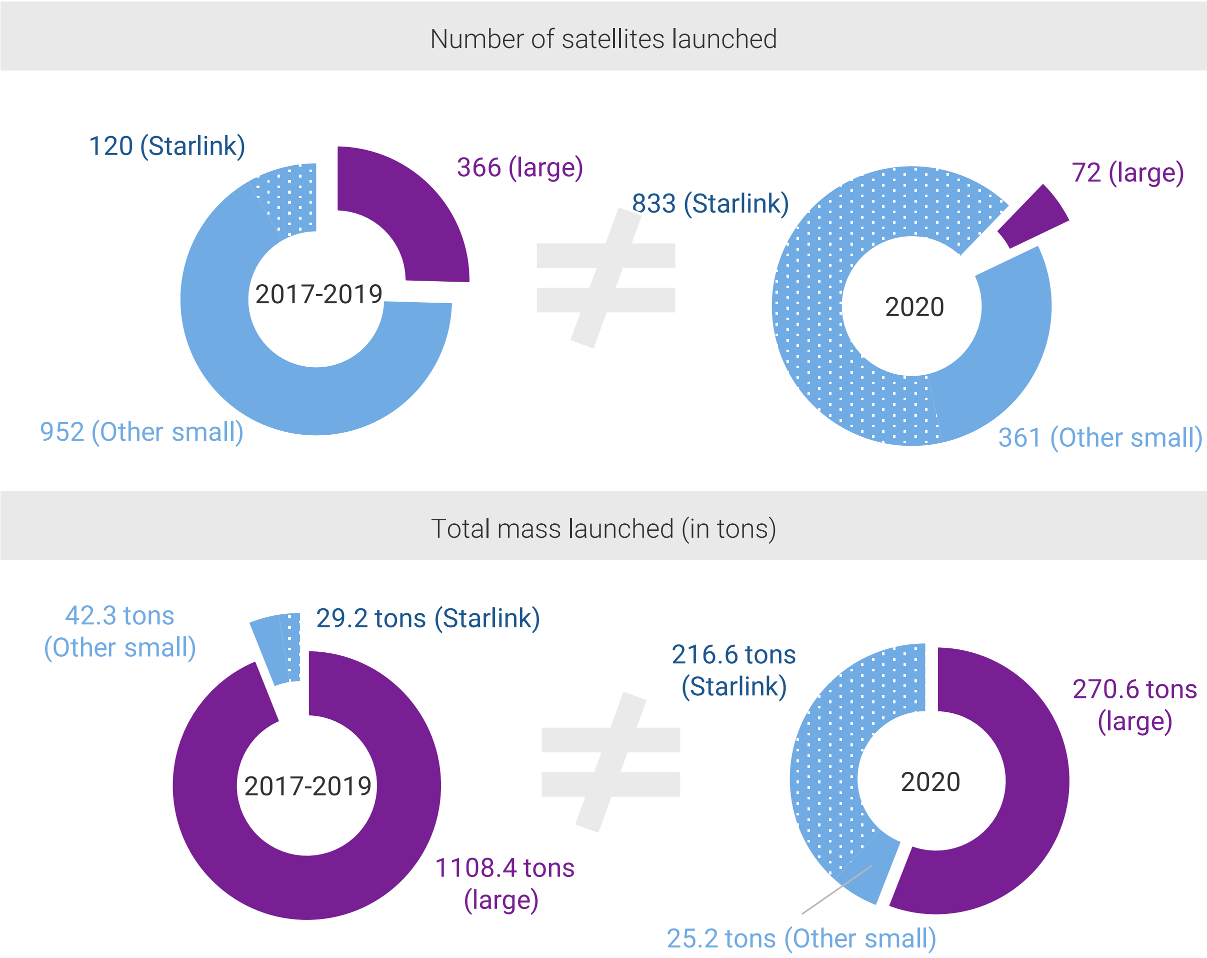


Figure 47: Comparison of the number of satellites and total mass launched per mass category between the period 2017-2019 (left) and the year 2020 (right)

4.1.3 Space missions and markets

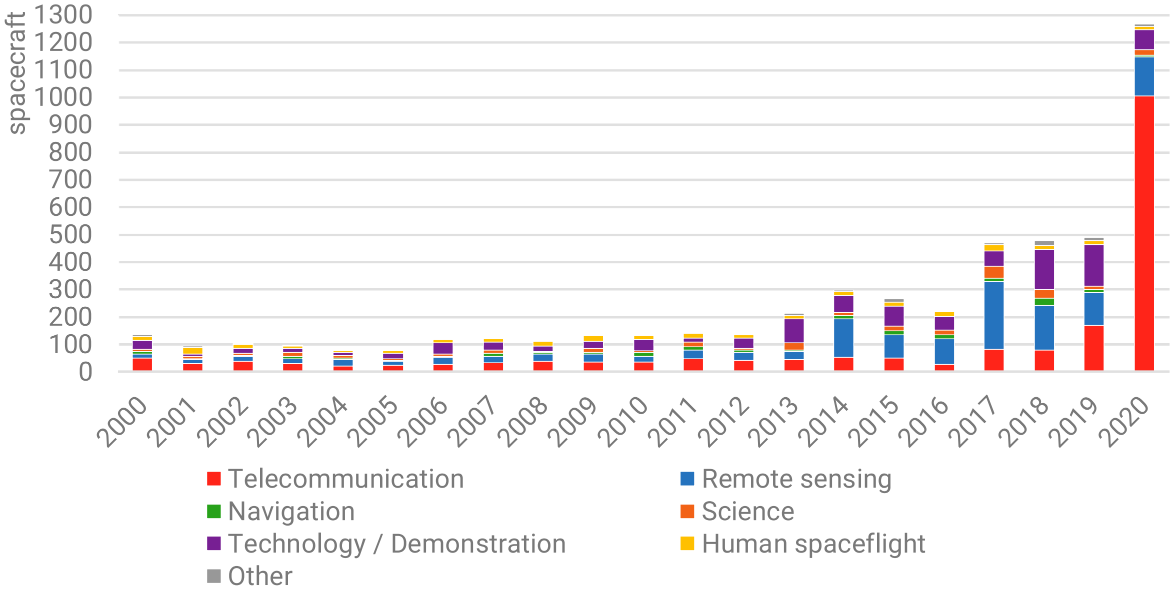


Figure 48: Evolution of the number of spacecraft launched, per mission (2000-2020)

A majority of spacecraft is now launched for telecommunication, remote sensing and technology/demonstration missions. Small satellites represent 78% of the mass launched for telecommunication missions in 2020, a significant change compared to the previous paradigm in which heavy GEO satcom accounted for the bulk of this mass. Despite this situation, telecommunication spacecraft still account for 53.2% of the total mass launched in 2020, compared to 18.5% for human spaceflight and 12% for technology/demonstration. The share of remote sensing spacecraft is almost divided by two in 2020 compared to the year before, accounting for only 8.4% of the total mass launched.

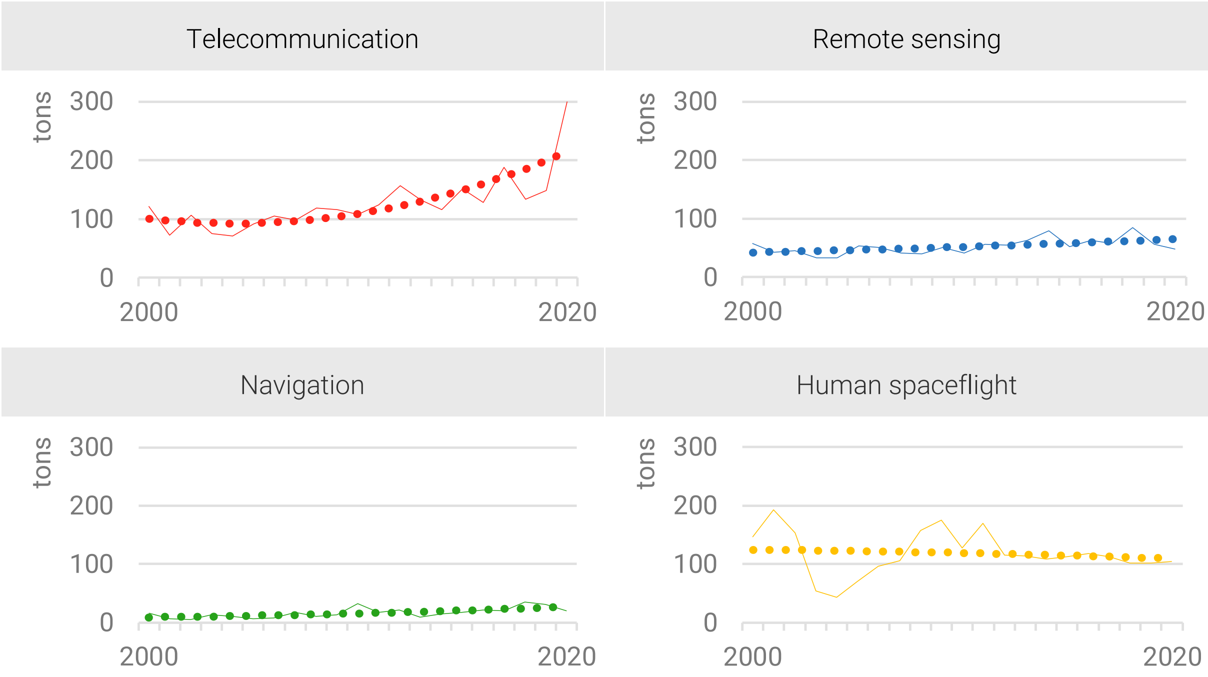


Figure 49: Evolution of the total mass launched (in tons) per mission (2000-2020) with trendline

The high number of telecommunication and remote sensing satellites launched during recent years is mostly due to the launch of constellations, including CubeSat constellations of Planet and Spire but also Starlink, OneWeb or Iridium-NEXT. The number of technology/demonstration satellites also increased substantially in 2018 and 2019 to reach a third of all spacecraft, but collapsed in 2020 (5.6% of all spacecraft, 16.4% without Starlink). However, their mass, even though it remains low, tends to increase. For instance, in 2018, the average mass of the 144 satellites launched for this category of missions was of 67 kg. It grew to 263 kg in 2019 and 950 kg in 2020. This major increase in 2020 can be explained by a few heavy Chinese and American satellites aimed at testing technologies for these countries' military and civil space programmes. Finally, the number of human spaceflight missions, mostly comprising the servicing of the ISS, remained rather steady with 12 to 20 missions per year (with the exception of the period following the Columbia disaster in 2003).

Telecommunications and human spaceflight spacecraft are the two main types of missions contributing to the total mass launched. Even though the mass related to human spaceflight missions has decreased slightly since 2010, more than 100 tons are still launched every year to service the ISS. On the same period, the total mass launched for telecommunications missions increased and 130 to 150 tons in average were launched every year. A new record high of 300 tons was achieved in 2020 (+60% compared to the previous record) due to the launch of Starlink satellites.

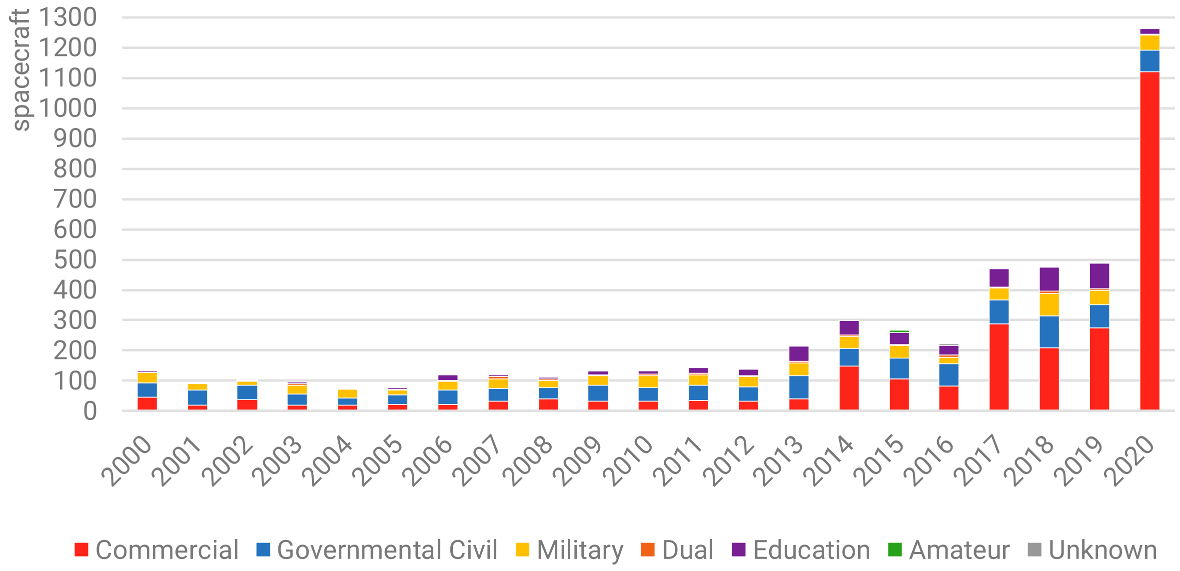


Figure 50: Evolution of the number of spacecraft launched per market (2000-2020)

Data show a steep increase of the number of commercial satellites over the period 2017-2019, but the year 2020 marks a change of scale. While more than 200 spacecraft were launched each year to provide commercial services between 2017 and 2019, representing between 40% and 60% of the total number of satellites launched, 1120 commercial satellites were launched in 2020 alone (88.5% of all spacecraft). Even with Starlink satellites excluded from the calculation, commercial satellites still account for 66.3% of the spacecraft launched in 2020. The total mass of commercial satellites also grew over time, although to a lesser extent, as many of these satellites belong to the category of small spacecraft. These figures illustrate the growing momentum in commercial space activities and the emergence of new entrants, services, and markets.

