SpaceTech Industry Analytical Framework

DEEP KNOWLEDGE GROUP

SpaceTech Analytics

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ISBN: 978-1-915559-08-1

ISBN: 978-1-915559-08-1

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Introduction

SpaceTech Analytics in partnership with the AI and Data Science Division of Deep Knowledge Group has published a new **SpaceTech Industry Analytical Framework**, constituting the most comprehensive classification system for SpaceTech Industry analysis to date. The framework has been published in an open-access format to better serve the needs of SpaceTech Industry participants and decision makers dedicated to developing products and services that are efficient, and versatile, and are likely to drive further innovation and growth in the industry.

As the dedicated SpaceTech analytics subsidiary of Deep Knowledge Group, STA conducts strategic analysis on markets in the Space Exploration, Spaceflight, Space Medicine, and Satellite Tech industries. It serves as an official sponsor of the Oxford University Aeronautical Society and has organized a number of conferences with such SpaceTech luminaries including Senior Program Directors of the International Space Station U.S. National Laboratory, the Chief Scientist of the NASA Human Research Program, senior members of the Aerospace Medical Council and more.

Its range of activities includes research and analysis on major areas of high potential in the SpaceTech industry, maintaining profiling of companies and governmental agencies based on their innovation potential and business activity, and providing consulting and analytical services to advance the Space Technology industry.

Deep Knowledge Group recognizes SpaceTech as a pivotal industry for the future of humanity, as well as a viable investment opportunity due to an ongoing trend that encompasses the complex interplay between emerging companies behind versatile and efficient products such as smaller and more powerful satellites that can perform advanced functions with less hardware and lower costs, accelerated artificial intelligence and machine learning for analyzing data from space and making more accurate predictions, and the development of novel reusable rockets and other space vehicles, which can significantly reduce launch costs and make space exploration more accessible.

Since 2021, SpaceTech Analytics has been producing regular analytical reports on key SpaceTech topics, including ratings of companies and governments based on their innovation potential and business activity in the SpaceTech sphere as well as providing strategic consulting and investment intelligence services.

SpaceTech, or space technology, refers to the various technologies and systems used in the exploration, study, and utilization of outer space. This includes spacecraft,

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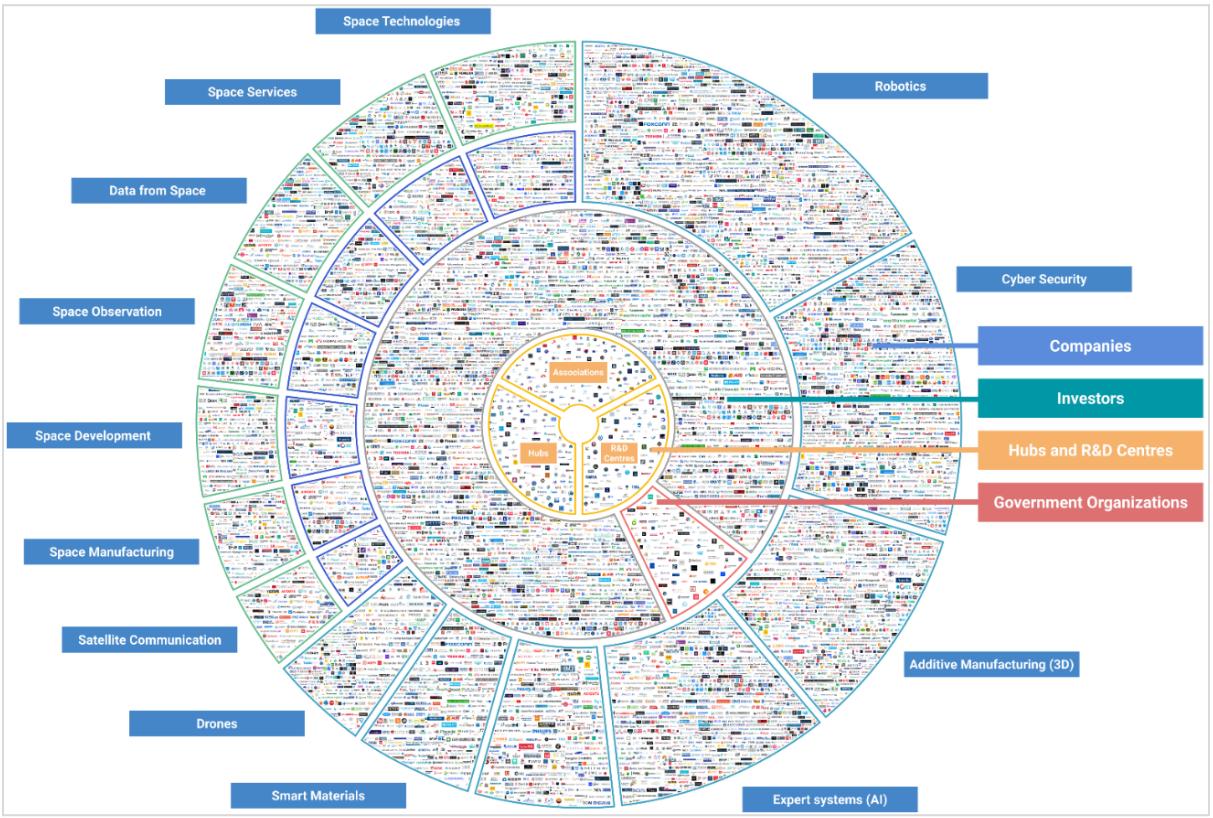
satellites, launch vehicles, ground-based systems, and other components necessary for space exploration and research. SpaceTech plays a critical role in advancing our understanding of the universe and developing new technologies that improve life on Earth.

Global SpaceTech Ecosystem



Source: Global SpaceTech Ecosystem Q1 2023

www.spacetech.global

The megacomplexity of all of these intersecting trajectories of progress mentioned above (the latest projections for which are covered in the chapter SpaceTech Industry Market Overview), creates the need for a consistent and comprehensive framework that can adapt to fast-changing metrics. Curating and presenting relevant data is also essential to minimizing noise and retaining a competitive edge in investment analytics and Big Data.

In 2022, this Industry Analytical Framework formed the basis of the SpaceTech Big Data Analytics System and Dashboard.

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SpaceTech Industry Big Data Analytics Dashboard

The SpaceTech Big Data Analytics Dashboard generates data-driven insights about emerging areas in the fields of space technologies and solutions, including Space Exploration, Spaceflight, Space Medicine, and Satellite Tech industries. The Dashboard is a well-suited tool for both private and institutional investors looking for an additional enhancement to their market analytics, providing sufficient means for the development of competitive advantages.

SpaceTech Big Data Analytics Dashboard at
www.deep-innovation.tech/deeptech-spacetech-dashboard

- The dashboard provides real-time analytics and data feeds on potential investment candidates, providing insight into their development prospects over time and their future growth potential.
- It provides advanced, sophisticated and quantitative Big Data analysis on SpaceTech companies and SpaceTech investment strategy.
- It includes a data mining engine, infrastructure for expert data curation, and advanced visualization dashboards, including mindmaps, knowledge graphs, advanced SWOT analysis, and 3-dimensional visualizations.
- Results of the analysis will be used to provide tailored recommendation packs to hedge risk and maximize diversification.

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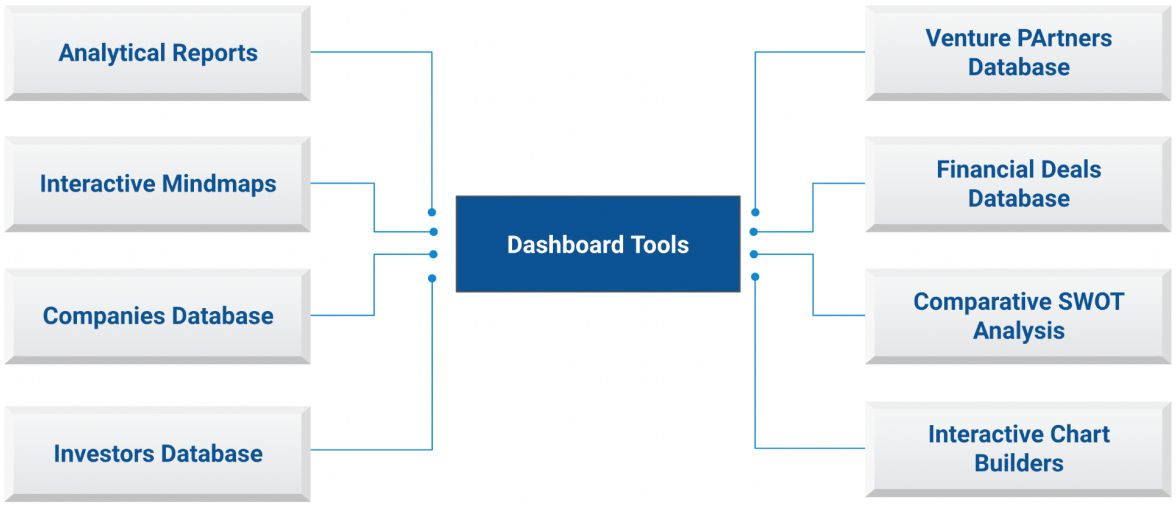
The analytics can deliver funding targets to investors, funding to companies, and detailed analysis of the companies represented there.

Who can benefit: investment institutions, private and public companies in the SpaceTech sphere, research institutions, universities, etc.

Dashboard Features

The following tools are currently active on the Dashboard.



In addition to the above tools, analytical reports on the industry, methodology for creating a database, and interactive mindmaps for all categories of the SpaceTech Industry are already available in the SpaceTech Big Data Analytics Dashboard.

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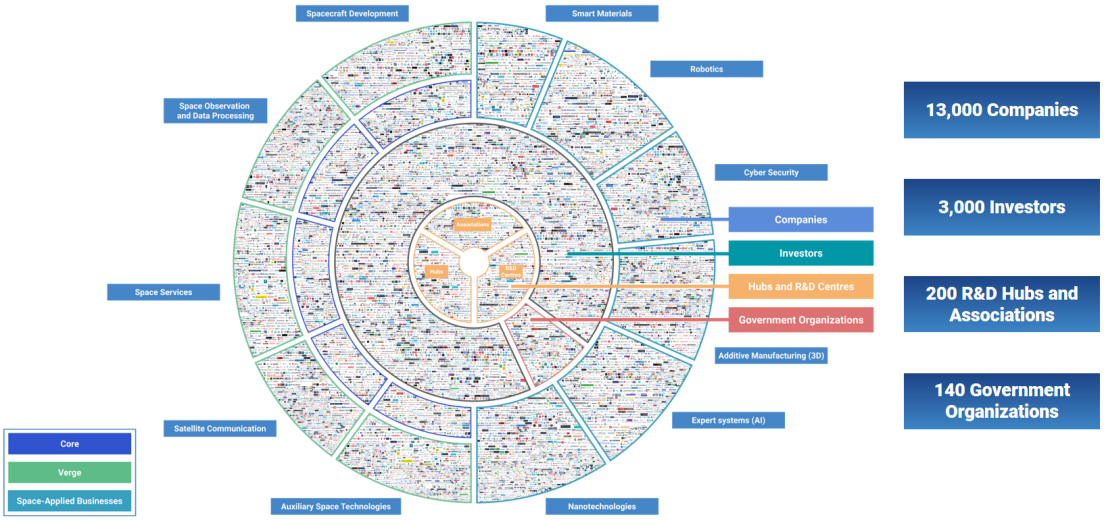
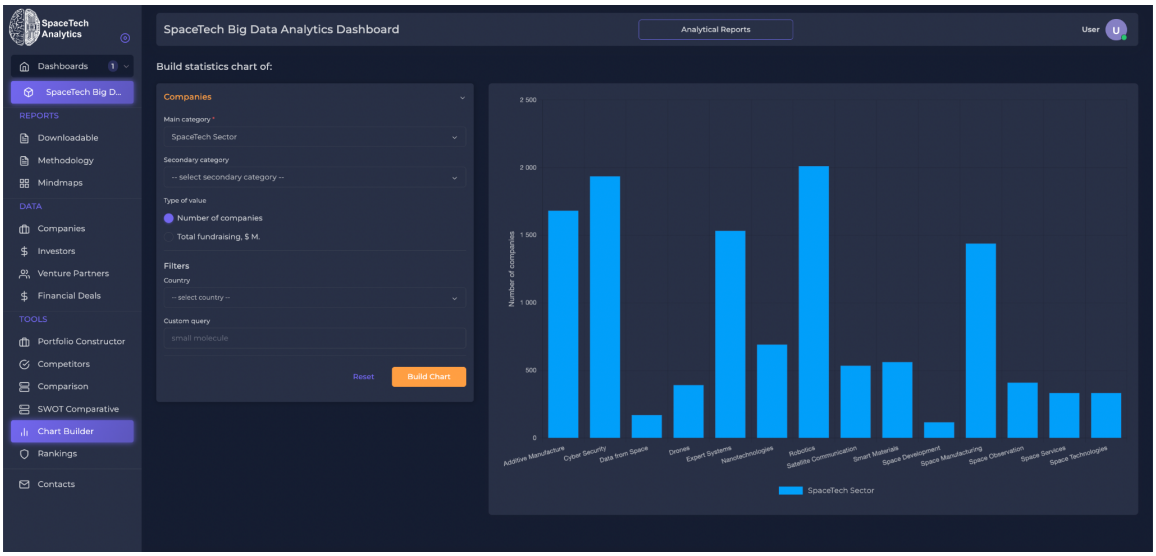
Interactive Mindmaps



Interactive Mindmaps of SpaceTech Industry Landscape at www.spacetech.global/mindmaps

This online interactive IT system uses advanced modes of data aggregation, structuring, filtering, and visualization to deliver a deeper, more comprehensive understanding of Industry landscape than was ever previously attainable. It allows for complex interactions between industry entities and stakeholders to be visualized, filtered, researched, and more easily understood, providing a more dynamic lens for viewing emerging trends.