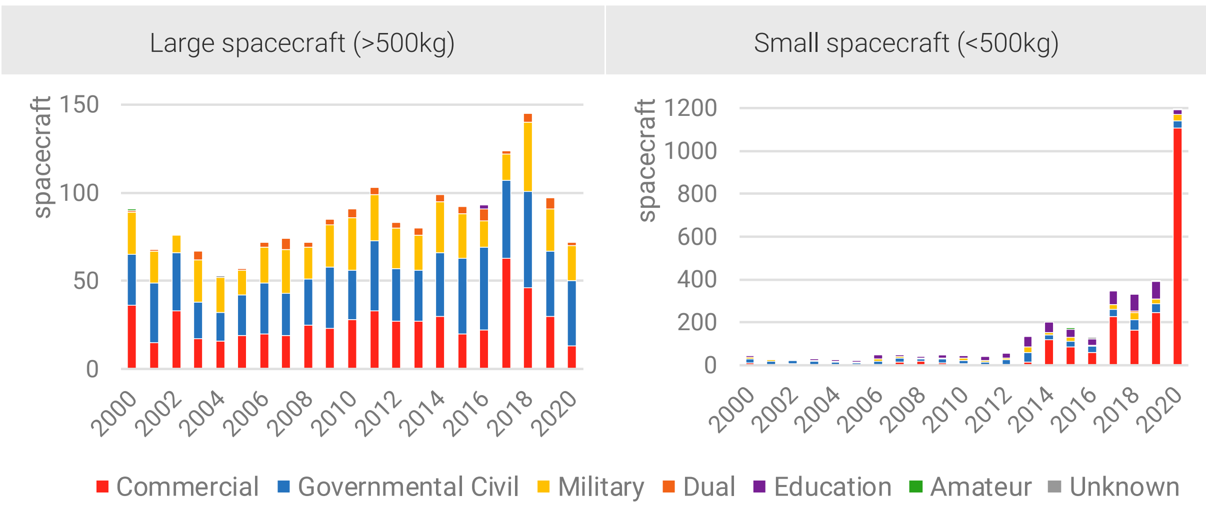


Figure 51: Evolution of the number of spacecraft launched per market and mass category (2000-2020)

While being less numerous than commercial satellites, spacecraft used for institutional purposes (governmental civil, military and dual) have continued to make up a great share of the total mass launched over the past years, representing between two thirds and three quarters of the total mass between 2015 and 2019. While this share significantly decreased in 2020, institutional spacecraft still account for 49.3% of the total mass launched. With regards to the military market, the number and mass of these satellites have grown, slightly but steadily, since 2000. Since 2015, between 40 and 50 military satellites have been launched per year, for an average mass of 76 tons per year. Various factors contribute to this growth, which concerns a variety of missions, both operational and experimental. It is also noteworthy that, while governmental civil missions have represented the largest share in terms of mass launched since 2000, primarily due to human spaceflight, this position is eroding in 2020 in front of the commercial activity. Commercial missions indeed account for 45.8% of the total mass launched that year, strongly driven by Starlink spacecraft.

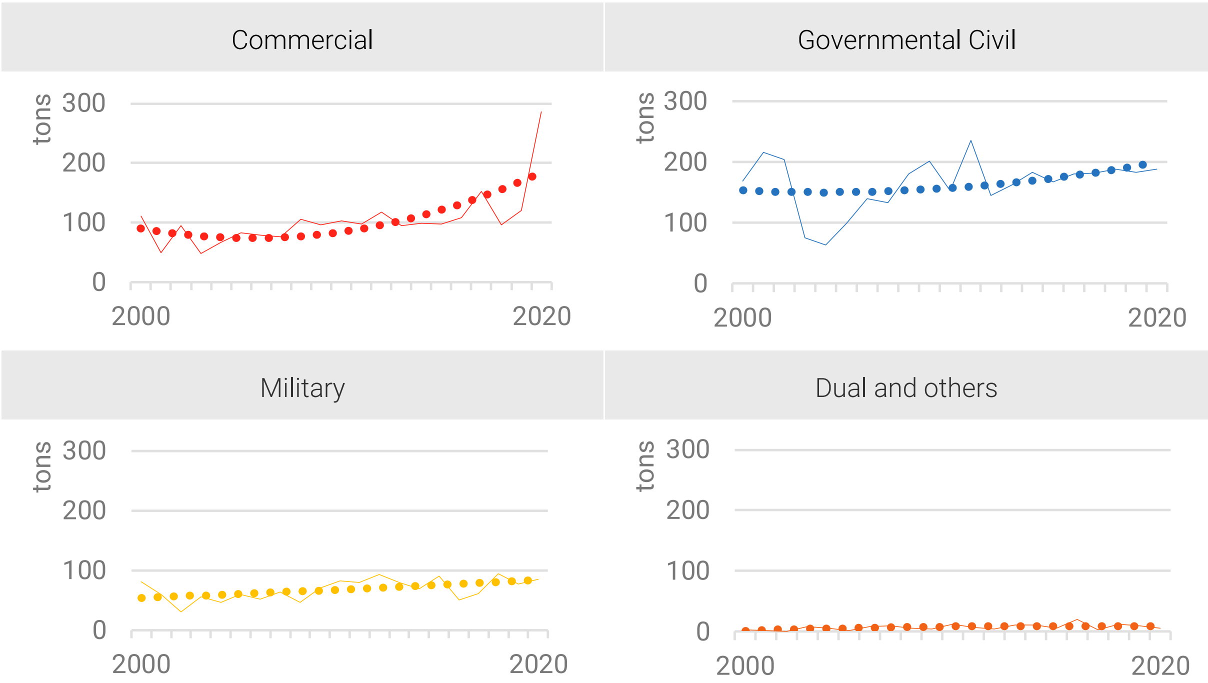


Figure 52: Evolution of total mass launched (in tons) per market (2000-2020) with trendline

4.1.4 Spacecraft manufacturing and procurement by country

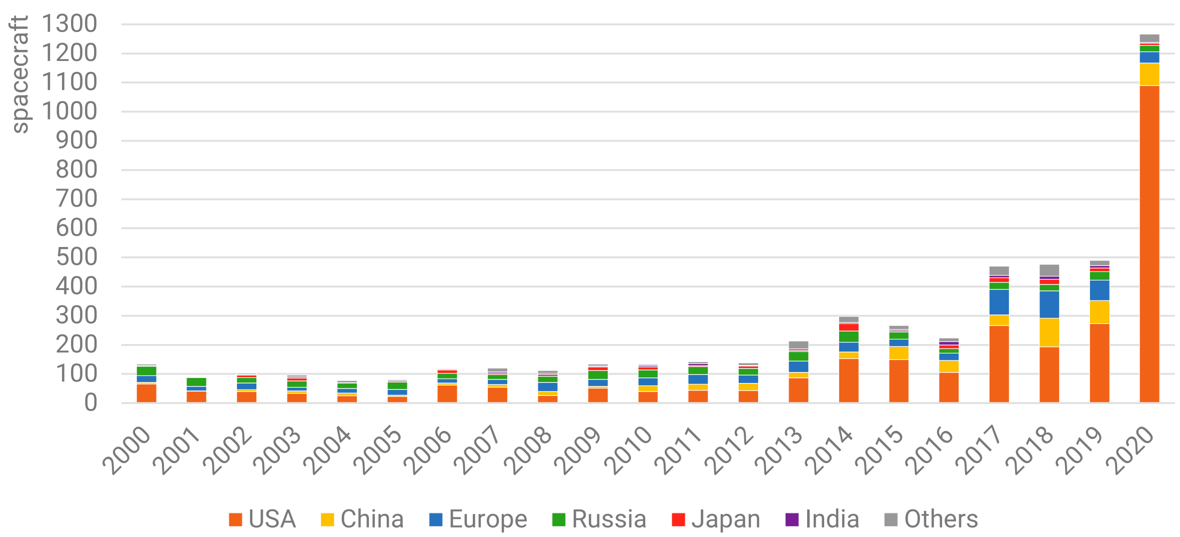


Figure 53: Evolution of the number of spacecraft per manufacturing country (2000-2019)

The manufacturing activity of the United States experienced an increase over the last decade. Between 2017 and 2019, 51% of all spacecraft launched worldwide were integrated in this country, corresponding to 38% of the total mass. In 2020, these shares reached 86% of all spacecraft and 63% of the mass, again largely boosted by Starlink (and OneWeb[634]). Comparably to the increase of the country's launch activity, spacecraft manufacturing in China also experienced a massive growth. Between 2017 and 2019, China produced 15% of spacecraft that were launched (17% of the total mass). The activity of Russia remained stable with a vast majority of its output concerning human spaceflight vehicles (Soyuz, Progress) and satellites for various domestic public programmes. The output of Europe has been irregular and does not allow to draw a clear trend. In the period 2017-2019, Europe manufactured 18% of all spacecraft put in orbit for about 17% of the mass launched. However, in 2020, these figures dropped to 3% of satellites launched and 3% of the total mass launched. However, when Starlink and human spaceflight, two domains where Europe is absent, are excluded, the contribution of European manufacturers slightly rise to 9.3% of all spacecraft launched in 2020, accounting for 7.6% of the mass launched.

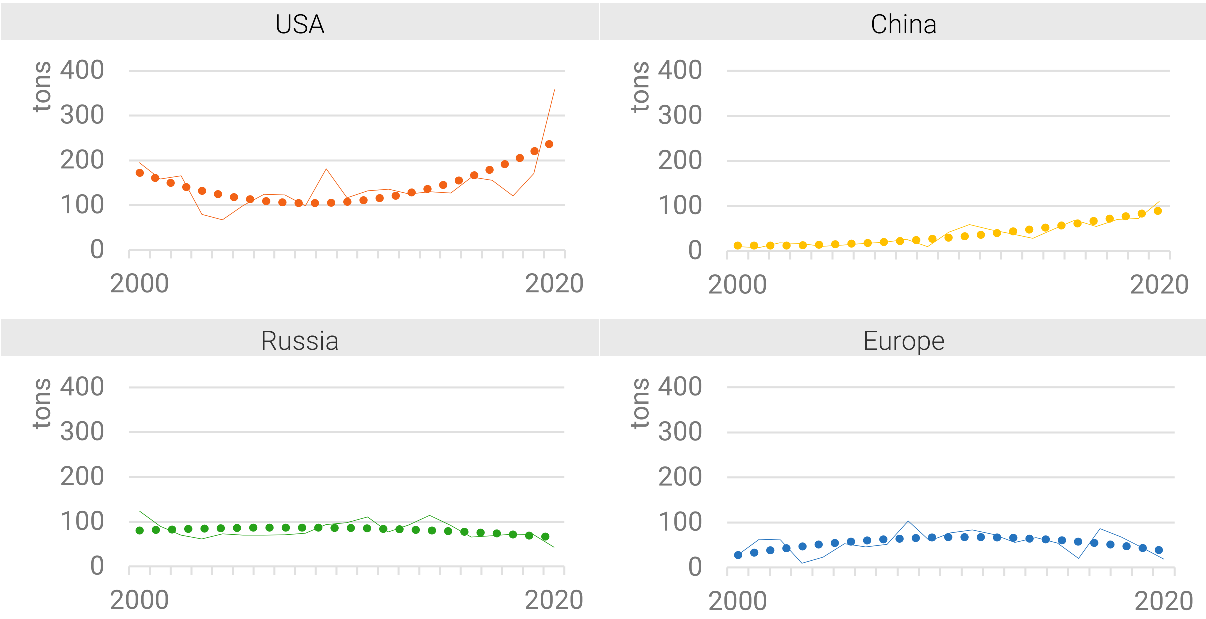


Figure 54: Evolution of spacecraft mass (in tons) per manufacturing country (2000-2020) with trendline

With the popularisation of the CubeSat standard, a growing number of countries and organisations have already developed a spacecraft, even though very basic. Since 2016, more than 350 organisations have produced a satellite, including agencies, governmental bodies, universities, research institutes and others. Nevertheless, the spacecraft manufacturing activity is still highly concentrated in a few countries but also a few companies. Over the last 5 years, the top 10 companies produced 80% of the total mass put in orbit.

This concentration is even more visible on the commercial market (mostly telecom). A few companies and organisations compete on the international commercial satellite market and capture most of the related activity. The top 10 manufacturers produced 95% of commercial satellite mass during the period 2015-2019, and 99% in 2020. U.S. companies, including Boeing, Lockheed Martin, Orbital ATK (now Northrop Grumman), Space Systems Loral (now Maxar Technologies) and SpaceX, capture most of the market. SpaceX put into orbit 120 operational Starlink satellites in 2019, and 833 more in 2020, giving way to one of the first large-scale fully vertically integrated activity: SpaceX is the manufacturer, operator and launch service provider of its constellation.

[634] OneWeb spacecraft are produced by OneWeb Satellites a joint venture between OneWeb and Airbus. Although these two companies are European, the main production line is located in Florida, hence ESPI considers the satellites as a U.S. output.

Position	Top 10 (2015-2019)	Share of the total commercial satellites mass	Top 10 (2020)	Share of the total commercial satellites mass
1	SSL/Maxar	26.1%	SpaceX	75.8%
2	TAS	19.9%	CASC	5.8%
3	Boeing	15.1%	OneWeb Satellites	5.3%
4	Airbus	12.8%	Maxar	4%
5	CASC	6.8%	Northrop Grumman	2.2%
6	SpaceX	5.5%	Lockheed Martin	2%
7	Orbital ATK/NG	3.4%	ISS Reshetnev	1.5%
8	Lockheed Martin	2.7%	TAS	1.3%
9	Mitsubishi Electric	1.8%	Chang Guang Satellite Technology	0.7%
10	NEC	0.9%	Nanoracks	0.4%
	Total	95%	Total	99%

Table 21: Share of the mass launched (in tons) for the commercial market by the top 10 manufacturers

European companies Airbus and Thales Alenia Space also perform very well and maintain a leading position on the market, although difficulties on the GEO satcom market start to have a noticeable impact. In the period 2017-2019, the two European companies delivered 150 tons of commercial satellites, corresponding to 40% of the total mass. 2020 was more complex for both manufacturers, as Airbus did not deliver any spacecraft for the commercial market (except through its joint venture with OneWeb), and only one TAS-built satellite went to orbit for commercial customers.

The commercial activity of the China Aerospace Science and Technology Corporation (through its subsidiaries), remains rather limited because of difficulties to enter large segments of the market, for example due to ITAR restrictions.

Interestingly, the mass produced by other manufacturers reached an all-time high in 2020 (more than 20 tons), illustrating the emergence of new actors in the space market and the diversification of procurement sources.

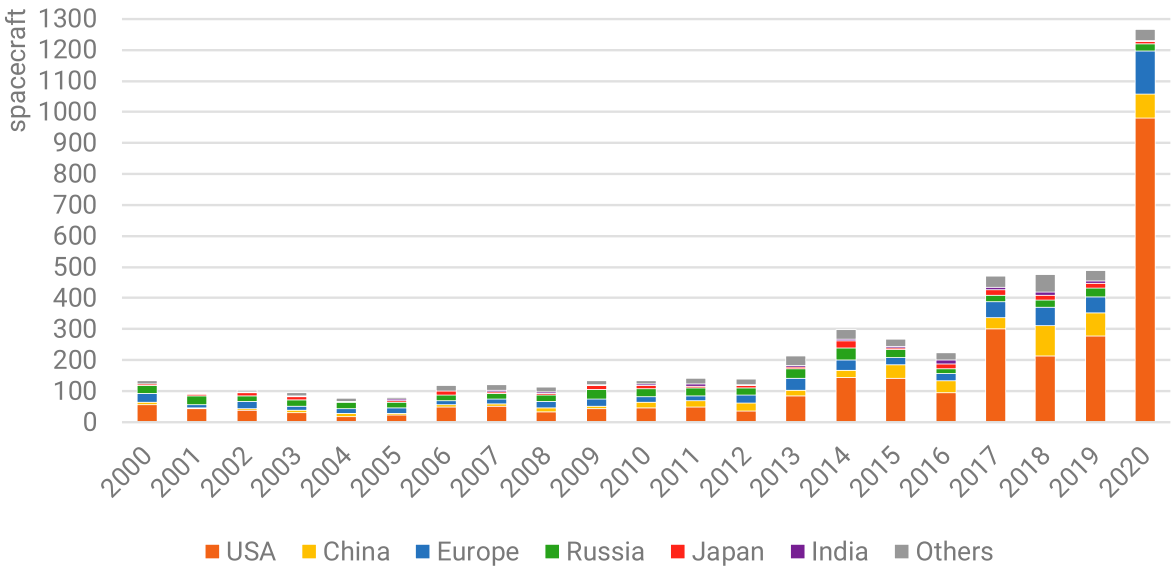


Figure 55: Evolution of the number of spacecraft per procuring country (2000-2020)

A large majority of spacecraft is procured domestically, mostly because of procurement rules and market constraints. For this reason, the distribution of spacecraft per manufacturing and procuring country is almost identical, with a slight variation related to import/export of commercial satellites. This is the case both for the number of spacecraft and the corresponding mass. As a result, it is not surprising that most of the spacecraft are also procured by U.S. organisations and companies. During the period 2017-2019, 55% of spacecraft launched worldwide were procured by the United States, corresponding to 36% of the total mass. This share reached 77.5% of spacecraft and 59% of the total mass launched in 2020. In China, a significant share of the space activity serves a domestic need. Therefore, China's growth comes first and foremost from an increase of the national investment in the space sector. The number and mass of satellites ordered by Chinese organisations and operators multiplied by more than 10 since 2000, for the first time exceeding 100 tons in 2020.

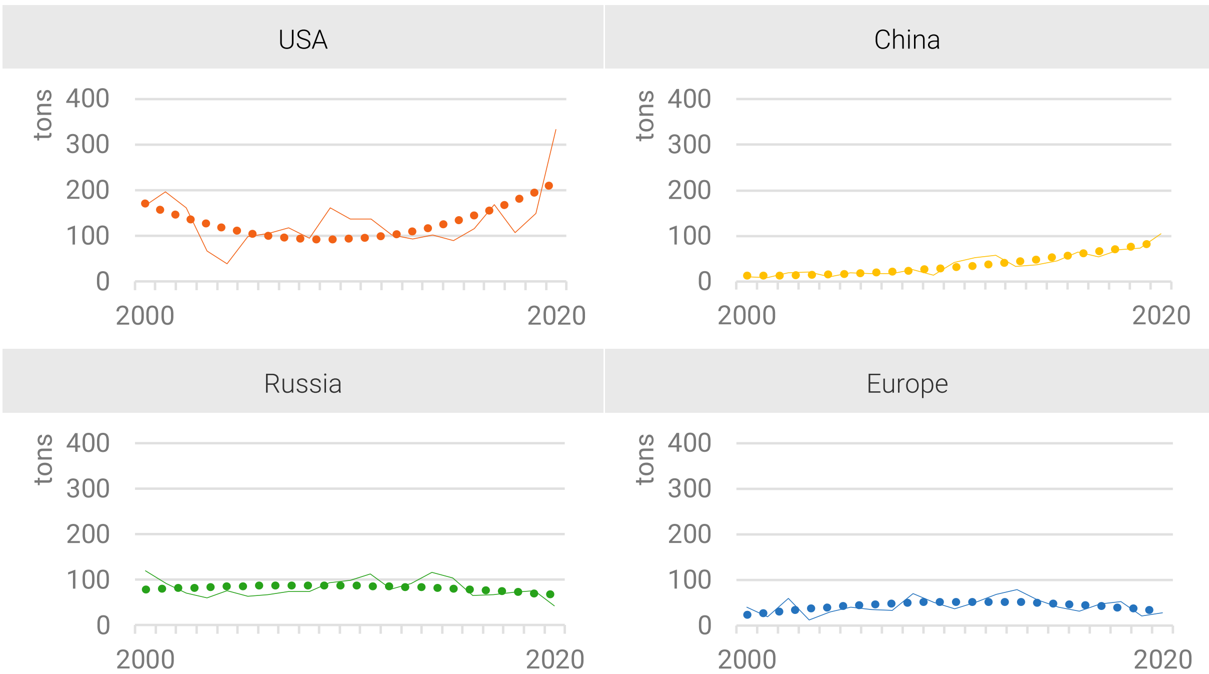


Figure 56: Evolution of total mass launched (in tons) per customer country (2000-2020) with trendline

Interestingly, Europe is the only region where the manufacturing output is much higher than the domestic demand, underlining the importance of export markets for European companies. The demand of European organisations is usually below 50 tons per year while the industry output is regularly well above this threshold. Procurement statistics in Russia are somewhat biased by the human spaceflight activity, as Progress and Soyuz capsules are attributed to Russia although they may be paid for, at least partially, by other countries.

On the commercial market, leading satellite operators and customers are more diverse and include European, American, Russian, Chinese, Japanese, Canadian and Arabic companies. Over the last 5 years, these satcom operators were responsible, together, for 75% of the mass launched for the commercial satellite market, including non-telecom markets such as remote sensing which remains, comparatively, very limited. Of course, the procurement of these operators is highly irregular, involving a few orders of large satellites. However, several of these operators are contemplating constellations of smaller satellites in LEO, either for their traditional activities (e.g. Telesat) or to address new markets (e.g. Eutelsat LEO for Objects, aimed at providing Internet of Things).

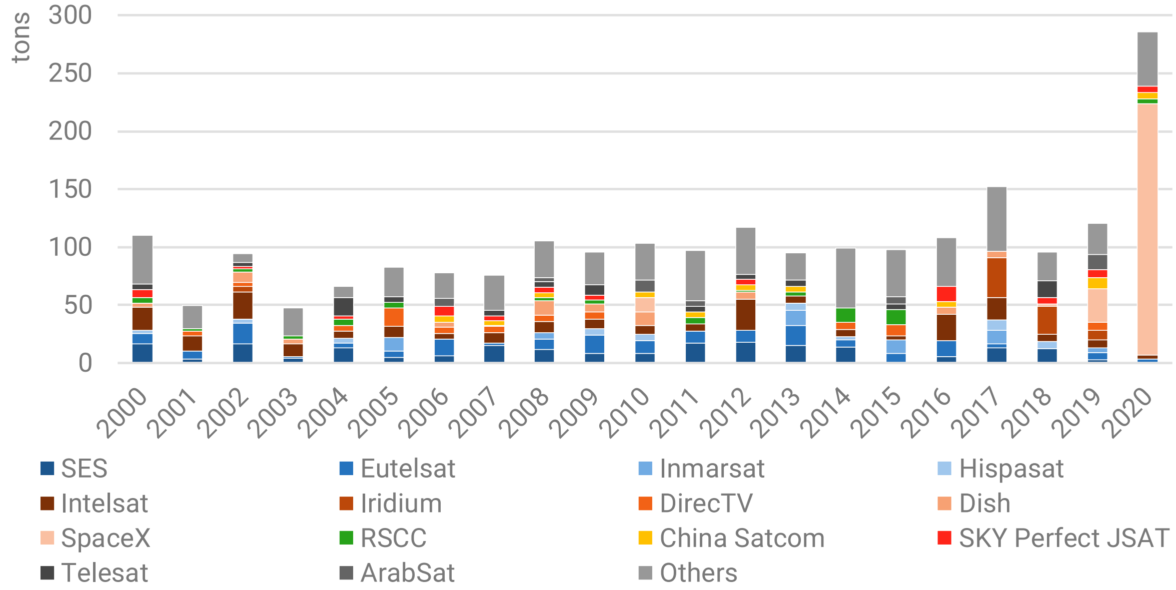


Figure 57: Evolution of the mass launched (in tons) for the commercial market per year per customer (2000-2020, selected companies)

Finally, several of these companies contributed to the bounce of the market of GEO satellites in 2020 (21 commercial satellites ordered compared to 10 in 2019 and 12 in 2018). However, most of the SES and Intelsat's satellites, which account for the majority of satellites ordered in 2020 (62.5%) have been ordered due to the replacement of satellites stemming from the C-band spectrum reallocation taking place in the United States.

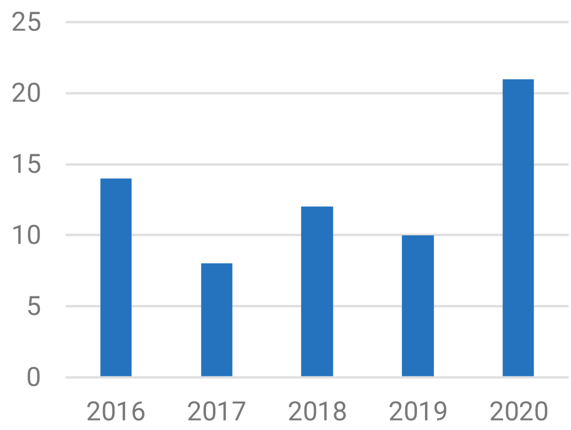


Figure 58: Evolution of the number of commercial GEO satellites' orders (2016-2020)

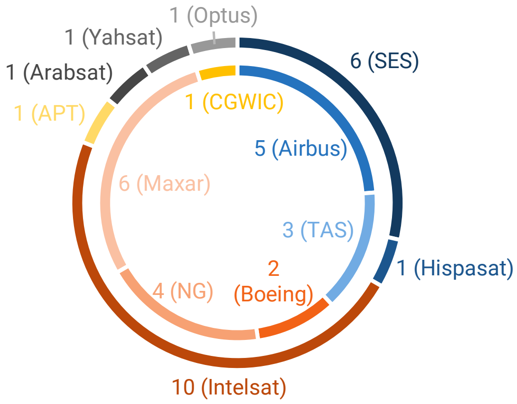


Figure 59: Number and share of commercial GEO satellites' orders by manufacturer (inner circle) and operator (outer circle) in 2020