SpaceTech Big Data Analytics Dashboard at www.deep-innovation.tech/deeptech-spacetech-dashboard

The remainder of this document outlines the framework that makes this possible.

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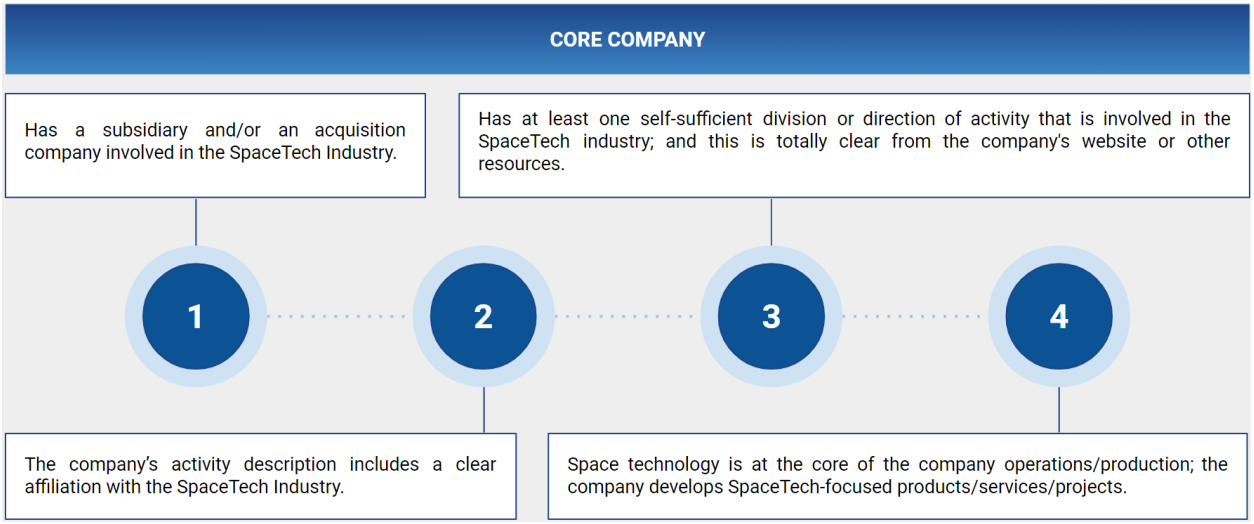
Methodology

The analysis includes more than 12,000 SpaceTech companies that were chosen according to the original methodology. All the entities that were analyzed for the SpaceTech Industry Landscape Overview were divided into three main categories: **Core Companies, Verge Companies, and Space-Applied Businesses** based on the following criteria:

Below is defined the criteria for inclusion in the SpaceTech Core category:



All the analyzed companies were selected by means of manual and automated search from open web sources. The further sorting of the database was executed both manually and with the use of algorithms. The methodology may contain a slight inaccuracy due to the partially manual construction of the database.

Below is defined the criteria for SpaceTech Verge Companies:

1. The company didn't specify clearly the industries and customers, but its products and services could potentially be applied in the SpaceTech Industry. The company operates in the general categories of Aerospace, Telecommunication, Defense, Navigation, and/or some other related categories. Some combination of these factors allows us to assume that the company is space-related.
2. Has space technologies, but not as a core technology or a core department.
3. One of the company's products is used in aerospace; it has products related to satellite communication.
4. SpaceTech is mentioned but not defined as a distinct sector; there is no specific space department.

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5. Related through the application of Satellite Communication or other space technologies in their core solutions.
6. The company operates in the aerospace industry and has SpaceTech-related partners or buyers/users/suppliers.
7. The company has a SpaceTech-related project or program that recently appeared and might become a self-sufficient entity.
8. The connection to space technology is mentioned in external resources describing the company's activity.

The largest share of the database consists of space-related companies. All of the companies included are developing technologies that will form the backbone of the rapidly growing space industry. Their technologies are at different stages of development, from prototype to first experiments, to being placed into orbit or on another planet. **They are as follows:**

- Nano-technologies: NanoTech, and molecular manufacturing in particular, will be crucial for all advanced activities within the space industry.
- Smart Materials: Smart materials, like multiferroics, piezoelectrics may significantly improve human viability in space and space settlement capabilities.
- Cybersecurity: With the growing amount of data transferred through space, the need for cybersecurity is becoming ever-more salient.
- Robotics: Robotics will form the main workforce on Earth, and will be even more an integral part of any space activity.
- Expert Systems (AI): AI is especially important due to its connectivity to all of the other discussed technologies and due to the increasing levels of data involved.
- Additive Manufacturing (3D): Additive Manufacturing is crucial for providing construction or assembly in a quick, efficient, reliable, and inexpensive manner (on Earth or beyond it).

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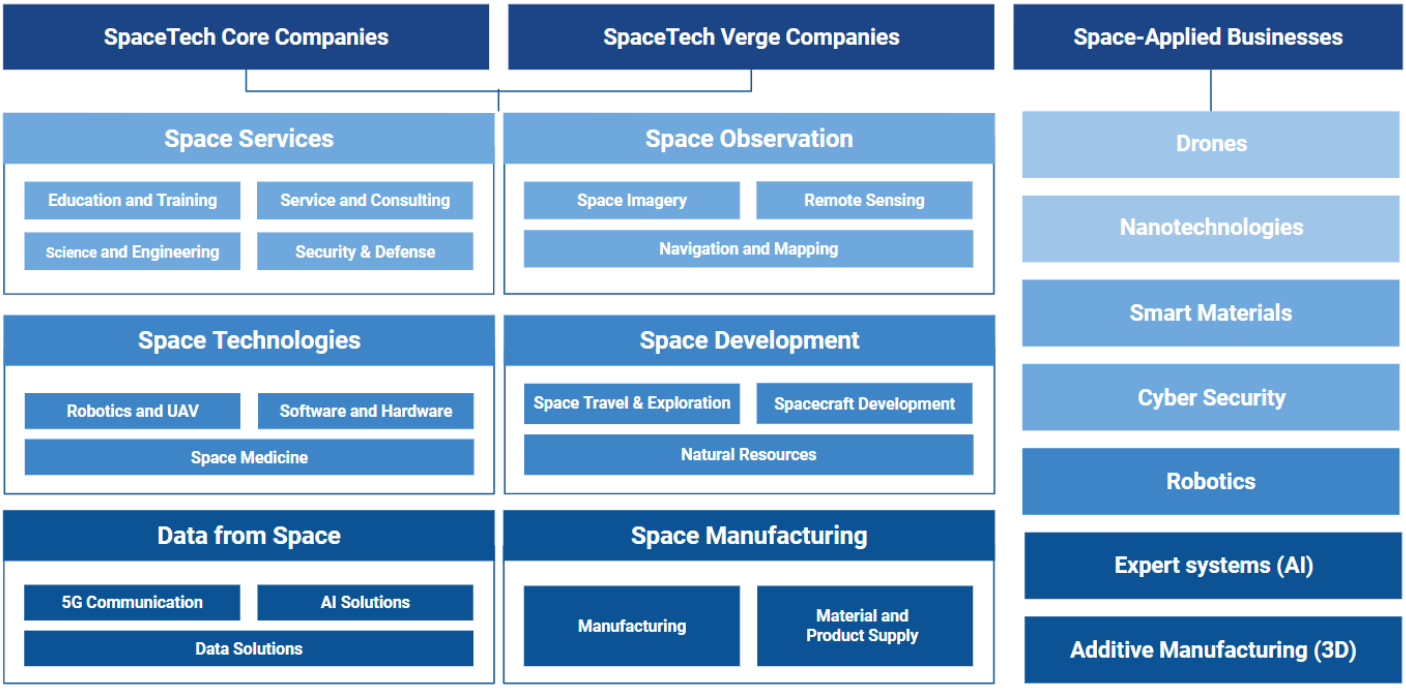
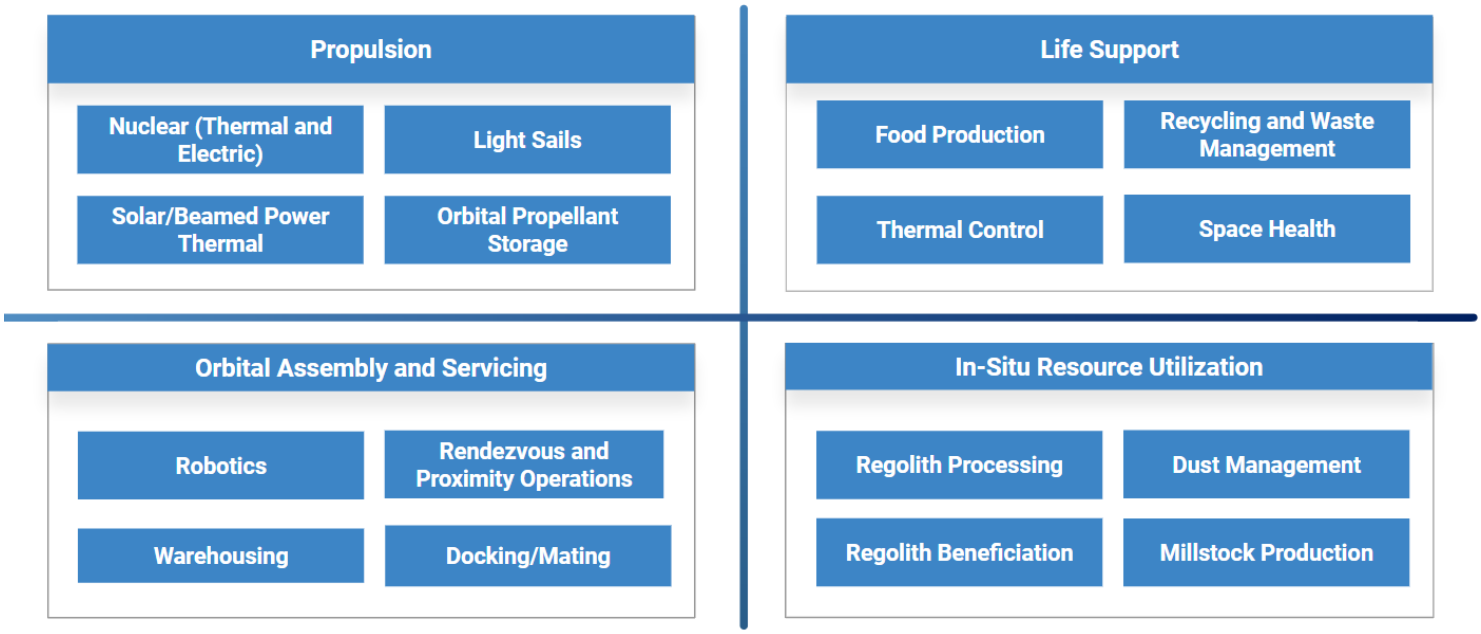
SpaceTech Industry Analytical Framework

SpaceTech General Framework



Advanced Space Technologies



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SpaceTech Industry Analytical Framework: General Framework Segments

Space Services (Core & Verge)

The Space Services segment of the SpaceTech industry focuses on providing a range of services that support the development and deployment of space-related technologies and infrastructure. This segment encompasses a diverse range of services, from launch services to space-based communications, and includes companies that work with both government agencies and private sector organizations. Some key features and benefits of the Space Services segment include:

- Launch services for satellites and other spacecraft, including launch vehicle design and development, payload integration, and launch operations.
- Space-based communications services, such as satellite-based internet, television, and radio, as well as tracking and telemetry services for spacecraft.
- Satellite imagery and remote sensing services, which provide high-resolution imagery and data for a range of applications, including environmental monitoring, natural resource management, and national security.
- Space-based navigation and positioning services, including the Global Positioning System (GPS) and other satellite-based navigation systems.
- Space weather monitoring and forecasting services, which provide information on solar flares, geomagnetic storms, and other space weather events that can affect space-based technologies and infrastructure.
- Space debris and orbital debris monitoring and mitigation services, which help to ensure the safety and sustainability of space operations by tracking and mitigating the risks posed by space debris.
- Collaboration with government agencies and other organizations in the SpaceTech industry to develop new services and solutions that support the growth and development of the space industry.