4.2 Global space activity in 2020

4.2.1 Launch activity in 2020

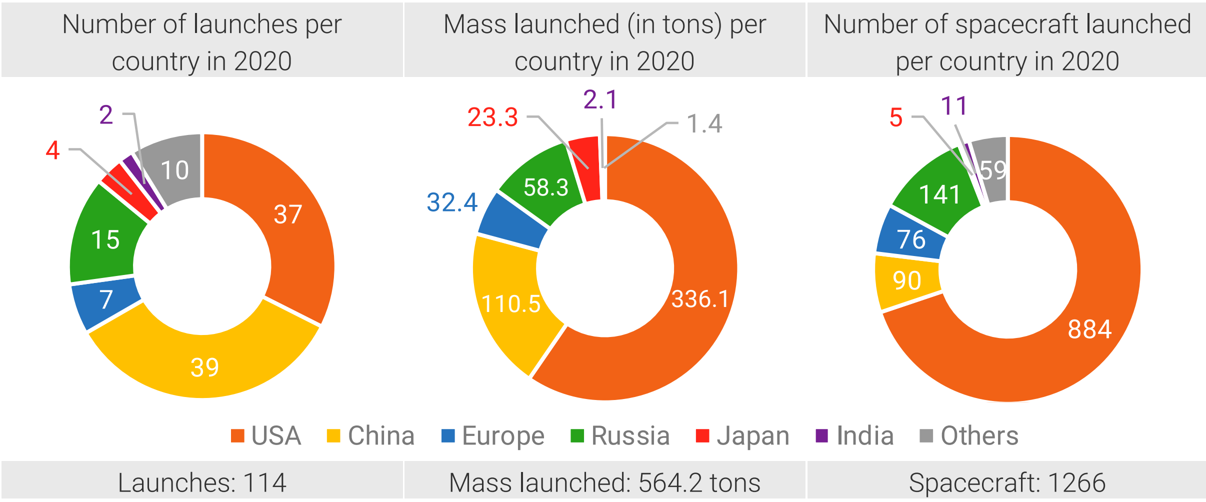


Figure 60: Number of launches, spacecraft and mass launched in 2020 per launch country

In 2020, nine countries (United States, China, France (for Europe), Russia, Japan, India, New Zealand, Iran and Israel) launched 1266 spacecraft belonging to 31 nations. Among these nations, Guatemala, Monaco and Slovenia had their first satellite launched, joining the increasingly long list of 80+ countries involved in outer space activities. These figures and the numbers given below also include failed launch attempts, which represent 8.8% of all launches carried out this year (10 failures for 114 launches).

For the third consecutive year, China conducted most of the launches (39, accounting for 34% of all launches), similar to its record high of 2018 and above the number of 2019 (34) despite the COVID-19 pandemic that hit the country. However, contrary to 2019, the number of launches from the United States (37) is almost equal to the Chinese one. The third traditional main launch country, Russia, lags behind with only 15 launches (13% of the total). However, the number of satellites that it put into orbit remains superior to the Chinese, in major part due to the launch of OneWeb satellites from Baikonur and Vostochny (launch service provided by Arianespace).

In terms of mass launched, the United States holds the first place, primarily due to the launch of Starlink satellites (64% of the total mass launched by the United States) and its human spaceflight activities. Interestingly, China is for the first time ahead of Russia, despite the role of the latter in bringing crew and cargo to the ISS (accounting for 49% of the total mass launched by Russia). This breakthrough is caused by the launch of numerous remote sensing satellites (in particular from the Gaofen series) and of heavy demonstration spacecraft, including for the Chinese human spaceflight programme.

With 7 launches, Europe underwent its lowest launch activity since 2006. Only 32.4 tons (including the failure of Vega) were launched from Kourou, the lowest level since 2004. These numbers can partly be explained by the closure of the Guiana Space Centre for several months, which reduced operations.

The most active spaceport for the year 2020 is Cape Canaveral for the second year in a row, both in terms of number of launches (20) and total mass launched (183 tons), largely due to SpaceX (14), in particular for its Starlink constellation (8 launches, the other 6 launches for the constellation taking place from the Kennedy Space Centre). Two Chinese spaceports hold the second and third positions: 13 launches took place from the Xichang spaceport, and 12 from Jiuquan. Baikonur, historically a major spaceport, falls far behind in 2020, with only 7 launches.

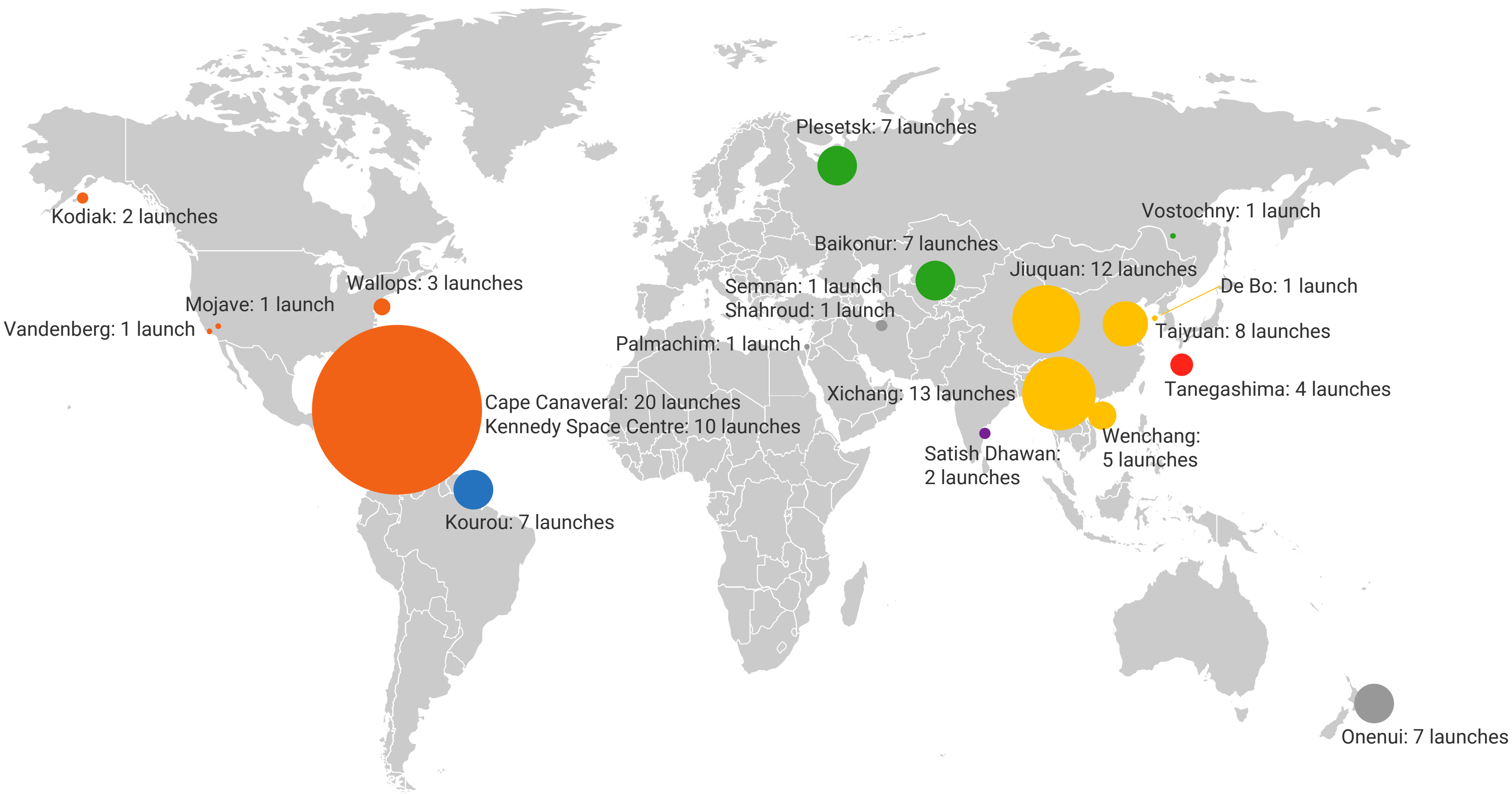


Figure 61: Number of launches per spaceport in 2020

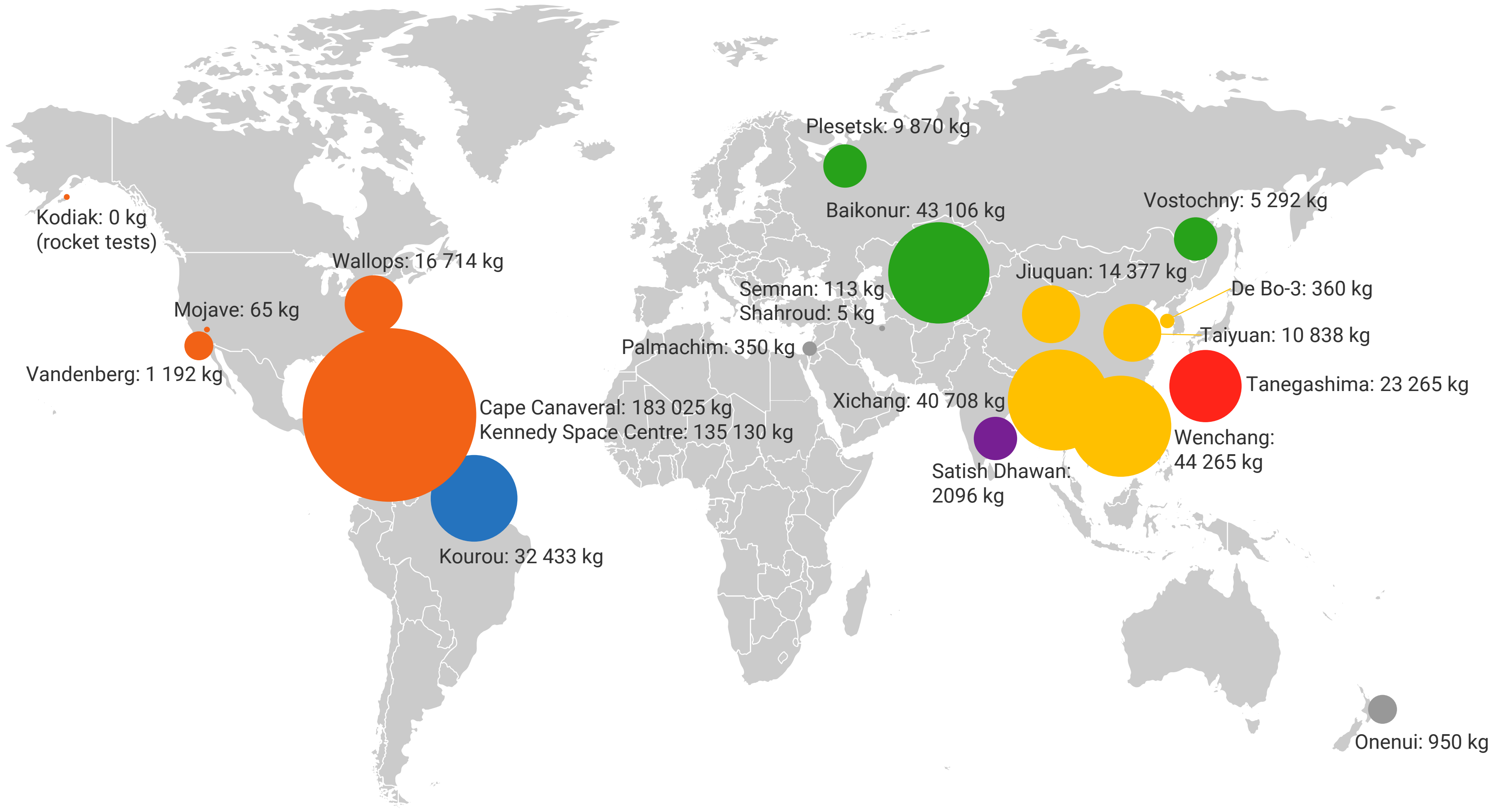


Figure 62: Total mass launched per spaceport in 2020

4.2.2 Spacecraft launched in 2020: customers and manufacturers

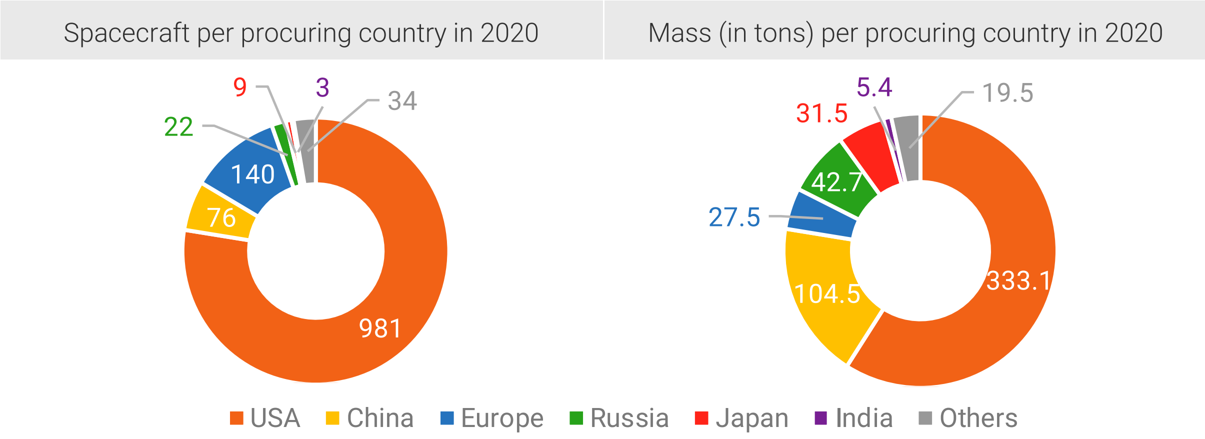


Figure 63: Number and mass of spacecraft per procuring country in 2020

The United States was the biggest customer country in 2020 with 981 satellites accounting for over 330 tons. 80% of the spacecraft launched in 2020 were American. In terms of mass, the United States accounts for 59% of the mass launched, and China for 18.5%, while the number of satellites it procured is 13 times lower than the American one. The average weight of spacecraft launched for Chinese organisations is thus much higher than it is for their American counterparts (1375 kg vs. 340 kg).