Overall, the Space Services segment plays a critical role in enabling the development and operation of space-based technologies and infrastructure. By providing a range of services that support space-based operations, this segment helps to unlock new opportunities for scientific research, commercial applications, and national security.

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Science and Engineering

The Science and Engineering subsector of the Space Services segment of the SpaceTech industry is focused on developing and providing advanced technologies and engineering solutions for space exploration and utilization. These companies are involved in the design, development, and testing of spacecraft and associated systems, as well as the provision of research and development services to support the growth and advancement of the space industry. Here are some of the key features and benefits of companies in this subsector:

- Advanced propulsion systems to enable efficient and effective space travel.
- Innovative materials and manufacturing processes to reduce the cost and increase the durability of spacecraft.
- Advanced guidance and control systems to ensure accurate and safe spacecraft navigation.
- Advanced sensor systems to gather data and provide critical insights into the environment and conditions in space.
- Collaboration with government agencies and private companies to design solutions that meet their unique needs and objectives.
- Integration with other space-related platforms and technologies to provide comprehensive and integrated solutions for the space industry.

Service and Consulting

The Service and Consulting subsector of the Space Services segment of the SpaceTech industry provides a wide range of consulting and advisory services, as well as technical and operational support for space-related activities. These companies work with governments, businesses, and individuals to provide a range of solutions to help them achieve their goals and objectives in space exploration and utilization. Here are some key features and benefits of companies in this subsector:

- Consulting services to help clients identify opportunities and develop strategies for space-related activities.
- Technical support for spacecraft design, development, and operation.
- Operational support for space missions, including launch and recovery operations, as well as ongoing mission management.
- Training and education programs to help individuals and organizations develop the

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skills and knowledge needed for space-related activities.

- Risk management and mitigation services to help clients manage the risks associated with space exploration and utilization.
- Regulatory compliance services to ensure that clients comply with applicable laws and regulations related to space activities.
- Strategic planning and advisory services to help clients develop long-term plans for space-related activities.
- Financial and investment services to help clients secure funding and investment for space-related activities.

Education and Training

The Education and Training subsector of the Space Services segment of the SpaceTech industry provides a range of programs and services to help individuals and organizations develop the skills and knowledge needed for space-related activities. These companies offer a variety of educational and training programs to help people prepare for careers in the space industry, as well as professional development opportunities for those already working in the field. Here are some key features and benefits of companies in this subsector:

- Educational programs to help individuals gain a strong understanding of space-related topics, including physics, engineering, and astronomy.
- Professional development opportunities to help individuals and organizations stay up-to-date with the latest advancements in the space industry.
- Hands-on training programs to provide individuals with practical experience in space-related activities, such as mission planning and spacecraft operation.
- Online and remote learning options to make educational and training programs accessible to individuals worldwide.
- Customized training programs to meet the unique needs and objectives of organizations in the space industry.
- Industry partnerships to ensure that educational and training programs are aligned with the needs of the space industry.

Security and Defense

The Security & Defense subsector of the Space Services segment of the SpaceTech industry focuses on providing solutions to protect space assets and ensure the security

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of space-related activities. These companies work with government agencies and private sector organizations to develop and implement security and defense strategies for the space industry. Here are some key features and benefits of companies in this subsector:

- Development and deployment of space-based defense systems, such as anti-satellite weapons and missile defense systems.
- Satellite and space asset protection services, including threat assessment and risk mitigation strategies.
- Cybersecurity solutions to protect space-related data and systems from cyber attacks and other security threats.
- Intelligence gathering and analysis services to support space-related activities and ensure national security.
- Training and education programs for individuals and organizations to improve their understanding of space-related security and defense issues.
- Strategic planning and advisory services to help clients develop and implement security and defense strategies for their space-related activities.

Space Observation (Core & Verge)

The Space Observation segment of the SpaceTech Industry focuses on developing and deploying technology solutions for Earth observation, remote sensing, and environmental monitoring from space. These companies leverage space-based platforms and sensors to gather data and information about our planet, which can be used to inform a wide range of applications and industries. The key features of the Space Observation segment include:

- Development and deployment of Earth observation satellites and other space-based platforms, such as the International Space Station, to gather data and imagery of the Earth from space.
- Use of remote sensing technologies, including radar and optical sensors, to capture high-resolution images and data on various aspects of the Earth, such as weather patterns, land use, and natural resources.
- Data analysis and interpretation using advanced algorithms and machine learning techniques to extract meaningful insights and patterns from the vast amounts of data collected from space.

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- Provision of data products and services to a range of industries, including agriculture, forestry, energy, and environmental management, to support decision-making and improve operational efficiency.
- Collaboration with government agencies and research institutions to develop and implement space-based observation and monitoring programs to address global challenges, such as climate change, natural disasters, and ecosystem management.
- Development of new technologies and solutions to improve the accuracy and precision of Earth observation and remote sensing data, such as new sensors and platforms, and advanced signal processing and data analysis techniques.
- Promotion of public awareness and education on the value of space-based observation and monitoring, and the potential for these technologies to address critical global challenges and support sustainable development.

Overall, the Space Observation segment of the SpaceTech Industry plays a critical role in providing Earth observation and remote sensing data to a wide range of industries and applications, supporting decision-making and innovation in fields such as agriculture, forestry, energy, and environmental management. Through collaboration with government agencies, research institutions, and industry partners, these companies are driving innovation and advancing our understanding of the Earth and its complex systems.

Space Imagery

The Space Imagery subsector is a key part of the Space Services segment of the SpaceTech industry, providing high-resolution satellite imagery and data for a range of applications. This subsector uses advanced satellite technology and data analysis tools to capture and process imagery of the Earth's surface and atmosphere, providing valuable insights for a variety of industries and applications. Here are some key features and benefits of companies in this subsector:

- Development and deployment of high-resolution satellite imaging systems to capture imagery of the Earth's surface and atmosphere.
- Processing and analysis of satellite imagery to provide real-time information on a range of applications, including weather forecasting, disaster response, and environmental monitoring.
- Customized imaging services for specific applications and industries, such as

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agriculture, mining, and urban planning.

- Integration with other space-based and ground-based observation systems to provide a comprehensive view of the Earth's surface and atmosphere.
- Collaboration with government agencies and other organizations to ensure the accuracy and reliability of satellite imagery data.
- Research and development of new satellite imaging technology and data analysis tools to improve the accuracy and effectiveness of satellite imagery systems over time.

Remote Sensing

The Security & Defense subsector of the Space Services segment of the SpaceTech industry focuses on providing solutions to protect space assets and ensure the security of space-related activities. These companies work with government agencies and private sector organizations to develop and implement security and defense strategies for the space industry. Here are some key features and benefits of companies in this subsector:

- Development and deployment of space-based defense systems, such as anti-satellite weapons and missile defense systems.
- Satellite and space asset protection services, including threat assessment and risk mitigation strategies.
- Cybersecurity solutions to protect space-related data and systems from cyber attacks and other security threats.
- Intelligence gathering and analysis services to support space-related activities and ensure national security.
- Training and education programs for individuals and organizations to improve their understanding of space-related security and defense issues.
- Strategic planning and advisory services to help clients develop and implement security and defense strategies for their space-related activities.

Navigation and Mapping

The Navigation and Mapping subsector is a crucial part of the Space Observation segment of the SpaceTech industry. This subsector focuses on developing and deploying satellite-based navigation and mapping systems to support a range of

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applications, from commercial aviation and shipping to scientific research and national defense. Companies in this subsector utilize advanced satellite technology and data analysis tools to provide accurate and real-time navigation and mapping services. Here are some key features and benefits of companies in this subsector:

- Development and deployment of satellite-based navigation systems, including GPS, GLONASS, and Galileo.
- Creation and updating of high-resolution satellite imagery and maps for a variety of applications, including agriculture, urban planning, and environmental monitoring.
- Use of advanced data analysis tools, such as machine learning and artificial intelligence, to process and interpret satellite data and provide real-time information.
- Customized navigation and mapping services for specific applications and industries, such as aviation, shipping, and defense.
- Integration with other space-based and ground-based observation systems to provide a comprehensive view of the Earth's surface and atmosphere.
- Collaboration with government agencies and other organizations to ensure the accuracy and reliability of navigation and mapping data.
- Research and development of new satellite technology and data analysis tools to improve the accuracy and effectiveness of navigation and mapping systems over time.

The Navigation and Mapping subsector plays a critical role in enabling a range of applications and services that depend on accurate and up-to-date information about the Earth's surface and atmosphere. With the continued growth of the SpaceTech industry, companies in this subsector will play an increasingly important role in supporting a wide range of industries and applications.

Space Technologies (Core & Verge)

Space Technologies is a segment of the SpaceTech industry that is focused on the development and application of advanced technologies for space exploration, research, and commercial activities. This segment includes a wide range of companies and organizations that are involved in various aspects of space technology, from designing and building spacecraft and launch vehicles to developing advanced materials and software for space applications. The key features of the Space Technologies segment include:

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- Research and development of advanced technologies for space exploration, including propulsion systems, materials science, and robotics.
- Development and deployment of satellite and other space-based systems for communication, navigation, earth observation, and remote sensing.
- Manufacturing and testing of launch vehicles, rockets, and other space transportation systems.
- Development of new space habitats and infrastructure to support human spaceflight and long-term space exploration.
- Collaboration with government agencies and other organizations in the SpaceTech industry to develop comprehensive space technologies and solutions.
- Innovation in areas such as space tourism and commercial space exploration, which are driving the development of new technologies and business models.

Overall, Space Technologies are critical for space exploration, research, and development, enabling humans to understand more about the universe and our place within it. Space Technologies have the potential to unlock new discoveries and innovations that can benefit life on Earth, including advancements in communication, transportation, and energy technologies. With ongoing investments in Space Technologies, the industry will continue to evolve and push the boundaries of what is possible in space exploration and beyond.

Robotics and UAV

The Robotics and UAV (Unmanned Aerial Vehicle) subsector is an important part of the Space Technologies segment of the SpaceTech industry. Companies in this subsector design and manufacture robots and drones for use in space exploration, as well as on Earth for various applications. Here are some key features and benefits of companies in this subsector:

- Development of robotic systems and drones for use in space exploration and research, including for tasks such as exploration, sample collection, and maintenance.
- Design and production of unmanned aerial vehicles (UAVs) for use in commercial applications such as surveying, mapping, and inspections.
- Use of advanced technologies such as machine learning and computer vision to enable autonomous operation of robots and drones in space and on Earth.
- Integration of robotics and UAVs with other space technologies such as satellites, ground stations, and data analysis systems to provide a comprehensive solution for

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customers.
- Collaboration with government agencies and private companies to develop specialized robotic and UAV systems for specific applications and industries.
- Development of innovative new technologies such as soft robotics and biomimetic systems to improve the capabilities and versatility of robotic systems and drones.