From a manufacturing perspective, the figures are quite similar for the United States, both for what concerns the number of spacecraft and the mass launched (respectively 86.1% and 60.7%), showing that most of the spacecraft built by U.S. companies are for U.S. customers. Regarding Europe, the continent is the third biggest manufacturer of spacecraft launched in 2020, and the mass produced is 22% higher than the level of European procurement. The share of other countries on the procured mass is 2.5 more important than their share in manufactured mass, showing their growing interest in space but also that their demand is mainly filled by the more capable industry of established spacefaring nations, in particular for heavy advanced systems. Finally, despite a reduced number of manufactured satellites, Japan is not so far from Europe in terms of mass produced.

Of course, the high figures for the United States are primarily due to SpaceX's spacecraft (Starlink and Dragons). Overall, 2020 could be labelled as "the SpaceX year", as the company alone represented 77% and 46% of the mass manufactured respectively in the United States and globally that was put in orbit that year.

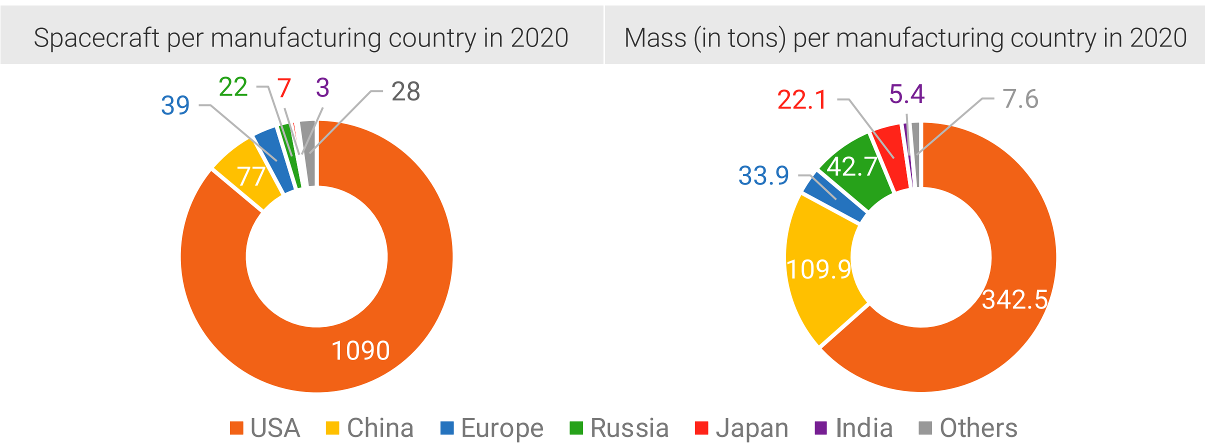


Figure 64: Number and mass of spacecraft per manufacturing country in 2020

4.2.3 Spacecraft launched in 2020: missions and markets

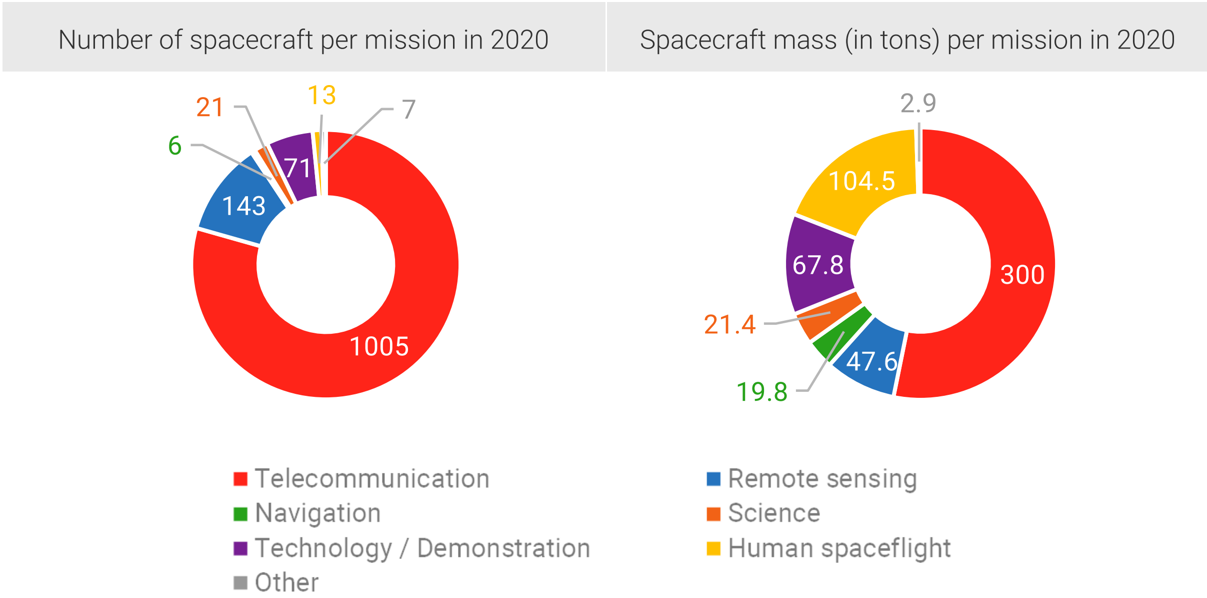


Figure 65: Number and mass of spacecraft per mission in 2020

Mainly as a result of the Starlink constellation, an overwhelming majority (80%) of the satellites launched in 2020 served telecommunication purposes, followed to a much lesser extent by remote sensing (11%) and technology/demonstration spacecraft (6%). However, telecommunication satellites only represent 53% of the total mass launched, while human spaceflight spacecraft's share is decreasing but remains the second main category of mission in terms of mass launched (19%). Interestingly, more than 20 tons were launched for scientific purposes (compared to 8 tons in 2019), primarily due to the three missions launched to Mars in July and the Chinese Chang'e-5 lunar mission.

Commercial satellites account for almost 90% of the satellites launched in 2020, but this is also the first year that the majority of the mass launched is dedicated to the commercial market (50.7%). One third of the mass was launched for governmental civil purposes (56% of which for human spaceflight) and 15% for military purposes. As usual, other markets remain negligible in terms of mass launched.

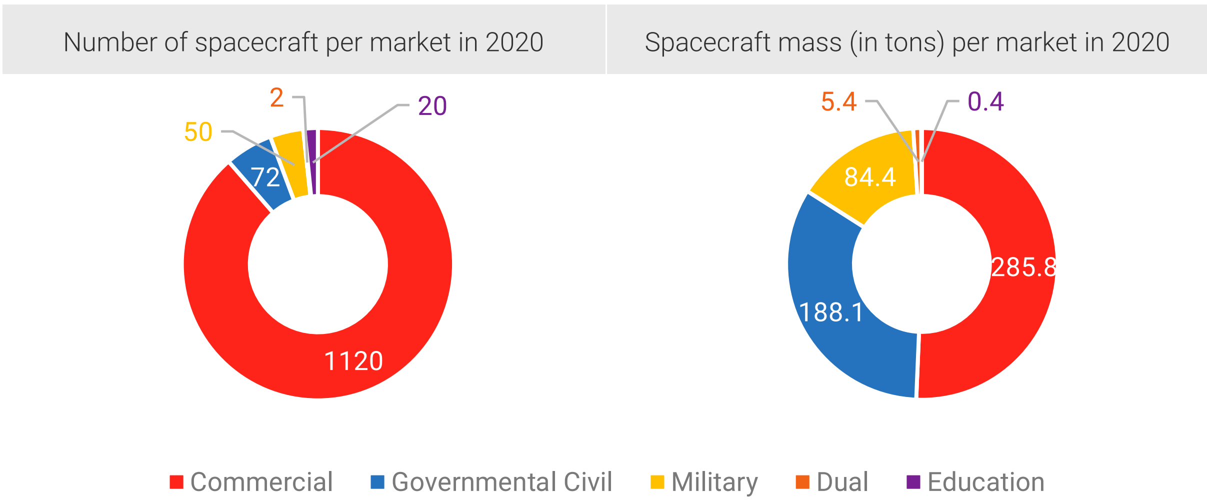


Figure 66: Number and mass of spacecraft per market in 2020 (excluding Other and Unknown missions)

4.3 Launch log and activity highlights

4.3.1 ESPI launch log 2020

Launch date	Launch country	Launcher	Outcome	Spacecraft name	Customer country	Manufacturer country	Mass at launch (kg)	Orbit	Mission	Market
07/01/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 2 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
07/01/2020	China	CZ-3B/G3	Success	Tongxin Jishu Shiyan 5	China	China	3000	GEO	Tech / Demo	Governmental
15/01/2020	China	CZ-2D(2)	Success	Jilin 1-Kuanfu 01	China	China	1250	LEO	Earth Observation	Commercial
				ÑuSat (7 & 8)	Argentina	Argentina	37 (each)	LEO	Earth Observation	Commercial
				Tianqi 5	China	China	8	LEO	Tech / Demo	Commercial
16/01/2020	France	Ariane-5ECA+	Success	Eutelsat Konnect	France	France	3619	GEO	Telecommunication	Commercial
				Gsat 30	India	India	3357	GEO	Telecommunication	Governmental
16/01/2020	China	Kuaizhou-1A	Success	Yinhe 1	China	China	227	LEO	Tech / Demo	Commercial
29/01/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 3 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
31/01/2020	New Zealand	Electron KS	Success	USA 294	USA	USA	140	LEO	Tech / Demo	Military
06/02/2020	Russia	Soyuz-2-1b Fregat-M	Success	OneWeb (34 satellites)	UK	USA	147 (each)	LEO	Telecommunication	Commercial
09/02/2020	Iran	Simorgh	Failure	Zafar 1	Iran	Iran	113	LEO	Earth Observation	Governmental
09/02/2020	Japan	H-2A-202	Success	IGS-Optical 7	Japan	Japan	1600	LEO	Earth Observation	Dual
10/02/2020	USA	Atlas-5(411)	Success	Solar Orbiter	Europe	France	1800	Escape	Space Science	Governmental
14/02/2020	USA	Antares-230+	Success	Cygnus CRS-13	USA	USA	7492	LEO	Cargo Transfer	Governmental
				DeMI	USA	USA	10	LEO	Tech / Demo	Governmental
				Red-Eye 2	USA	USA	100	LEO	Tech / Demo	Governmental
				TechEdSat 10	USA	USA	8	LEO	Tech / Demo	Education
17/02/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 4 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
18/02/2020	France	Ariane-5ECA+	Success	GEO-KOMPSAT 2B	South Korea	South Korea	3379	GEO	Meteorology	Governmental
				JCSat 17	Japan	USA	5857	GEO	Telecommunication	Commercial
19/02/2020	China	CZ-2D(2)	Success	XJS (4 satellites)	China	China	500 (each)	LEO	Tech / Demo	Military
20/02/2020	Russia	Soyuz-2-1a Fregat-M	Success	Meridian-M 9	Russia	Russia	2000	HEO	Telecommunication	Military

07/03/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Bartolomeo	Europe	France	484	LEO	Space Station Infrastructure	Governmental
				Dragon CRS-20	USA	USA	6650	LEO	Cargo Transfer	Governmental
				G-Satellite	Japan	Japan	4	LEO	Other	Governmental
				Lynk 4	USA	USA	10	LEO	Tech / Demo	Commercial
				Quetzal 1	Guatemala	Guatemala	1	LEO	Tech / Demo	Education
09/03/2020	China	CZ-3B/G3	Success	BD-3 G2Q	China	China	4600	GEO	Navigation	Military
16/03/2020	Russia	Soyuz-2-1b Fregat-M	Success	Glonass-M 51	Russia	Russia	1415	MEO	Navigation	Military
16/03/2020	China	CZ-7A	Failure	Xinjishu Yanzheng-6	China	China	6000	GEO	Tech / Demo	Military
18/03/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 5 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
21/03/2020	Russia	Soyuz-2-1b Fregat-M	Success	OneWeb (34 satellites)	UK	USA	147 (each)	LEO	Telecommunication	Commercial
24/03/2020	China	CZ-2C(3)	Success	Yaogan (30-06-01, -02 & -03)	China	China	300 (each)	LEO	Signal Intelligence	Military
26/03/2020	USA	Atlas-5(551)	Success	AEHF 6	USA	USA	6168	GEO	Telecommunication	Military
				TDO 2	USA	USA	24	LEO	SSA	Military
09/04/2020	Russia	Soyuz-2-1a	Success	Soyuz-MS 16	Russia	Russia	7080	LEO	Crew Transfer	Governmental
09/04/2020	China	CZ-3B/G2(2)	Failure	Palapa N1	Indonesia	China	5550	GEO	Telecommunication	Commercial
22/04/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 6 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
22/04/2020	Iran	Qased	Success	Noor 1	Iran	USA	5	LEO	Earth Observation	Military
25/04/2020	Russia	Soyuz-2-1a	Success	Progress-MS 14	Russia	Russia	7280	LEO	Cargo Transfer	Governmental
A05/05/2020	China	CZ-5B	Success	RCF-FC-SC	China	China	200	LEO	Tech / Demo	Governmental
				XZF-SC	China	China	21600	LEO	Tech / Demo	Governmental
12/05/2020	China	Kuaizhou-1A	Success	Xingyun-2 (01 & 02)	China	China	93	LEO	Telecommunication	Commercial
17/05/2020	USA	Atlas-5(501)	Success	FalconSat 8	USA	USA	136	LEO	Tech / Demo	Military
				X-37B OTV 6	USA	USA	5400	LEO	Tech / Demo	Military
20/05/2020	Japan	H-2B-304	Success	HTV 09	Japan	Japan	16500	LEO	Cargo Transfer	Governmental
				iSIM	Spain	Spain	15	LEO	Tech / Demo	Commercial
22/05/2020	Russia	Soyuz-2-1b Fregat-M	Success	Tundra 04	Russia	Russia	1500	HEO	Early Warning	Military
25/05/2020	USA	LauncherOne	Failure	Intern-Sat	USA	USA	15	LEO	Other	Education
				Starshine 4	USA	USA	50	LEO	Earth Science	Education
29/05/2020	China	CZ-11	Success	XJS (G & H)	China	China	250 (each)	LEO	Tech / Demo	Military

30/05/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Crew Dragon DM-2	USA	USA	12055	LEO	Crew Transfer	Governmental
31/05/2020	China	CZ-2D(2)	Success	Gaofen 09-02	China	China	750	LEO	Earth Observation	Governmental
				HEAD 4	China	China	45	LEO	AIS	Commercial
04/06/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 7 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
10/06/2020	China	CZ-2C(3)	Success	HaiYang 1D	China	China	442	LEO	Earth Science	Governmental
13/06/2020	USA	Falcon-9 v1.2 (Block 5)	Success	SkySat (16, 17 & 18)	USA	USA	120 (each)	LEO	Earth Observation	Commercial
				Starlink 8 (58 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
13/06/2020	New Zealand	Electron KS	Success	ANDESITE	USA	USA	5,5	LEO	Earth Science	Education
				RAAF M2 Pathfinder	Australia	Australia	4	LEO	Tech / Demo	Military
				USA 301, 302 & 303	USA	USA	40 (each)	LEO	Tech / Demo	Military
17/06/2020	China	CZ-2D(2)	Success	Gaofen 9-03	China	China	750	LEO	Earth Observation	Governmental
				HEAD 5	China	China	45	LEO	AIS	Commercial
				Zheda Pixing 3A	China	China	0,2	LEO	Tech / Demo	Education
23/06/2020	China	CZ-3B/G3	Success	BD-3 G3Q	China	China	4600	GEO	Navigation	Military
30/06/2020	USA	Falcon-9 v1.2 (Block 5)	Success	GPS-3 3	USA	USA	4311	MEO	Navigation	Military
03/07/2020	China	CZ-4B	Success	BY 2	China	China	2	LEO	Tech / Demo	Education
				Gaofen Duomo	China	China	2500	LEO	Earth Observation	Governmental
04/07/2020	China	CZ-2D(2)	Success	Shiyan 6-02	China	China	200	LEO	Tech / Demo	Military
04/07/2020	New Zealand	Electron KS	Failure	CE-SAT 1B	Japan	Japan	50	LEO	Earth Observation	Commercial
				Faraday-1	UK	Denmark	10	LEO	Tech / Demo	Commercial
				Flock-4e (5 satellites)	USA	USA	5 (each)	LEO	Earth Observation	Commercial
06/07/2020	Israel	Shavit-2	Success	Ofeq 16	Israel	Israel	350	LEO	Earth Observation	Military
09/07/2020	China	CZ-3B/G2(2)	Success	APStar-6D	China	China	5550	GEO	Telecommunication	Commercial
10/07/2020	China	Kuaizhou-11	Failure	CentiSpace-1 S2	China	China	97	LEO	Tech / Demo	Commercial
				Jilin-1 Gaofen-02E	China	China	172	LEO	Earth Observation	Commercial
15/07/2020	USA	Minotaur-4	Success	USA 305, 306, 307 & 308	USA	USA	400 (each)	LEO	Tech / Demo	Military
19/07/2020	Japan	H-2A-202	Success	Al-Amal	UAE	UAE	1350	Escape	Planetary Science	Governmental
20/07/2020	USA	Falcon-9 v1.2 (Block 5)	Success	ANASIS-2	South Korea	France	5000	GEO	Telecommunication	Military
23/07/2020	Russia	Soyuz-2-1a	Success	Progress-MS 15	Russia	Russia	7280	LEO	Cargo Transfer	Governmental

23/07/2020	China	CZ-5	Success	Tianwen-1	China	China	5000	Escape	Planetary Science	Governmental
25/07/2020	China	CZ-4B	Success	Longxia Yan X Shexian	China	China	50	LEO	Space Science	Governmental
				Tianqi 10	China	China	50	LEO	Tech / Demo	Commercial
				ZY-3 03	China	China	2630	LEO	Earth Observation	Governmental
30/07/2020	Russia	Proton-M Briz-M (Ph.3)	Success	Ekspress 103	Russia	Russia	2280	GEO	Telecommunication	Commercial
				Ekspress 80	Russia	Russia	2110	GEO	Telecommunication	Commercial
30/07/2020	USA	Atlas-5(541)	Success	Mars 2020 (Perseverance)	USA	USA	3839	Escape	Planetary Science	Governmental
06/08/2020	China	CZ-2D(2)	Success	Gaofen 9-04	China	China	1080	LEO	Earth Observation	Governmental
				Tsinghua Kexue Weixing	China	UK	150	LEO	Earth Science	Education
07/08/2020	USA	Falcon-9 v1.2 (Block 5)	Success	BlackSky Global (7 & 8)	USA	USA	55 (each)	LEO	Earth Observation	Commercial
				Starlink 9 (57 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
15/08/2020	France	Ariane-5ECA+	Success	BSat 4B	Japan	USA	3530,00	GEO	Telecommunication	Commercial
				Galaxy 30	USA	USA	3300,00	GEO	Telecommunication	Commercial
				MEV-2	USA	USA	2875,00	GEO	In-Orbit Servicing	Commercial
18/08/2020	USA	Falcon-9 v1.2 (Block 5)	Success	SkySat (19, 20 & 21)	USA	USA	120 (each)	LEO	Earth Observation	Commercial
				Starlink 10 (58 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
23/08/2020	China	CZ-2D(2)	Success	Duo Gongneng Shiyan Weixing	China	China	25	LEO	Tech / Demo	Military
				Gaofen 9-05	China	China	750	LEO	Earth Observation	Governmental
				TianTuo 05	China	China	75	LEO	Tech / Demo	Education
30/08/2020	USA	Falcon-9 v1.2 (Block 5)	Success	GNOMES 1	USA	USA	30	LEO	Meteorology	Commercial
				SAOCOM 1B	Argentina	Argentina	1600	LEO	Earth Observation	Governmental
				Tyvak 0172	Unknown	USA	8	LEO	Unknown	Unknown
31/08/2020	New Zealand	Electron Photon-LEO	Success	Capella 2 (Sequoia)	USA	USA	100	LEO	Earth Observation	Commercial
				First Light	New Zealand	New Zealand	200	LEO	Tech / Demo	Commercial
02/09/2020	France	Vega	Success	AMICal-Sat	France	Poland	2	LEO	Earth Science	Education
				Athena	USA	USA	138	LEO	Tech / Demo	Commercial
				DIDO 03	Switzerland	Switzerland	4	LEO	Biology	Commercial
				ESAIL	Canada	Luxembourg	112	LEO	AIS	Commercial
				Flock-4v (26 satellites)	USA	USA	5 (each)	LEO	Earth Observation	Commercial

				FSSCat (A & B)	Spain	USA	8	LEO	Earth Observation	Governmental
				GHGSat C1	Canada	Canada	15,4	LEO	Earth Observation	Commercial
				ION-SCV Lucas	Italy	Italy	90	LEO	Tech / Demo	Commercial
				Lemur-2 (8 satellites)	USA	USA	5	LEO	Earth Observation	Commercial
				NAPA 1	Thailand	Netherlands	10	LEO	Earth Observation	Military
				NEMO-HD	Slovenia	Canada	65	LEO	Earth Observation	Governmental
				ÑuSat 6	Argentina	Argentina	43,5	LEO	Earth Observation	Commercial
				OSM-1 CICERO	Monaco	USA	10	LEO	Earth Observation	Commercial
				PICASSO	Belgium	Sweden	4	LEO	Earth Science	Governmental
				SIMBA	Belgium	Netherlands	4	LEO	Tech / Demo	Governmental
				SpaceBEE (12 satellites)	USA	USA	0.4 (each)	LEO	Telecommunication	Commercial
				TARS / Kepler 3	Canada	Sweden	4	LEO	Tech / Demo	Commercial
				TRISAT	Slovenia	Slovenia	5	LEO	Tech / Demo	Education
				TTÜ100	Estonia	Estonia	1	LEO	Tech / Demo	Education
				Tyvak 0171	USA	USA	8	LEO	Tech / Demo	Commercial
				UPMSat 2	Spain	Spain	45	LEO	Tech / Demo	Education
03/09/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 11 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
04/09/2020	China	CZ-2F/T	Success	Chongfu Shiyong Shiyan Hangtian Qi	China	China	8500	LEO	Tech / Demo	Military
07/09/2020	China	CZ-4B	Success	Gaofen 11-02	China	China	805	LEO	Earth Observation	Governmental
12/09/2020	China	Kuaizhou-1A	Failure	Jilin-1 Gaofen-02C	China	China	230	LEO	Earth Observation	Commercial
12/09/2020	USA	Astra Rocket-3	Failure	Astra Rocket-3.1	USA	USA	0 (rocket test)	LEO	Tech / Demo	Commercial
15/09/2020	China	CZ-11H	Success	Jilin-1 Gaofen-03B (6 satellites)	China	China	40 (each)	LEO	Earth Observation	Commercial
				Jilin-1 Gaofen-03C (3 satellites)	China	China	40 (each)	LEO	Earth Observation	Commercial
21/09/2020	China	CZ-4B	Success	HaiYang 2C	China	China	1575	LEO	Earth Observation	Governmental
27/09/2020	China	CZ-4B	Success	HJ (2A & 2B)	China	China	470 (each)	LEO	Earth Observation	Governmental
28/09/2020	Russia	Soyuz-2-1b Fregat-M	Success	Dekart	Russia	Russia	4	LEO	Tech / Demo	Governmental
				Gonets (-M 17, -M18 & -M19)	Russia	Russia	280 (each)	LEO	Telecommunication	Governmental
				ICEYE (X6 & X7)	Finland	Finland	85 (each)	LEO	Earth Observation	Commercial
				Kepler 4	Canada	Canada	16	LEO	Telecommunication	Commercial

				Kepler 5	Canada	Canada	16	LEO	Telecommunication	Commercial
				LacunaSat 3	UK	Lithuania	3	LEO	Tech / Demo	Commercial
				Lemur-2 120 (4 satellites)	USA	USA	4 (each)	LEO	Earth Observation	Commercial
				MeznSat	UAE	UAE	3	LEO	Earth Observation	Education
				NetSat (4 satellites)	Germany	Germany	4 (each)	LEO	Tech / Demo	Education
				Norbi	Russia	Russia	6	LEO	Tech / Demo	Governmental
				SALSAT	Germany	Germany	12	LEO	Tech / Demo	Education
				Yarilo (-1 & -2)	Russia	Russia	2 (each)	LEO	Space Science	Governmental
03/10/2020	USA	Antares-230+	Success	Bobcat 1	USA	USA	4	LEO	Tech / Demo	Governmental
				Cygnus CRS-14	USA	USA	7492	LEO	Cargo Transfer	Governmental
				NEUTRON 1	USA	USA	3,5	LEO	Space Science	Governmental
				SPOC	USA	Sweden	4	LEO	Tech / Demo	Governmental
06/10/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 12 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
11/10/2020	China	CZ-3B/G3	Success	Gaofen 13	China	China	5000	GEO	Earth Observation	Governmental
14/10/2020	Russia	Soyuz-2-1a	Success	Soyuz-MS 17	Russia	Russia	7080	LEO	Crew Transfer	Governmental
18/10/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 13 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
24/10/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 14 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
25/10/2020	Russia	Soyuz-2-1b Fregat-M	Success	GLONASS-K1 03	Russia	Russia	962	MEO	Navigation	Military
26/10/2020	China	CZ-2C(3)	Success	Tianqi 6	China	China	8	LEO	Telecommunication	Commercial
				Yaogan 30-07 (-01, -02 & -03)	China	China	300 (each)	LEO	Signal Intelligence	Military
28/10/2020	New Zealand	Electron KS	Success	CE-SAT 2B	Japan	Japan	36	LEO	Earth Observation	Commercial
				Flock-4e' (9 satellites)	USA	USA	5 (each)	LEO	Earth Observation	Commercial
05/11/2020	USA	Falcon-9 v1.2 (Block 5)	Success	GPS-3 4	USA	USA	3880	MEO	Navigation	Military
06/11/2020	China	CZ-6	Success	Beihangkongshi-1 / TY 20	China	China	30	LEO	Tech / Demo	Commercial
				BY 3 / Bayi-03	China	China	2	LEO	Tech / Demo	Education
				ÑuSat (10 satellites)	Argentina	Argentina	41 (each)	LEO	Earth Observation	Commercial
				Tianyan 05	China	China	70	LEO	Earth Observation	Commercial
07/11/2020	China	Ceres-1	Success	Tianqi 11	China	China	50	LEO	Telecommunication	Commercial
07/11/2020	India	PSLV-DL	Success	EOS-01 (RISAT-2BR2)	India	India	630	LEO	Earth Observation	Governmental