Software and Hardware

The Software and Hardware subsector is a crucial component of the Space Technologies segment of the SpaceTech industry. This subsector is responsible for developing and manufacturing software and hardware components that are essential for space missions and operations. Here are some key features and benefits of companies in this subsector:

- Development of software systems for spacecraft, satellites, and ground-based space infrastructure, including mission control and communication systems.
- Design and manufacture of specialized hardware components for space missions, including microprocessors, sensors, and antennas.
- Use of advanced technologies such as artificial intelligence and machine learning to improve the performance and efficiency of software and hardware systems in space.
- Development of specialized tools and systems for space research and exploration, including remote sensing and imaging technologies.
- Integration of software and hardware systems with other space technologies such as robotics, navigation, and communication systems to provide a comprehensive solution for customers.
- Collaboration with government agencies, private companies, and academic institutions to develop innovative new technologies and solutions for space missions and operations.

Space Medicine

The Space Medicine subsector is a crucial component of the Space Technologies segment of the SpaceTech industry. This subsector is responsible for developing medical technologies and procedures that enable humans to live and work in space for extended periods. Here are some key features and benefits of companies in this subsector:

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- Development of medical technologies and procedures to support astronaut health and well-being during space missions, including remote monitoring and diagnostic tools.
- Conduct of research to better understand the effects of long-term space travel on the human body and develop solutions to mitigate these effects.
- Design and development of space habitats and life-support systems that support human health and comfort in space.
- Development of exercise equipment and programs that enable astronauts to maintain their physical fitness in space.
- Collaboration with government agencies, private companies, and academic institutions to develop new and innovative solutions for space medicine.
- Provision of training and support services to astronauts and ground-based medical personnel to ensure proper use of medical technologies and procedures in space.
- Application of space medicine technologies and research to improve healthcare on Earth, including telemedicine and remote monitoring technologies.

The Space Medicine subsector plays a critical role in ensuring the health and well-being of astronauts during space missions. Companies in this subsector are responsible for developing the medical technologies and procedures that enable humans to live and work in space for extended periods, as well as conducting research to better understand the effects of long-term space travel on the human body. As the demand for space exploration and research continues to grow, companies in this subsector will play an increasingly important role in developing new and innovative solutions for space medicine.

Space Development (Core & Verge)

Space Technologies is a segment of the SpaceTech industry that is focused on the development and application of advanced technologies for space exploration, research, and commercial activities. This segment includes a wide range of companies and organizations that are involved in various aspects of space technology, from designing and building spacecraft and launch vehicles to developing advanced materials and software for space applications. The key features of the Space Technologies segment include:

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Space Travel & Exploration

The Space Travel & Exploration subsector of the Space Development segment of the SpaceTech industry focuses on developing and implementing technologies and strategies to enable human space travel and exploration. These companies work on various aspects of space travel and exploration, including spacecraft design, propulsion systems, life support systems, and more. Here are some key features and benefits of companies in this subsector:

- Development and manufacturing of spacecraft and launch vehicles for human space travel and exploration.
- Design and implementation of life support systems to sustain human life in space environments.
- Development of propulsion systems to enable faster and more efficient space travel.
- Exploration and surveying of space environments to identify potential resources and hazards.
- Development of strategies and technologies for long-duration human space missions,

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such as to Mars and beyond.
- Collaboration with government agencies and other organizations to advance space travel and exploration capabilities.
- Education and public outreach programs to promote public awareness and interest in space travel and exploration.

Spacecraft Development

The Spacecraft Development subsector of the Space Development segment of the SpaceTech industry is focused on the design, development, and manufacturing of spacecraft for a range of space exploration and commercial applications. Here are some key features and benefits of companies in this subsector:

- Development of spacecraft for various purposes, including communication, remote sensing, and scientific research.
- Integration of advanced technologies, such as propulsion systems, navigation and control systems, and thermal management systems.
- Testing and validation of spacecraft systems to ensure they can operate effectively in the harsh space environment.
- Collaboration with government agencies and private sector organizations to develop spacecraft solutions that meet their specific needs and requirements.
- Maintenance and repair services for spacecraft to extend their operational life and ensure their continued performance.
- Use of sustainable and environmentally-friendly practices in spacecraft design and manufacturing.
- Implementation of quality control measures to ensure spacecraft are built to the highest standards of safety and reliability.

Natural Resources

The Natural Resources subsector of the Space Development segment of the SpaceTech industry focuses on the exploration and utilization of extraterrestrial natural resources. These companies work to identify and extract resources from space that can be used to support space activities and advance technologies. Here are some key features and benefits of companies in this subsector:

- Identification and mapping of extraterrestrial resources, including minerals, water,

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and gasses.
- Development of technologies for resource extraction and utilization, including mining equipment and refining processes.
- Exploration and prospecting of asteroids and other celestial bodies for resource potential.
- Collaboration with government agencies and other organizations to develop policies and regulations for the utilization of extraterrestrial resources.
- Promotion of sustainable and responsible resource utilization practices to minimize environmental impact and ensure long-term viability.
- Creation of new economic opportunities and industries through the development and utilization of extraterrestrial resources.
- Advancement of scientific knowledge through the study of extraterrestrial resources and their potential for supporting life and understanding the history of our solar system.

Natural resources in space have a lot of potential for enabling sustainable space exploration and advancement of technology. For example, water on the moon or other planets can be used to create breathable air, drinking water, and rocket fuel. The use of extraterrestrial resources can reduce the cost and risk of launching resources from Earth and expand the possibilities for space exploration and human habitation beyond Earth. However, there are also ethical and legal challenges to be addressed in the responsible utilization of natural resources in space.

Data from Space (Core & Verge)

Data from Space is a segment of the SpaceTech industry that focuses on collecting, analyzing, and utilizing data acquired from space-based assets. This segment relies on the use of advanced technology and innovation to capture and process data, providing valuable insights and solutions to various industries. Here are some key features and benefits of this segment:

- Collection and analysis of data from Earth observation satellites, providing vital information on climate change, natural disasters, and environmental patterns.
- Utilization of satellite communications to provide internet and other communication services in remote areas where traditional infrastructure is lacking.

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- Use of satellite-based navigation systems to provide accurate location and timing information to various industries, such as transportation and logistics.
- Development of advanced space-based sensors and instruments to capture and analyze data from the universe, enabling new discoveries in astronomy and astrophysics.
- Use of satellite data for precision agriculture, enabling farmers to optimize crop yields and reduce waste.
- Provision of critical data for disaster response and relief efforts, allowing for faster and more effective responses to emergencies.
- Development of new technologies and data analysis methods to enhance the value and accuracy of space-based data, unlocking new applications and opportunities for various industries.

Overall, Data from Space is a critical segment of the SpaceTech industry, providing a wealth of information and solutions to various sectors. The use of space-based assets to collect and process data has revolutionized industries such as agriculture, telecommunications, and environmental monitoring, among others. With continued innovation and development, the potential applications of Data from Space are endless, paving the way for a more sustainable and connected world.

5G Communication

The Space Travel & Exploration subsector of the Space Development segment of the SpaceTech industry focuses on developing and implementing technologies and strategies to enable human space travel and exploration. These companies work on various aspects of space travel and exploration, including spacecraft design, propulsion systems, life support systems, and more. Here are some key features and benefits of companies in this subsector:

- Development and manufacturing of spacecraft and launch vehicles for human space travel and exploration.
- Design and implementation of life support systems to sustain human life in space environments.
- Development of propulsion systems to enable faster and more efficient space travel.
- Exploration and surveying of space environments to identify potential resources and hazards.
- Development of strategies and technologies for long-duration human space missions,

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such as to Mars and beyond.
- Collaboration with government agencies and other organizations to advance space travel and exploration capabilities.
- Education and public outreach programs to promote public awareness and interest in space travel and exploration.

AI Solutions

The Spacecraft Development subsector of the Space Development segment of the SpaceTech industry is focused on the design, development, and manufacturing of spacecraft for a range of space exploration and commercial applications. Here are some key features and benefits of companies in this subsector:

- Development of spacecraft for various purposes, including communication, remote sensing, and scientific research.
- Integration of advanced technologies, such as propulsion systems, navigation and control systems, and thermal management systems.
- Testing and validation of spacecraft systems to ensure they can operate effectively in the harsh space environment.
- Collaboration with government agencies and private sector organizations to develop spacecraft solutions that meet their specific needs and requirements.
- Maintenance and repair services for spacecraft to extend their operational life and ensure their continued performance.
- Use of sustainable and environmentally-friendly practices in spacecraft design and manufacturing.
- Implementation of quality control measures to ensure spacecraft are built to the highest standards of safety and reliability.

Data Solutions

The Data Solutions subsector of the Data from Space segment of the SpaceTech industry focuses on providing solutions to collect, process, and analyze space-based data for various applications. These companies work with government agencies, research institutions, and private sector organizations to develop and implement innovative data solutions for the space industry. Here are some key features and benefits of companies in this subsector:

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- Development and deployment of remote sensing technologies, including satellites and other spacecraft, to collect data from space.
- Processing and analysis of space-based data using advanced algorithms and analytics tools to generate insights and identify patterns.
- Provision of data services to various industries, including agriculture, mining, and environmental monitoring, to improve decision-making processes and optimize operations.
- Provision of data solutions for disaster response and management, including real-time monitoring of natural disasters and rapid response to emergencies.
- Development of artificial intelligence and machine learning algorithms to analyze and interpret large volumes of space-based data for various applications.
- Provision of software and hardware tools to support data analysis and visualization, including geographic information systems (GIS) and remote sensing software.
- Collaboration with government agencies and other organizations in the SpaceTech industry to develop innovative data solutions for various space-related applications.

As the use of satellite data becomes increasingly important across industries, the Data Solutions subsector of the Data from Space segment has become a critical player in the SpaceTech industry. Companies in this subsector are focused on processing, analyzing, and interpreting satellite data to provide valuable insights to their clients. These insights can be used for a variety of purposes, from monitoring environmental changes to assessing crop yields and predicting market trends. As the demand for accurate and timely satellite data continues to grow, companies in the Data Solutions subsector are well-positioned to play a key role in the SpaceTech industry's future.

Space Manufacturing (Core & Verge)

Space Manufacturing is a segment of the SpaceTech Industry that focuses on the development and production of products and materials for use in space. It involves the design, construction, and assembly of equipment and structures that can withstand the harsh conditions of space. The key features of Space Manufacturing include:

- Development of specialized manufacturing processes and technologies that are suitable for use in space.

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- Production of materials and components that can withstand the extreme temperature fluctuations, radiation exposure, and vacuum environment of space.
- Design and assembly of space structures, such as habitats and stations, that can provide a sustainable living environment for humans in space.
- Production of satellite components, including solar panels, batteries, and sensors, that are essential for the functioning of space-based infrastructure.
- Development of additive manufacturing technologies that can be used to create complex structures and components in space, using locally sourced materials.
- Collaboration with other segments of the SpaceTech industry to design and build integrated systems that can support human exploration and commercial activities in space.
- Research and development of new materials and manufacturing processes that can further enhance the capabilities and sustainability of space manufacturing.

Overall, Space Manufacturing plays a critical role in enabling human exploration and commercial activities in space. By developing new manufacturing technologies and processes, and producing specialized materials and components, Space Manufacturing is paving the way for a sustainable and prosperous space economy. The goal of Space Manufacturing is to create products and structures that are optimized for use in space, and that can support long-term human presence and exploration in this exciting frontier.

Material and Product Supply

The Material and Product Supply subsector of the Space Manufacturing segment of the SpaceTech industry is responsible for providing the necessary materials, components, and products to support the development and manufacturing of space technologies. Here are some key features and benefits of companies in this subsector:

- Production and supply of materials and components needed for space technologies, such as specialized alloys, composites, and electronics.
- Development and manufacturing of space-grade products, such as sensors, antennas, and solar panels.
- Design and production of specialized manufacturing equipment and processes for space-related applications.
- Quality control and testing services to ensure that materials and products meet the rigorous standards required for use in space.
- Logistics and supply chain management services to ensure timely delivery of

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materials and products to space technology manufacturers.

- Research and development of new materials and products to improve the performance, reliability, and sustainability of space technologies.
- Collaboration with space technology manufacturers and other stakeholders in the SpaceTech industry to develop innovative solutions and drive progress in the field.