				KSM (1A, 1B, 1C & 1 D)	Luxembourg	Denmark	8 (each)	LEO	Signal Intelligence	Commercial
				Lemur-2 (4 satellites)	USA	USA	4 (each)	LEO	Earth Observation	Commercial
				M6P 2	Lithuania	Lithuania	8	LEO	Tech / Demo	Commercial
12/11/2020	China	CZ-3B/G3	Success	Tiantong-1 02	China	China	5400	GEO	Telecommunication	Commercial
13/11/2020	USA	Atlas-5(531)	Success	USA 310	USA	USA	7000	MEO	Tech / Demo	Military
16/11/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Crew Dragon USCV-1	USA	USA	12055	LEO	Crew Transfer	Governmental
17/11/2020	France	Vega	Failure	SEOSAT-Ingenio	Spain	France	830	LEO	Earth Observation	Governmental
				TARANIS	France	France	175	LEO	Earth Science	Governmental
20/11/2020	New Zealand	Electron KS	Success	APSS 1	New Zealand	New Zealand	1,5	LEO	Earth Science	Governmental
				BRO (2 & 3)	France	Denmark	6 (each)	LEO	Signal Intelligence	Commercial
				Dragracer A	USA	USA	15	LEO	Tech / Demo	Commercial
				Dragracer B	USA	USA	10	LEO	Tech / Demo	Commercial
				Gnome Chompski	USA	New Zealand	1,5	LEO	Other	Other
				SpaceBEE (24 satellites)	USA	USA	0.4 (each)	LEO	Telecommunication	Commercial
21/11/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Sentinel 6A / Jason-CS A	Europe	France	1192	LEO	Earth Observation	Governmental
23/11/2020	China	CZ-5	Success	Chang'e 5	China	China	8200	Escape	Planetary Science	Governmental
24/11/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Starlink 15 (60 satellites)	USA	USA	260 (each)	LEO	Telecommunication	Commercial
29/11/2020	Japan	H-2A-202	Success	JDRS 1	Japan	Japan	3800	GEO	Satellite Data Relay	Dual
02/12/2020	France	Soyuz-ST-A Fregat-M	Success	Falcon Eye 2	UAE	France	1190	LEO	Earth Observation	Military
03/12/2020	Russia	Soyuz-2-1b Fregat	Success	ERA-1 / Kosmos 2548	Russia	Russia	5	LEO	Tech / Demo	Military
				Gonets-M (20, 21 & 22)	Russia	Russia	280 (each)	LEO	Telecommunication	Governmental
06/12/2020	USA	Falcon-9 v1.2 (Block 5)	Success	Bishop	USA	USA	1090	LEO	Space Station Infrastructure	Commercial
				Dragon CRS-21	USA	USA	12000	LEO	Cargo Transfer	Governmental
06/12/2020	China	CZ-3B/G5	Success	Gaofen 14	China	China	2400	LEO	Earth Observation	Governmental
09/12/2020	China	CZ-11	Success	GECAM A & B	China	China	150 (each)	LEO	Astronomy	Governmental
10/12/2020	USA	Delta-4H (upg.)	Success	Orion 10 / USA 311	USA	USA	5200	GEO	Signal Intelligence	Military
13/12/2020	USA	Falcon-9 v1.2 (Block 5)	Success	SXM 7	USA	USA	7000	GEO	Telecommunication	Commercial
14/12/2020	Russia	Angara-A5 Briz-M	Success	IPM 2	Russia	Russia	2042	GEO	Tech / Demo	Governmental
15/12/2020	USA	Astra Rocket-3	Failure	Astra Rocket-3.2	USA	USA	0 (rocket test)	LEO	Tech / Demo	Commercial
15/12/2020	New Zealand	Electron KS	Success	StriX-α	Japan	Japan	150	LEO	Tech / Demo	Commercial
17/12/2020	India	PSLV-XL	Success	CMS 01 / GSat 12R	India	India	1410	GEO	Telecommunication	Governmental
18/12/2020	Russia	Soyuz-2-1b Fregat	Success	OneWeb (36 satellites)	UK	USA	147 (each)	LEO	Telecommunication	Commercial

19/12/2020	USA	Falcon-9 v1.2 (Block 5)	Success	USA 312 & 313	USA	USA	2500 (each)	LEO	Tech / Demo	Military
22/12/2020	China	CZ-8	Success	ET-SMART-RSS	Ethiopia	China	10	LEO	Earth Observation	Governmental
				Haisi 1	China	China	185	LEO	Earth Observation	Military
				Tianqi 8	China	China	50	LEO	Telecommunication	Commercial
				XJY 7	China	China	3000	LEO	Tech / Demo	Governmental
				Yuanguang	China	China	20	LEO	Space Science	Governmental
28/12/2020	China	CZ-4C	Success	Weina Jishu Shiyan	China	China	5	LEO	Other	Governmental
				Yaogan 33R	China	China	1040	LEO	Earth Observation	Military
29/12/2020	France	Soyuz-ST-A Fregat-M	Success	CSO 2	France	France	3562	LEO	Earth Observation	Military

4.3.2 ESPI Database definitions

Launch outcome

- Success: launch attempt performed nominally, all spacecraft injected in the intended orbit.
- Failure: launch attempt led to the total loss of the payloads (destruction, unrecoverable orbit).
- Partial failure: launch attempt led to a recoverable harm for the payloads (damage, orbit).

System categories

- Satellite: standard spacecraft designed to orbit the Earth and comprised of a bus/platform and one or more payloads.
- Cubesat: spacecraft designed according to the cubesat standard and comprised of one or more units (U) of 10x10x10cm.
- Space Station Module: element of a space station including habitats, nodes, structure, external platforms and other permanent or temporary parts.
- Transfer Vehicle: spacecraft designed to transfer cargo or humans to a space station.
- Space Exploration System: specific spacecraft designed for space exploration purposes including probes, landers, rovers and other systems with a mission outside Earth orbit.
- Space Plane: reusable spacecraft with advanced manoeuvring capabilities including the capacity to land autonomously.
- Servicing Vehicle: spacecraft with advanced Rendezvous and Proximity Operations capabilities, designed to provide services to other satellites (e.g. life extension, refuelling, inspection).
- Dummy payload: passive object without operational payload (e.g. mockup, passive target…).
- Attached package: system remaining attached to the launcher upper stage.

Mass categories

- Large spacecraft (>500kg)
  - Extra heavy-class More than 8,000kg
  - Heavy-class Between 2,000 and 8,000kg
  - Medium-class Between 500 and 2,000kg
- Small spacecraft (<500kg)
  - Mini-class Between 100 and 500kg
  - Micro-class Between 10 and 100kg
  - Nano-class Less than 10kg

Orbits

- GEO: an orbit at an altitude of approximately 36 000 km from Earth.
- MEO: an orbit at an altitude between 2000 and 36 000 km from Earth.
- LEO: an orbit at an altitude between 100 and 2000 km from Earth.
- HEO: highly elliptical orbit, an elliptical orbit with a high eccentricity.
- Escape: an orbit beyond Earth orbit with an eccentricity higher than 1.

Missions

- Telecommunication
  - Telecommunication services by satellites
  - Automatic Identification System: detection and tracking of ships
  - Satellite Data Relay: telecommunication relay for other satellites
- Remote sensing
  - Earth Observation: observation of the Earth for an operational purpose (not scientific)
  - Meteorology: study of the Earth atmosphere with a focus on weather forecast (not scientific)
- Navigation
  - Navigation: Global Navigation Space Systems (GNSS) and Satellite-Based Augmentation Systems
- Human spaceflight
  - Cargo Transfer: transfer of supplies to a space station
  - Crew Transfer: transfer of astronauts to a space station
  - Space Station Infrastructure: supply of a space station's element
- Science
  - Astronomy: remote study of celestial bodies and phenomena
  - Biology: study of life and living organisms
  - Earth Science: study of the Earth
  - Planetary Science: study of planets, moons, asteroids, comets
  - Space Science: study of the space environment and of the functioning of the Universe
- Military-specific
  - Early Warning: detection of missile launches through infrared observation
  - Signal Intelligence: interception of electronic signals
  - Space Situational Awareness: detection and tracking of objects in orbit
- Technology / Demonstration
  - Technology / Demonstration: testing of new systems or technologies
- Other
  - In-Orbit Servicing: provision of services to another spacecraft
  - Radio Amateur: radiocommunication for amateur purpose
  - Other/Unknown: missions not falling in the above definitions

Markets

- Governmental civil: the spacecraft is primarily intended to serve the mission of an organisation providing a public service or having scientific research objectives.
- Military: the spacecraft is primarily intended to serve armed forces operational needs.
- Commercial: the spacecraft is primarily intended to serve a commercial market and to make profit.
- Education: the spacecraft is primarily intended to serve an academic or training purpose from system design to operation.
- Dual: the spacecraft is intended to serve both military and civil purposes.
- Amateur: the spacecraft is operated for private, non-for-profit actors, and usually conducts a rather basic mission (e.g. radio).

4.4 Space activity highlights in 2019

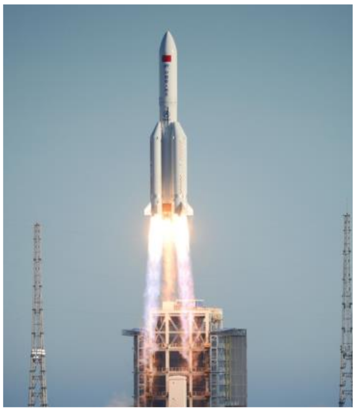
The United States recovers Human spaceflight capability

Credit: SpaceX

For the first time in almost nine years, a crew flight was launched from the U.S. territory, with astronauts Bob Behnken and Doug Hurley onboard SpaceX's Falcon 9 rocket and Crew Dragon capsule, developed in the frame of NASA's Commercial Crew Program. The launch, called Demo-2, took place on May 30th from the Kennedy Space Centre in Florida, after having been postponed of two days because of bad weather. The capsule docked to the ISS after a trip of 19 hours. Behnken and Hurley spent two months on the ISS, a longer duration than initially planned. Indeed, they were used for some additional work, such as the replacement of ISS batteries. The first operational flight of Crew Dragon took place in November 2020.

Maiden launch for Long March 5B and prototype of Chinese next-gen crewed spacecraft

On May 5th, 2020, China launched for the first time a new version of its Long March 5B. The success of the launch was crucial for the country, as this rocket configuration will carry parts of the future Chinese Space Station to LEO. The rocket is single stage and can lift until 25 tons to LEO. In line with Chinese efforts in space exploration, the launcher carried a demonstrator for the next-generation spacecraft of China as well as a cargo return spacecraft equipped with an inflatable heat shield, which was tested during re-entry but failed. The rocket created international concern due to its first stage, which re-entered Earth atmosphere without control one week after the launch: this stage, weighing almost 20 tons, was the largest uncontrolled object to fall from LEO since 1991, and it is estimated that debris could have hit populated areas.



Credit: Su Dong/China Daily

Return to flight for Vega, successful launch and new failure

Credit: Arianespace

On September 2nd, a Vega rocket made its first launch since the accident that the launcher suffered in July 2019. The launch, initially planned for March, was postponed due to the COVID-19 pandemic and the subsequent closure of the Guiana Space Centre. The rocket launched 53 satellites, the first rideshare launch with as many satellites for Arianespace. The launch was the Proof of Concept of the Small Spacecraft Mission Service (SSMS), which aims at offering routine services tailored to small satellites using ESA-developed launch vehicles. One of the payloads launched was the ION-SCV Lucas, developed by D-Orbit, a demonstration spacecraft for the delivery of small spacecraft in precise orbital slots. Once released from the Vega rocket, the ION-SCV moved to deploy individually 12 Flock satellites from Planet following the customer's specifications. Moreover, the Vega rocket also launched Athena, an experimental communications satellite testing technologies for a potential future constellation. Athena's customer is PointView Tech, a subsidiary of Facebook.

Despite this success in a first rideshare launch, on November 17th, for the second time in its last three flights, Vega suffered a failure. After eight minutes, the rocket left its planned trajectory, leading to the loss of the mission. The problem occurred with the upper stage of the rocket and was due to a human error (two cables being inverted). This would allow a quicker return to flight of the launcher, expected in 2021. The failure led to the loss of two European satellites: SEOSAT-Ingenio and TARANIS. SEOSAT was the optical component of the Spanish Earth Observation programme, with civil and governmental applications, and would have complemented the radar component already in orbit; TARANIS was a first-of-its-kind mission developed by CNES to study luminous, radiative and electromagnetic events above thunderstorms.

Credit: Arianespace

Credit: H. Xujie/Xinhua

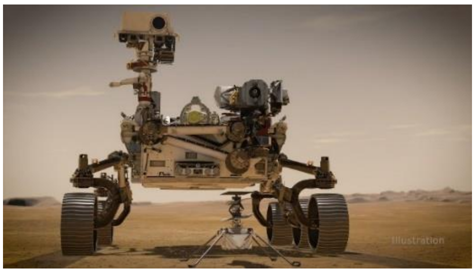
Completion of the BeiDou constellation

In June, China launched the last satellite of its GNSS constellation, called BeiDou. This launch marked the completion of the system's third generation, which will provide global services (contrary to the regional services provided by the second generation). The spacecraft is the 55th operational BeiDou satellite launched in orbit, and the 30th of the third generation. It has a life expectancy of at least 12 years and is meant to improve the network's accuracy. Quite unusually for such inland launch, the operation was broadcasted and streamed by Chinese state media.