Space-Applied Businesses

Space-Applied Businesses is a category of companies that are not currently involved in the SpaceTech industry but have a potential for integration into this field in the future. These businesses have technologies that can be applied to space-related activities, such as:

- Drones: Companies that manufacture drones can potentially develop drones for space exploration and monitoring.
- Nanotechnologies: Companies that work with nanomaterials can develop materials that are more suitable for use in space environments.
- Smart Materials: Companies that work with smart materials can develop materials that can be used in spacecraft and space equipment that can adapt to changing conditions.
- Cyber Security: Companies that provide cybersecurity solutions can offer their services to protect space assets and infrastructure from cyber threats.
- Expert Systems (AI): Companies that develop AI systems can potentially create AI systems that can assist with space exploration and decision-making.
- Robotics: Companies that manufacture robots can potentially develop robots for space exploration and maintenance of space infrastructure.
- Additive Manufacturing (3D): Companies that use 3D printing can potentially print space equipment and spare parts on demand, reducing the need for resupply missions.

These companies may not currently participate in SpaceTech activities, but they have a significant potential for integration into the industry in the future. As the SpaceTech sector continues to grow and develop, these companies may find new opportunities to apply their technologies and expertise to support the needs of the space industry. From developing autonomous drones for space exploration to creating smart materials for spacecraft components, these companies can play an important role in advancing the capabilities of SpaceTech. By exploring the potential synergies between their

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technologies and the needs of the space industry, these companies can pave the way for a new era of innovation in space exploration and beyond.

Drones

Drones are a segment of the Space-Applied Businesses segment of the SpaceTech industry that are currently focused on terrestrial applications, but have a huge potential for integration into space-related activities in the future. Here are some key features and benefits of companies in this segment:

- Development of drones for a variety of purposes, including aerial surveying, mapping, inspection, and delivery services.
- Integration of advanced technologies, such as high-resolution cameras, sensors, and GPS systems.
- Testing and validation of drone systems to ensure they can operate effectively in challenging environments and weather conditions.
- Collaboration with government agencies and private sector organizations to develop drone solutions that meet their specific needs and requirements.
- Maintenance and repair services for drones to extend their operational life and ensure their continued performance.
- Use of sustainable and environmentally-friendly practices in drone design and manufacturing.
- Implementation of quality control measures to ensure drones are built to the highest standards of safety and reliability.

Nanotechnologies

The Nanotechnologies segment of the Space-Applied Businesses sector in the SpaceTech industry focuses on the development and application of nanotechnology and has a potential of providing the same solutions for space-related activities. Here are some key features and benefits of companies in this segment:

- Development of nanotechnology-enabled materials and components for spacecraft, such as lightweight and high-strength materials, radiation-resistant coatings, and thermal control systems.
- Integration of nanotechnology into space exploration technologies, including sensors, detectors, and imaging systems.

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- Advancement of nanosatellites and nanorobots to enable new space applications, such as in-space assembly and maintenance of space structures, space debris removal, and space-based manufacturing.
- Collaboration with government agencies and private sector organizations to develop nanotechnology solutions that meet their specific needs and requirements.
- Use of sustainable and environmentally-friendly practices in nanotechnology development and manufacturing.
- Implementation of quality control measures to ensure nanotechnology-enabled products are built to the highest standards of safety and reliability.

Smart Materials

The Smart Materials subsector of the Space-Applied Businesses segment of the SpaceTech industry is focused on the development and application of materials that have unique properties and can enhance the performance of spacecraft and other space-related technologies. Here are some key features and benefits of companies in this subsector:

- Development of smart materials that can adapt to changing environmental conditions and provide protection against radiation and other hazards in space.
- Integration of advanced materials, such as shape memory alloys, nanomaterials, and polymers, to enhance the durability and functionality of spacecraft and other space technologies.
- Testing and validation of smart materials to ensure their effectiveness in the harsh space environment.
- Collaboration with government agencies and private sector organizations to develop new smart material solutions that meet their specific needs and requirements.
- Maintenance and repair services for smart materials to ensure their continued performance in space.
- Use of sustainable and environmentally-friendly practices in smart material development and manufacturing.
- Implementation of quality control measures to ensure smart materials are built to the highest standards of safety and reliability.

Cyber Security

The Cyber Security subsector of the Space-Applied Businesses segment of the

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SpaceTech industry is focused on ensuring the security and protection of space-related technologies and systems against cyber threats. Here are some key features and benefits of companies in this subsector:

- Development of advanced cyber security solutions and technologies to protect spacecraft, satellites, and other space-related systems from cyber attacks.
- Integration of state-of-the-art encryption and authentication technologies to ensure the confidentiality, integrity, and availability of space-related data and communications.
- Testing and validation of cyber security solutions to ensure their effectiveness and resilience against evolving cyber threats.
- Collaboration with government agencies and private sector organizations to develop customized cyber security solutions that meet their specific needs and requirements.
- Maintenance and support services for cyber security systems to ensure their continued performance and protection against cyber threats.
- Implementation of sustainable and environmentally-friendly practices in cyber security solution development and deployment.
- Implementation of quality control measures to ensure cyber security solutions are built to the highest standards of safety and reliability.

Robotics

The Robotics subsector of the Space-Applied Businesses segment of the SpaceTech industry is focused on the development and application of robots and other autonomous systems for a range of space-related applications. Here are some key features and benefits of companies in this subsector:

- Development of robots and autonomous systems for various purposes, including exploration, servicing, and maintenance of spacecraft and space infrastructure.
- Integration of advanced technologies, such as artificial intelligence, computer vision, and machine learning, to enable robots and autonomous systems to operate effectively in the harsh space environment.
- Testing and validation of robotics systems to ensure their reliability and effectiveness in space missions.
- Collaboration with government agencies and private sector organizations to develop robotics solutions that meet their specific needs and requirements.
- Use of sustainable and environmentally-friendly practices in robotics development

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and manufacturing.
- Implementation of quality control measures to ensure robots and autonomous systems are built to the highest standards of safety and reliability.

Expert systems (AI)

The Expert Systems (AI) subsector of the Space-Applied Businesses segment of the SpaceTech industry is focused on the development and application of artificial intelligence (AI) technologies that can enhance the performance of spacecraft and other space-related technologies. Here are some key features and benefits of companies in this subsector:

- Development of AI-based systems that can automate various space-related tasks, such as navigation, communication, and exploration.
- Integration of advanced machine learning algorithms, natural language processing, and computer vision technologies to enhance the capabilities and efficiency of space systems.
- Testing and validation of AI-based systems to ensure their reliability and effectiveness in the harsh space environment.
- Collaboration with government agencies and private sector organizations to develop new AI-based solutions that meet their specific needs and requirements.
- Maintenance and repair services for AI-based systems to ensure their continued performance in space.
- Use of sustainable and environmentally-friendly practices in AI development and manufacturing.
- Implementation of quality control measures to ensure AI systems are built to the highest standards of safety and reliability.

Additive Manufacturing (3D)

The Additive Manufacturing (3D) subsector of the Space-Applied Businesses segment of the SpaceTech industry is focused on the development and utilization of 3D printing technology to manufacture components and structures for use in space-related applications. Here are some key features and benefits of companies in this subsector:

- Design and production of complex and intricate structures and components that

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are difficult or impossible to produce using traditional manufacturing methods.

- Manufacture of lightweight and durable parts using a variety of materials, including plastics, metals, and composites.
- Reduction of waste and material usage through the ability to print parts on-demand, eliminating the need for excess inventory and storage.
- Integration of 3D printing technology with robotic systems and other automation technologies to streamline the manufacturing process and increase efficiency.
- Collaboration with government agencies and private sector organizations to develop new 3D printing solutions that meet their specific needs and requirements.
- Maintenance and repair services for 3D printed parts to ensure their continued performance in space.
- Use of sustainable and environmentally-friendly practices in 3D printing processes and material sourcing.
- Implementation of quality control measures to ensure 3D printed components meet the highest standards of safety and reliability in the harsh space environment.

Overall, the Additive Manufacturing (3D) subsector has revolutionized the way components and structures are produced for space-related applications. The ability to design and manufacture complex parts using a range of materials with less waste and reduced inventory has significantly increased efficiency and lowered costs. The integration of 3D printing with automation technologies has further streamlined the manufacturing process, enabling faster and more reliable production of space-related components.

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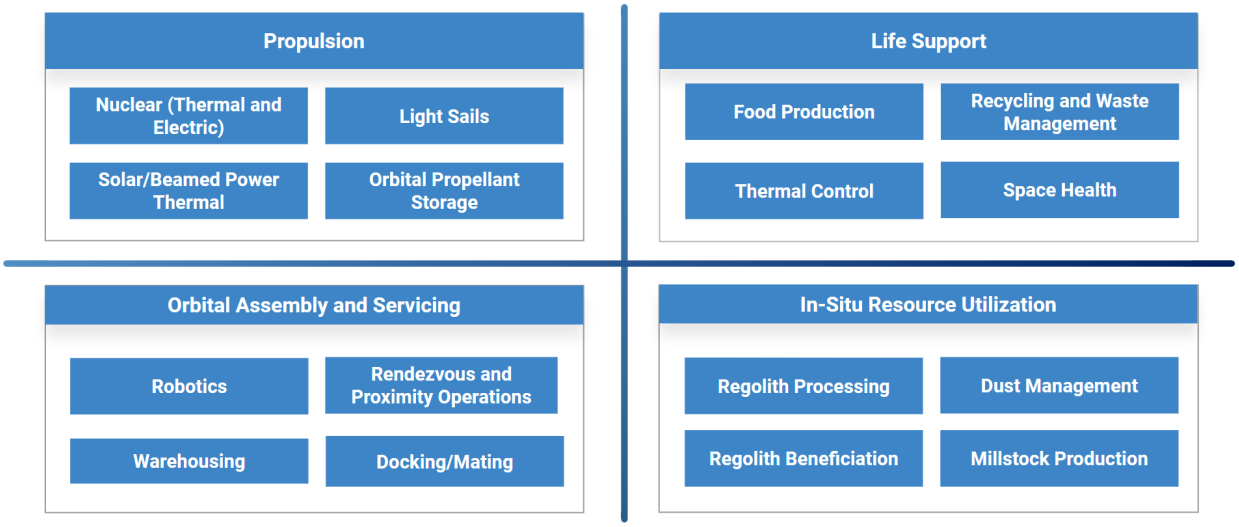
SpaceTech Industry Analytical Framework: Advanced Space Technologies



Propulsion

Nuclear (Thermal and Electric)

Nuclear (Thermal and Electric) propulsion is an advanced space technology that enables spacecraft to travel at faster speeds and for longer distances compared to conventional propulsion methods. This category of technology involves the use of nuclear reactions to generate propulsion for spacecraft. Nuclear thermal propulsion utilizes a nuclear reactor to heat up a propellant and generate thrust, while nuclear electric propulsion uses ion engines powered by nuclear reactors to produce thrust.

Solar/Beamed Power Thermal

The Solar/Beamed Power Thermal subcategory of the Propulsion category of Advanced Space Technologies is focused on the development and utilization of solar energy and beamed power to provide thermal propulsion for spacecraft. This technology involves the use of solar energy and high-powered lasers or microwave beams to heat a propellant and create thrust. The benefits of this technology include the ability to provide long-duration propulsion for spacecraft, as well as the potential to use renewable energy sources for space missions.

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Light Sails

Light sails are a type of propulsion technology that harnesses the power of light to propel spacecraft through space. This innovative technology involves the use of a large, reflective sail that captures the momentum of photons from the sun or other light sources. As the photons bounce off the sail, they impart a small amount of momentum, which over time can build up to significant speeds. Light sails offer several advantages over traditional propulsion methods, including the ability to travel faster and more efficiently, as well as reduced fuel requirements and costs.

Orbital Propellant Storage

The Security & Defense subsector of the Space Services segment of the SpaceTech industry focuses on providing solutions to protect space assets and ensure the security of space-related activities. These companies work with government agencies and private sector organizations to develop and implement security and defense strategies for the space industry.

Life Support

Food Production

Food production is an essential aspect of the life support category of advanced space technologies. With plans for future long-duration missions, astronauts need to be self-sufficient and have the ability to grow their own food in space. The successful implementation of food production technology in space could greatly reduce the cost and risk associated with long-duration missions, and enable the creation of sustainable habitats in space.

Thermal Control

Thermal control is an essential part of the life support category of advanced space technologies. Maintaining a stable temperature within a spacecraft is critical for ensuring the health and safety of the crew and the proper functioning of equipment. To achieve this, advanced thermal control systems are used to regulate the temperature and humidity levels within the spacecraft. These systems utilize various technologies,

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including heat exchangers, radiators, and thermal insulation, to manage the transfer of heat between different areas of the spacecraft and its surroundings.

Recycling and Waste Management

Recycling and waste management are critical components of life support systems in space. With the limited resources available in space, it is essential to recycle and reuse as much waste as possible to reduce the need for resupply missions and minimize the environmental impact of human activity in space. Recycling in space involves the conversion of waste materials into usable resources, such as water, oxygen, and food. This is achieved through a variety of processes, including filtration, composting, and chemical reactions.

Space Health

Space Health is focused on maintaining the health and wellbeing of astronauts during space missions. It involves the development and implementation of medical technologies, procedures, and protocols to address the unique challenges of the space environment, including radiation exposure, microgravity effects, and isolation from Earth's environment. Space health technologies include telemedicine, wearable medical devices, remote monitoring systems, and advanced medical imaging techniques.

Orbital Assembly and Servicing

Robotics

Robotics is an essential component of the Orbital Assembly and Servicing category of Advanced Space Technologies, allowing for the assembly and maintenance of spacecraft and other space-related infrastructure in orbit. Robotic systems are used to perform a wide range of tasks, from simple maneuvers to complex repairs, and are designed to operate in the harsh space environment. These systems often incorporate advanced sensing and control technologies, such as machine vision and artificial intelligence, to enhance their capabilities and improve their accuracy and efficiency.

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Rendezvous and Proximity Operations

The Rendezvous and Proximity Operations (RPO) is focused on developing and implementing systems and technologies that enable spacecraft to approach, rendezvous, and dock with other space vehicles or objects in orbit. These capabilities are essential for many space-based activities, such as crewed missions, satellite servicing, and debris removal. Companies in this subsector employ a range of technologies, including optical sensors, computer vision, and machine learning algorithms, to accurately and safely guide spacecraft during RPO operations.

Warehousing

The Warehousing subcategory of the Orbital Assembly and Servicing category of Advanced Space Technologies involves the development and deployment of space-based facilities for storage and management of supplies and equipment. In-space warehousing provides the capability to pre-position supplies and equipment in orbit, enabling rapid assembly and servicing of spacecraft and other space-based platforms. This can reduce the cost and complexity of launching all components from Earth and can lead to more sustainable and efficient space missions.

Docking/Mating

The Docking/Mating involves the development and implementation of docking and mating mechanisms that allow spacecraft to connect with each other while in orbit. This is an essential capability for space exploration, as it enables the assembly of large structures, servicing of spacecraft, and transfer of crew and cargo between vehicles. Safety and reliability are of paramount importance in this subcategory, and companies implement rigorous testing and quality control measures to ensure that docking and mating operations are successful and free from potential hazards.

In-Situ Resource Utilization

Regolith Processing

Regolith processing is a key aspect of in-situ resource utilization, which refers to the use of materials found on celestial bodies, such as the Moon or Mars, to support human exploration and settlement. Regolith is a layer of loose soil and rock that covers the

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surface of many celestial bodies, and contains a variety of minerals that could be used to produce oxygen, water, and other resources needed for human activities. Regolith processing involves extracting and processing these minerals, which can be used to produce a range of useful products, including building materials, fuel, and even food.

Dust Management

Dust management is a critical aspect of In-Situ Resource Utilization (ISRU) in space exploration, as dust can pose a significant risk to spacecraft and crew. This category of Advanced Space Technologies focuses on developing methods for managing the fine dust particles that are present on the surface of planetary bodies. Dust can interfere with the operation of equipment, clog air filters, and damage sensitive electronic components. Dust management technologies can enable more efficient and safe exploration of planetary surfaces by minimizing the risks associated with dust exposure.

Regolith Beneficiation

Regolith beneficiation is a process of extracting valuable minerals and materials from regolith, which is the layer of loose, heterogeneous material covering solid rock on the moon, asteroids, and other celestial bodies. This process involves the use of various techniques, such as magnetic separation, acid leaching, and electrostatic separation, to separate the desired materials from the regolith. The extracted materials can include water, oxygen, iron, silicon, and other elements that can be used for various purposes in space exploration, such as life support, construction, and propulsion.

Millstock Production

Millstock production involves the processing of raw materials, such as regolith or asteroids, to create high-quality feedstock that can be used for various manufacturing purposes. The process usually involves crushing, grinding, and milling the raw materials to produce a fine powder that can be used to create alloys, ceramics, and other materials required for the construction of space structures and equipment. Millstock production technology is crucial for long-duration space missions where the reliance on Earth-based supplies is not feasible due to the high costs and logistical challenges involved.

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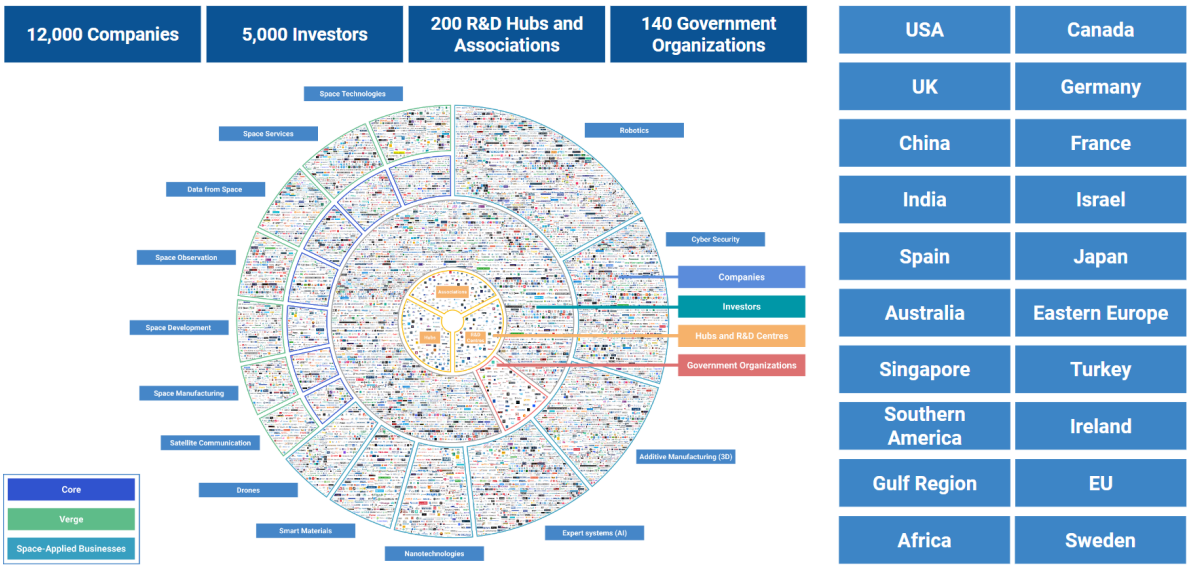
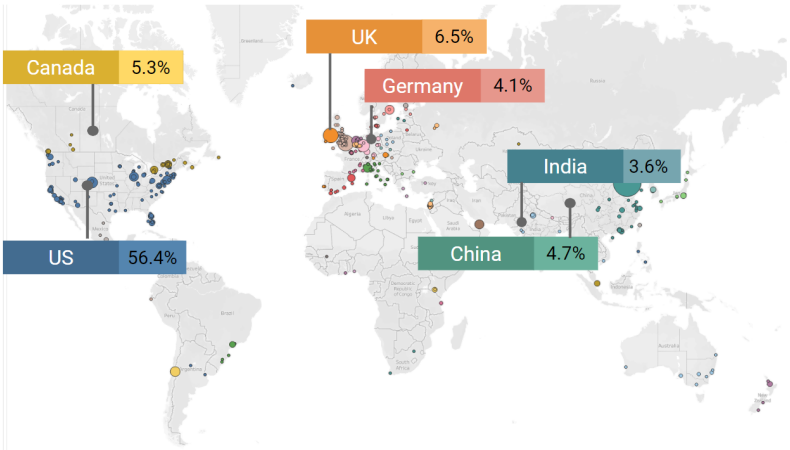
SpaceTech Industry Market Overview

Global SpaceTech Ecosystem 2023

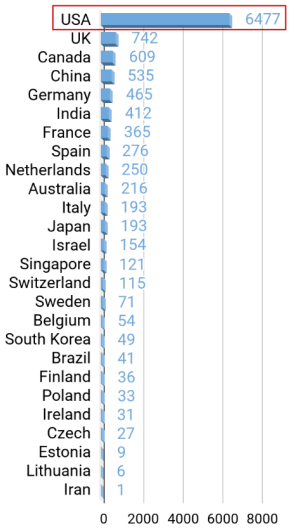


Source:www.spacetech.global/mindmaps

Regional Distribution of SpaceTech Companies in 2023



The US is firmly in the lead, representing 56.4% of the world's SpaceTech companies. The UK ranks second (6.5%), followed by Canada, China, Germany, and India at 5.3%, 4.7%, 4.1% and 3.6% respectively.



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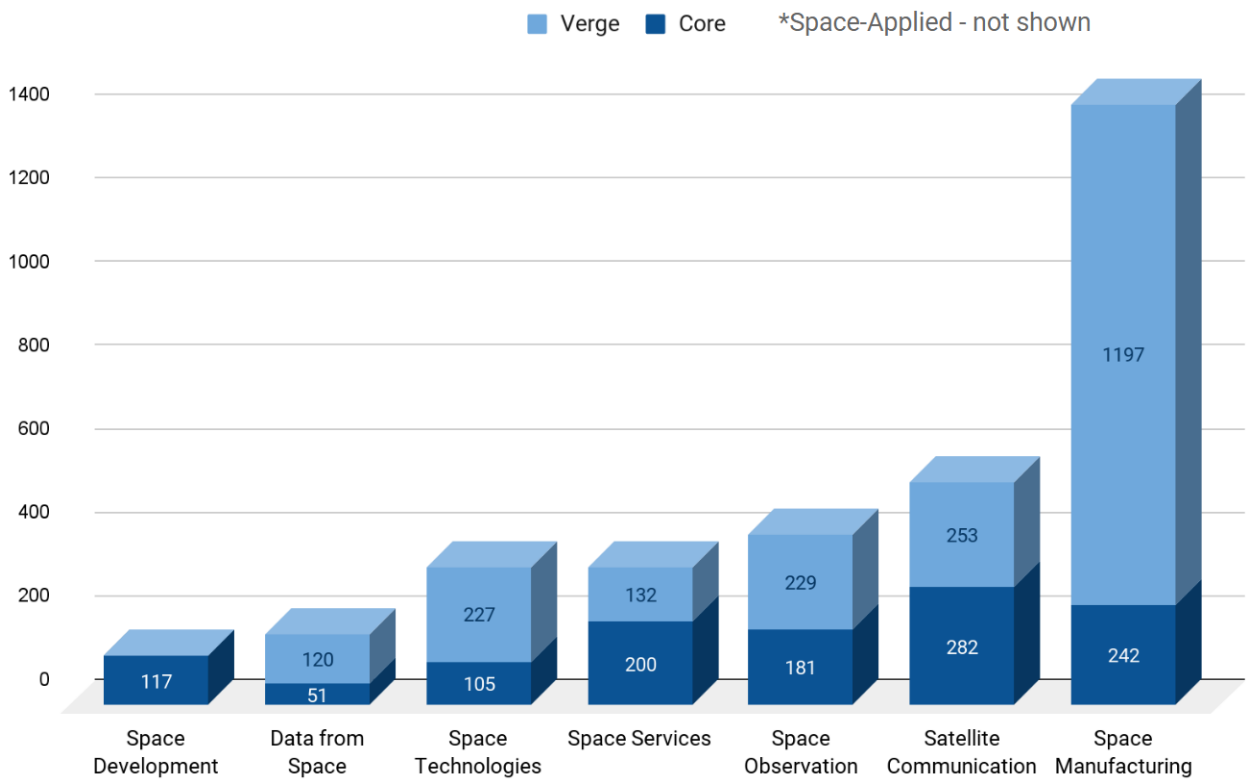
SpaceTech Core and Verge Sectors by Number of Companies in 2023



More than 3,000 core and verge SpaceTech companies have been classified into 14 categories. Space Manufacturing and Satellite Communication appear to be the two largest sectors. The Space Observation subsector is also significant in its size. There are a large number of different subsectors fueling the space industry.

Investment Levels by Region

The US and Canada are the world leaders by the number of SpaceTech companies and levels of investment received so far in 2023. East Asia and Europe have received similar levels of funding, but Europe has a higher number of companies. Despite a small share of companies (only 1.4% of the total), the Middle East and North Africa region has received more than $3.4B in investment so far, putting it in fourth place by that measure.