States do not miss the opportunity of July's launch window to Mars

In July 2020, three countries benefitted from the launch window that opened to send missions to the planet Mars. The first one is the UAE's "Hope Probe", launched from Japan on July 19th, and represents the first interplanetary mission as well as the first planetary science mission to be led by an Arab country. The mission has been conducted in partnership with several U.S. academic institutions, in particular with a team of the University of Colorado Boulder to develop and assemble the spacecraft. The probe will collect data about the climate and atmosphere of the Red Planet. It entered Mars orbit in February 2021.

The second mission, launched three days later, was the Chinese Tianwen-1, marking the start of the first solo Chinese mission to Mars. The Long March 5 rocket carrying the spacecraft launched from Wenchang and used tracking support from ESA ESTRACK. The spacecraft is comprised of an orbiter and a rover and carries 13 science payloads to study the atmosphere, magnetosphere, surface, subsurface and climate of Mars. Previously, China had attempted a Mars mission in collaboration with Russia, but the rocket used at the time failed to reach orbit.



Credit: NASA/JPL-Caltech

The final mission is the most ambitious of the three. On July 30th, ULA launched Mars 2020 for NASA with an Atlas V. Mars 2020 primarily includes the Perseverance rover, a state-of-the-art system aimed at pursuing the work started with Curiosity. The mission also embarks the Ingenuity helicopter (the first flying drone used on another planet) and several other scientific payloads such as cameras and a microphone, which will provide unprecedent visibility into Mars landings. Perseverance will also collect samples, with the overall goal of the mission being to return these samples to Earth thanks to two future missions conducted in partnership with ESA. The rover successfully touched down on Mars on February 18th, 2021.

Chinese first reusable spacecraft

Credit: Jonathan McDowell/Twitter

On September 4th, China launched a reusable experiment spacecraft with a Long March-2F carrier rocket from the Jiuquan Satellite Launch Centre. While much remains secretive about the exact nature of the mission, the spacecraft may be a spaceplane similar to the U.S. X-37B (with a horizontal landing), as such projects were presented by Chinese organisations (CASC and CASIC) in the past years. Moreover, the spacecraft used an orbital path close to the one employed by the X-37B. The spacecraft returned to Earth after a two-day period of in-orbit operations and tests of reusable technologies. Two orbits before returning to Earth, it released an object into space, which was not clearly identified by observers. However, according to a Russian radio-astronomer, this may be a satellite orbiting only 50 km from an ultra-secret American payload, thus raising concerns about the objectives of the mission.

Second Angara-5 rocket demonstration launch by Russia

Credit: Russian Ministry of Defence

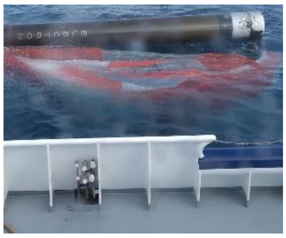
On December 14th, Russia launched for the second time its Angara-5 rocket, after a gap of almost exactly six years. The first launch of this rocket indeed took place on December 23rd, 2014, but further test flights were delayed, partly because of production issues. The Angara-5 is the new heavy-lift launch vehicle developed by Russia and should be able to send 24.5 tons to LEO and 5.4 tons to GTO. The mission did not carry any operational payload but rather a mass demonstrator. A payload separation manoeuvre with the upper stage took place near the geostationary orbit; later on, this stage moved to a graveyard orbit to avoid any collision with other spacecraft. After the launch, Dmitry Rogozin, the Director General of Roscosmos, announced that two more launches of Angara-5 were planned for 2021.

Credit: Arianespace

A boosted Ariane 5 ECA transports three spacecraft to GTO

On August 15th, for the first launch from Kourou since the start of the COVID-19 pandemic, an Ariane 5 rocket launched two GEO telecommunication satellites as well as the MEV-2, the second in-orbit servicer developed by Northrop Grumman. This was the first time that the European launcher transported three spacecraft to a geostationary transfer orbit, making this rocket the most powerful Ariane 5 ever launched. The total payload capacity was increased by 300 kg, to a total of 10 200 kg. Several upgrades were present on the launcher, such as modified pressure vents on the fairing, a lighter vehicle equipment bay and a new autonomous location system.

Rocket Lab retrieves a first stage for the first time



Credit: Peter Beck/Twitter

On November 20th, Rocket Lab launched its 16th Electron mission. For the first time, the company tried, and succeeded, in recovering the first stage of its rocket (a first for a small launcher). Contrary to SpaceX's technology, Rocket Lab did not attempt to vertically land the stage, but rather used parachutes to make it smoothly fall into water and recover it with a vessel. The ultimate goal of the company is to recover a first stage mid-air with a helicopter but some work (e.g. on thermal protection systems) needs to be done before reaching this step. With reusable rockets, Rocket Lab primarily aims at increasing its launch cadence.

Soyuz beats a record to reach the ISS

Credit: Space Facts

On October 14th, the Soyuz-MS 17 spacecraft transported a crew of two Russian cosmonauts and one U.S. astronaut to the International Space Station. The speed of the flight was particularly noteworthy: indeed, docking to the Station took place only three hours after launch, while approximately six hours are usually required. It thus established a new record for the fastest trip to the outpost. This gain of time is due to the use of an "ultrafast" method, which allows Soyuz to catch the ISS in two orbits instead of four. The method was employed in a crewed mission for the first time, after having been tested with the Progress-MS 15 cargo transfer mission.

SpaceX demonstrates a high launch cadence

Credit: SpaceX

In October, SpaceX demonstrated its capacity to carry out several launches in a record time. That month, the company conducted three Starlink missions, thus launching 180 satellites in less than two weeks. In particular, the second and third launches took place in a timeframe of six days. Moreover, the mission launched on October 24th marked the 100th successful launch for SpaceX, which had flown until then 95 Falcon 9s, 3 Falcon Heavys and two Falcon 1s, as well as landed 63 Falcon first stage boosters and relaunched a booster 45 times. By the end of 2020, the company has launched seven more Falcon 9s and, for the first time, flown a booster seven times.

Credit: Arianespace

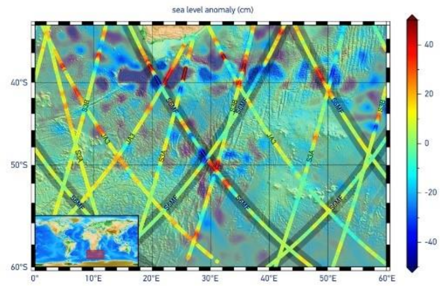
Launch of Eutelsat Konnect, the first Spacebus Neo satellite

In January 2020, the Eutelsat Konnect satellite was launched onboard an Ariane 5 rocket. The satellite, built by Thales Alenia Space, is the first one based on the all-electric Spacebus Neo platform. This platform was developed in cooperation with ESA and CNES in the frame of the ARTES programme, which aims at helping the European industry build more competitive communication satellites. Eutelsat Konnect will provide high-throughput broadband services in Ka-band for up to 40 countries across Africa and 15 over Europe.

Solar Orbiter aims at studying the Sun

The Solar Orbiter mission was launched by an Atlas V in February 2020. ESA is the leader of the mission, which carries 10 instruments to study the Sun, but NASA is also part of the project by providing one instrument, components for other instruments as well as the launch of the spacecraft. The satellite will go as close as 42 million kilometres from the Sun to better understand its magnetic field, the formation of solar wind and the impact of solar activity on Earth. For the first time, the spacecraft will also be able to provide images of the poles of our star. The satellite will coordinate with Parker Solar Probe and they will both complement each other. Given the time needed to approach the Sun, the full mission will formally start in November 2021.

Credit: ESA



Credit: ESA

New Copernicus satellite: Sentinel-6 Michael Freilich

On November 21st, the Sentinel-6 Michael Freilich satellite was launched from Vandenberg Air Force Base. The satellite, which will be operated by Eumetsat, is part of the Copernicus programme of the European Union and ESA, and is also the latest spacecraft in the Jason satellite series. The satellite will measure sea-surface height through a radar altimetry technology, providing data on 95% of the world's ice-free oceans every 10 days. Sentinel-6 is the result of a European-American cooperation, with NASA and NOAA developing several instruments and directly receiving data from the spacecraft. This partnership also explains why the satellite was launched on a Falcon 9 rocket, rather than on a European launcher. First data products from Sentinel-6 were generated on December 5th.

Failure of Long March-7A

In March 2020, the first launch of the Long March-7A rocket failed, thus preventing its classified payload from being inserted into geosynchronous transfer orbit. Problems in identifying the source of the failure created concerns, given that this new launcher shares elements with other rockets of the Long March family. For instance, the second stage engines are the same as on Long March-6 and -7 while some side boosters and the core stage have commonalities with Long March-5. However, despite concerns on the schedule of following missions, especially those belonging to China's flagship programmes (e.g. Tianwen-1), these activities were not massively impacted.

Credit: NasaSpaceflight.com

About the Authors

Sebastien Moranta, Concept & Editing

Sebastien is Coordinator of Studies at the European Space Policy Institute. Prior to supervising the research activities of the Institute, he was a Senior Associate at PricewaterhouseCoopers Advisory and Industry Analyst at Eurospace. Sebastien managed multiple studies for public and private organisations in the space sector and worked on a variety of space policy issues.

Jules Varma, Analysis & Production

Jules is a Resident Research Fellow at the European Space Policy Institute (ESPI). At ESPI his work focuses on the space economy and New Space related activities. Prior to joining ESPI, he worked at the United Nations Environment Programme in the economy division. He holds a MSc. in the department of Space and Climate Physics from University College London (UCL).

Tomas Hrozensky, Policy & Programmes

Tomas is a Resident Fellow at the European Space Policy Institute (ESPI) in Vienna, Austria. Previously he was a visiting Fulbright Scholar at the Space Policy Institute of the George Washington University in Washington, DC and a researcher for the Space Security Index 2017 project. Tomas holds an M.A. and Ph.D. in international relations from the Matej Bel University in Banska Bystrica, Slovakia.

Sara Dalledonne, Policy & Programmes

Sara is a Resident Fellow at the European Space Policy Institute. Prior to joining ESPI, she worked at the Institute of Air and Space Law (McGill University) as Research Assistant. She holds a L.L.M. in Air and Space Law from McGill University, a L.L.M. in International Trade Law from the International Training Centre of the ILO (University of Turin) and a 5-year Law degree from University of Bologna.

Clémence Poirier, Industry & Innovation

Clémence Poirier is a Research Fellow seconded by CNES at the European Space Policy Institute (ESPI). She holds a master's degree in International Relations, International Security and Defense and a bachelor's degree in Foreign Applied Languages from the University Jean Moulin Lyon 3, France.

Mathieu Bataille, Launches & Satellites

Mathieu Bataille is a Resident Fellow at the European Space Policy Institute, whose research mostly focuses on security and defence-related topics. He worked previously at the Studies Department of the French Air Force, in Paris. He holds a master's degree in Political Science and International Relations from Sciences Po Paris.

Rodolfo Zontini, Research intern

Rodolfo Zontini is a Research Intern at the European Space Policy Institute. He holds a M.Sc in International Relations from LUISS University as well as a Masters in Space Policies and Institutions from the United Nations Association of Italy (SIOI-UNA Italy). He also holds a B.A. in Politics, Philosophy and Economics from LUISS and was an exchange student at the Institut d'Études Politiques de Paris.

Ewan Wright, Research intern

Ewan Wright is a Research Intern at the European Space Policy Institute. He holds a master's degree in Aerospace Engineering from the University of Sheffield and has worked at the Satellite Applications Catapult, UK, as a business analyst. He is currently pursuing an interdisciplinary PhD in Astrophysics and Political Science at UBC.

Michelle Hermes, Research intern

Michelle Hermes is a Research Intern at the European Space Policy Institute (ESPI). Prior to joining ESPI, she worked in the Legislative Affairs Office at NASA Langley Research Center in Hampton, Virginia, USA. She holds bachelor's degrees in Government and German Studies from the College of William & Mary in Virginia, USA.

About ESPI

Policy & Strategy | Economy & Business | Security & Defence | International & Legal

ESPI is the European think-tank for space. The Institute is a not-for-profit organisation based in Vienna, World capital of space diplomacy, providing decision-makers with an informed view on mid to long-term issues relevant to Europe's space activities since 2003.

ESPI is supervised by a General Assembly of member organisations and supported by an Advisory Council of independent high-level experts.

ESPI fulfils its objectives through various multi-disciplinary research activities leading to the publication of books, reports, papers, articles, executive briefs, proceedings and position papers, and to the organisation of conferences and events including the annual ESPI Autumn Conference.

Who we are	What we do
Independent think-tank specialised in space policy	Research and analysis on major space policy issues
Multinational team with interdisciplinary expertise	Monitoring of global space trends and policy developments
Part of a network of European and international partners	Organisation of thematic conferences and workshops

Download our reports, check our events and subscribe to our newsletter online

www.espi.or.at

Schwarzenbergplatz 6 | A-1030 Vienna, Austria | (Entrance: Zaunergasse 1)
Phone +43 1 718 11 18 - 0 | E-Mail: office@espi.or.at

www.espi.or.at