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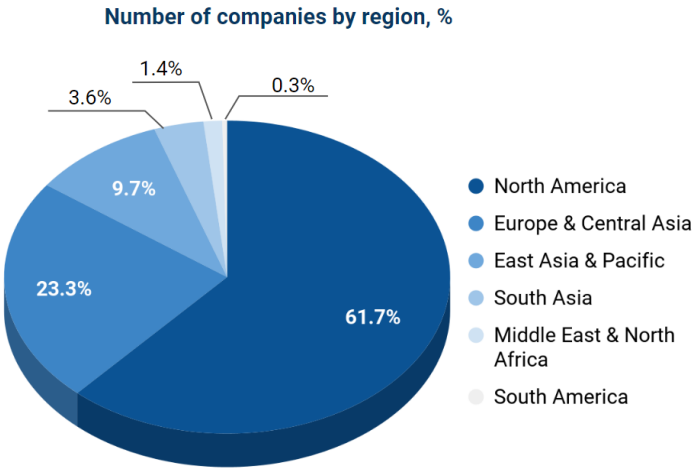
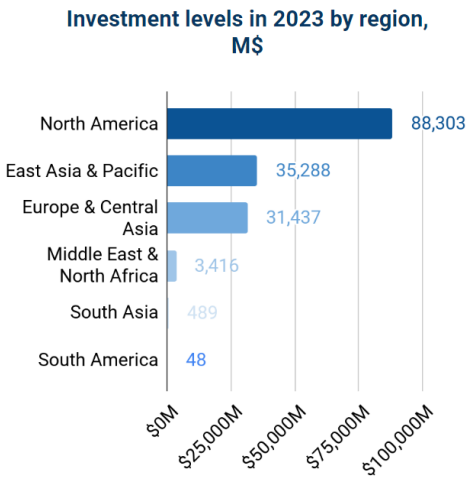
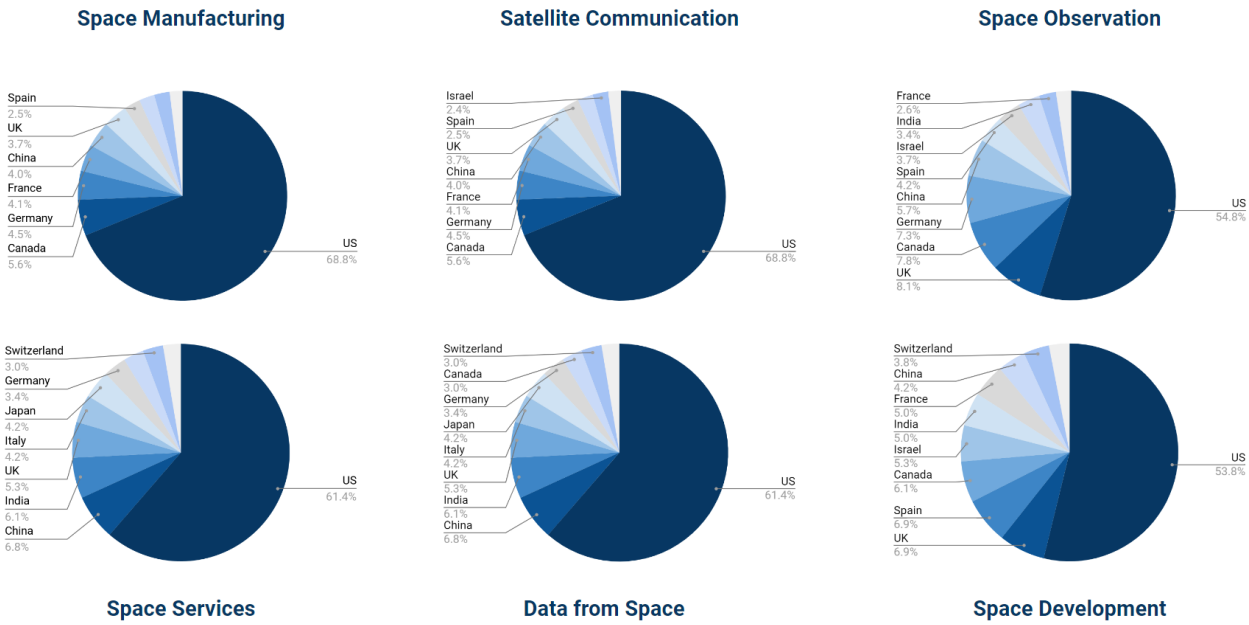




Regional Distribution of Companies in 2023 (by Category & Number of Companies)



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Areas of SpaceTech Usage (Core Companies by SpaceTech Subsector)

Over the past few decades, the space industry has attracted a large number of participants, with new space and non-space companies entering various industry-development chains. Most companies are involved in Space Manufacturing (over 1,400 companies, or 43.1% of all core companies). This sector is followed by the Space Communication and Space Observation sectors with 535 (16.0%) and 410 (12.3% of total) companies respectively.

The Global SpaceTech Economy

Showing stable growth, the global SpaceTech capitalization was estimated at $4.671T in the Q1 2023 and is expected to grow to $10T by 2030.

According to the most conservative estimates, it accounts for 5% of global GDP.

This will have a dramatic impact on the annual growth of the global SpaceTech market, primarily because of the growth of the development of Satellite Technologies; the Space Exploration sector and advances in IT, FinTech; and other digital technologies.

Public-Sector interest in the SpaceTech industry is expected to grow. In May 2020, NASA launched a crewed flight to the International Space Station (ISS) on a commercially developed U.S. rocket. The launch represented the first time that the US had flown a crewed mission to the ISS since 2011.

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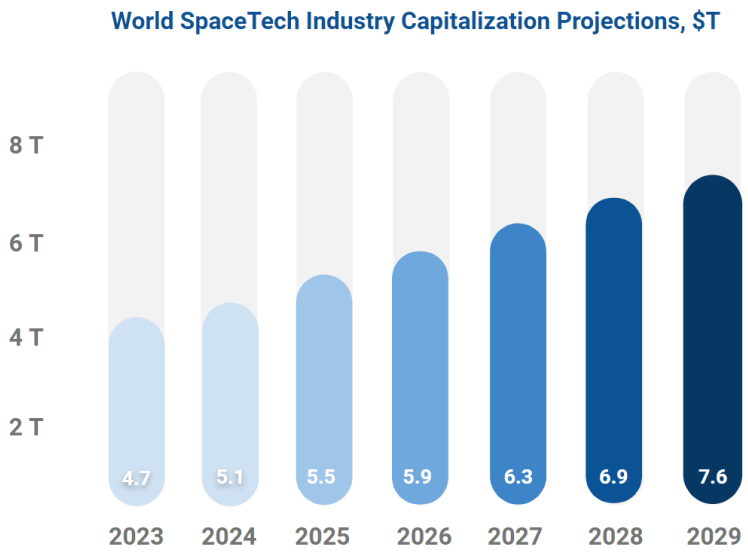

SpaceTech Trends and Future Projections

While SpaceTech is an independent industry, it has many interconnections with other major industries in Deep Knowledge Group's analytics and portfolio, both in the DeepTech and non-DeepTech sectors. With the number of such connections growing, new trends are emerging in the SpaceTech Industry. There are several technological advances that could be applied for further development of the SpaceTech Industry, including blockchain technology, AI, and virtual reality. All of these and many more are currently being considered for the future expansion of the SpaceTech sector and the appearance of new sub-industries within it.

Blockchain in SpaceTech

As blockchain moves into outer space, its ability to tokenize spacecraft and payloads emerges as a key to its success, which could help in massive upcoming space projects such as the international, collaborative Gateway space station NASA wants to build in lunar orbit. With blockchain, it is possible to commercialize space exploration faster and more efficiently. Tokenizing a spacecraft would allow different entities to make other spacecraft components, giving institutions like NASA and ESA the ability to procure things more efficiently, with much more transparency and traceability.

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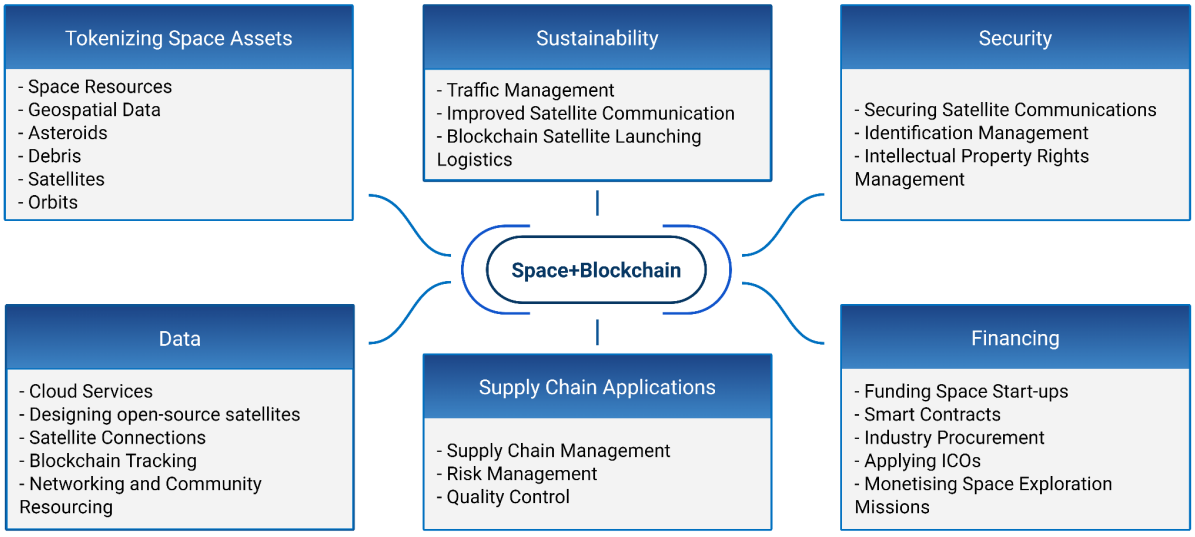
As such, both of these innovative industries can be considered as the top performers of the economy in general. The markets provide many attractive opportunities to investors both new and established, minor and significant. While the SpaceTech market provides more moderate levels of risk, the Blockchain market, in general, is far more volatile and diversified. Despite the extreme advancement of both spheres of blockchain and space, due to the nature of the first sphere, no institution yet exists to take over the authority to regulate the intersection of these two spheres.

The Ways Blockchain and SpaceTech Connect



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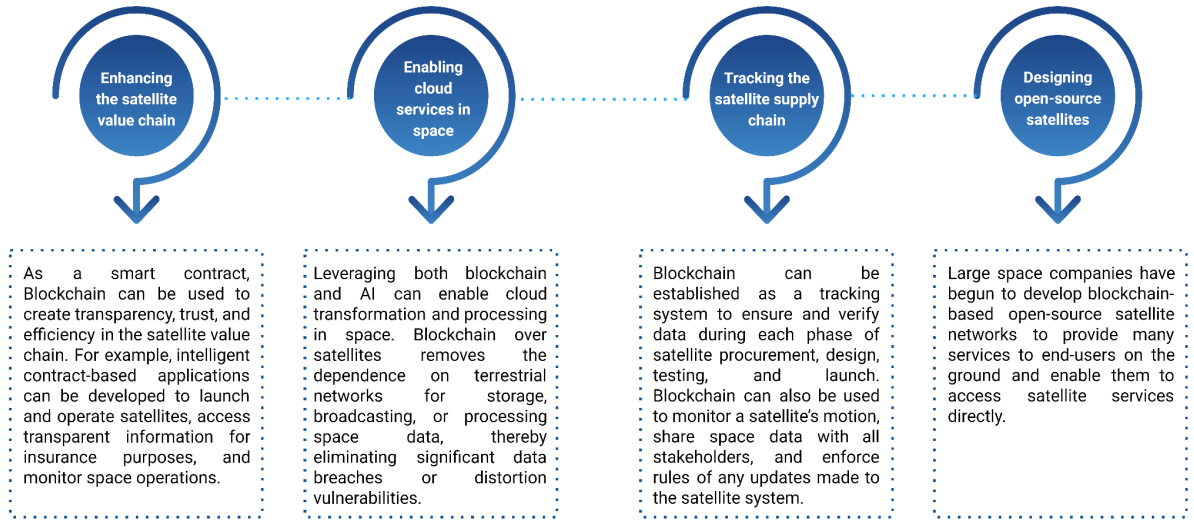
Blockchain Technology Services in Space



Over the course of its operation, SpaceTech Analytics has been able to build a vast network of investors and companies in the blockchain space. We have created a [case study] in collaboration with our industry partner, Copernic Space, which is engaged in the digitalization of space assets.

Source: www.spacetech.global/blockchain-in-spacetech-case-study-access

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Space Medicine

With the growing financial capabilities of the space industry, commercialization of space tourism is inevitable. But first, to prepare for long-term space flights, we have to get a better understanding of how the human body changes in weightlessness. In fact, Space Medicine is a required core competence for space exploration, development, and settlement.

The primary space-related medical issues include the following: loss of bone and muscle mass, immune dysfunction, and heart and liver problems. Numerous studies have shown that adaptation to the space environment differs between men and women. The difference lies in almost all organism systems: cardiovascular, immunological, sensorimotor, musculoskeletal, and behavioral alterations. Significant changes in gene expression responsible for tissue remodeling have been identified. Most of these genes are pro-oncogenes, as well as genes involved in bone metabolism and the early stages of muscle regeneration.

Among traditional approaches in medical research in space and risk mitigation in astronauts, new ones are advancing in development: organ engineering, 3D printing, medical devices, etc.

Investors in the Space Medicine Industry

More than half (around 74%) of investors in Space Medicine come from the United States. An additional 14% of investors are located in Europe, including 4% each in the UK and Germany, 3% each in Finland and Switzerland. Also 3% of investors are based in Singapore. Other investors are spread worldwide.

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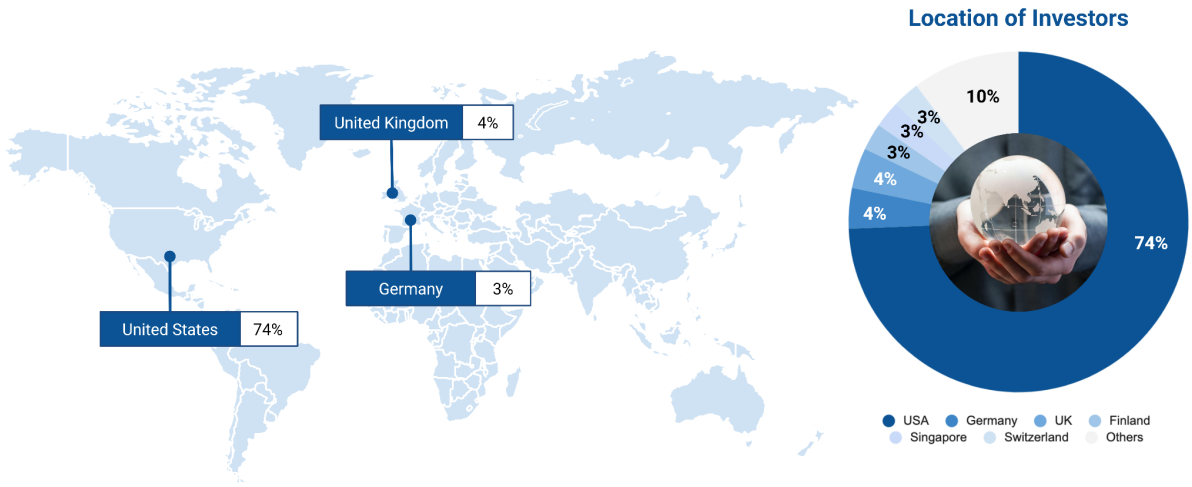

Source: Space Medicine and Human Longevity in Space Q3 2021

Top Companies Advancing Space Medicine

United States

- **Biogen Inc** — Cambridge, Massachusetts, United States
- **Amgen** — Thousand Oaks, California, United States
- **RevBio** — Lowell, Massachusetts, United States
- **Angiex** — Cambridge, Massachusetts, United States
- **Kernal Biologics** — Cambridge, Massachusetts, United States
- **Merck** — Kenilworth, New Jersey, United States
- **MicroQuin** — Cambridge, Massachusetts, United States
- **490 BioTech** — Knoxville, Tennessee, United States
- **Tympanogen, Inc.** — Richmond, Virginia, United States
- **Eli Lilly** — Indianapolis, Indiana, United States
- **SP8CEVC, Venture Capital** — New York, New York, United States

60% of companies shown have their headquarters in the **U.S.**, with **Israel, France and Switzerland** sharing second place (**30%** of all private companies). Other companies are distributed equally among the **UK, Netherlands** and **Italy**.

Israel

- **SpacePharma** — Herzliya Israel, Courgenay Switzerland
- **Pluristem Therapeutics Inc.** — Haifa, Israel

France

- **Sanofi** — Paris, Ile-de-France, France
- **Medes** — Toulouse, Midi-Pyrenees, France

United Kingdom

- **AstraZeneca** — Cambridge, Cambridgeshire, United Kingdom

Netherlands

- **OrgaNext Research** — Arnhem, Gelderland, The Netherlands

Italy

- **Kayser Italia** — Livorno, Toscana, Italy

Switzerland

- **Nova Space Biotechnology** — Zürich, Zurich, Switzerland
- **Novartis** — Basel, Basel-Stadt, Switzerland

Source: Mitochondria in Longevity and Space Medicine

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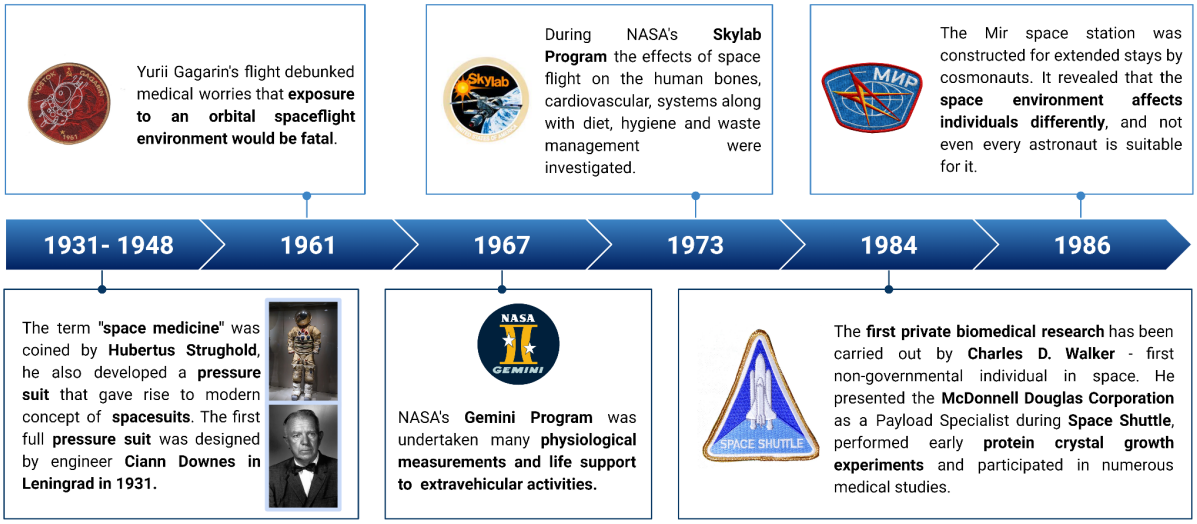
Key Space Medicine Achievements of the 20th Century



Source: SpaceTech Analytics' research

The Issue of Aging in Space

Spaceflight presents immensely difficult challenges. Weightlessness, partial gravity, planetary dust, and space radiation pose a significant threat to humans in both spaceflight and living in planetary habitats, which can result in the rapid development of life-threatening diseases in astronauts. In addition, the closed environments can create additional stress on a space crew's work performance and mental well-being.

Advancements in Longevity are crucial for the future of space exploration. As more private companies continue to expand the space economy, the viability of space-Longevity research substantially increases.

Private Age-Related Research in Space

Low-Earth orbit (LEO) is a unique environment for investigating novel approaches to mitigate age-related disorders. Some 35% of all private research on the ISS is dedicated to drug-delivery systems to conquer cancer. Another 47% of applied sciences are equally focused on neurodegenerative disorders therapy, mainly Alzheimer's, and regenerative medicine: muscle and bone restoration, using human-cell culture. As

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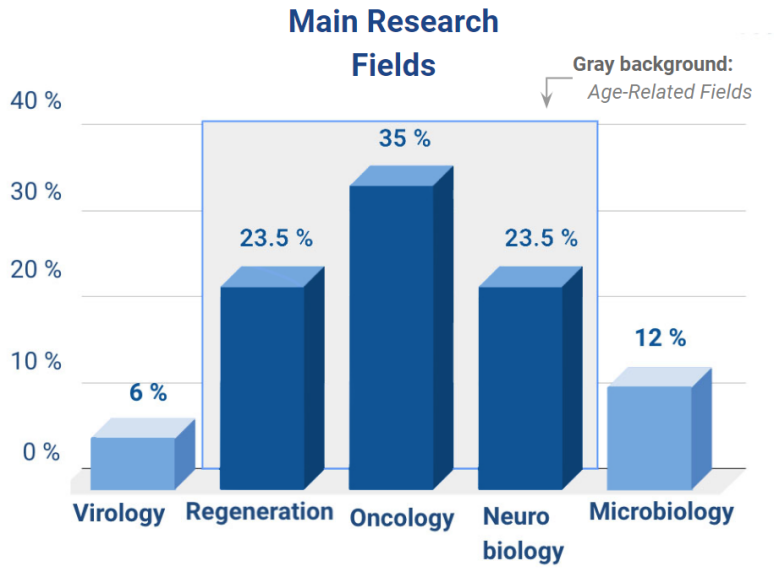
microbes in space change their metabolism and cause serious harm to astronauts, almost 12% of private research is dedicated to microbiology and 6% to viral replication and production studies, including the development of vaccines for space.



Source: Mitochondria in Longevity and Space Medicine

Space Medicine as the Frontier Sector in SpaceTech

SpaceTech Analytics is constantly working on the development of the space medicine topic. Their task is to accumulate all the knowledge and promote the development to ensure that the astronauts reach their destination. With the active development of launch systems, rockets, and other technological aspects, human survival in space is still not sufficiently studied and there are almost no real experiments that would allow us to better understand the conditions of life in space. Some of our projects include:

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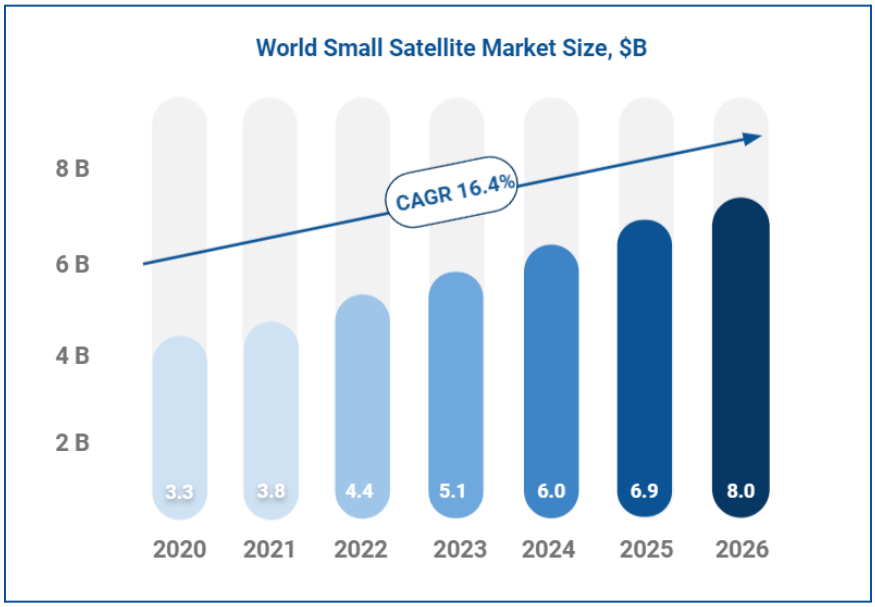
Visit www.spacetech.global to learn more about space medicine activity by SpaceTech Analytics, which include sophisticated analytical case studies, events, and ambassadors.

Small Satellites

Small satellites have recently become more popular. Miniature satellites make designs cheaper, and advances in industrial technology allow for mass production. Start-ups are developing small satellites that allow space companies to carry out missions typically encountered by large satellites. In addition, small satellites are well suited for use in wireless networks, as well as for scientific observation, data collection, and monitoring of the Earth using GPS.



Source: Allied Market Research

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Small satellites are being developed in large quantities for use in various sectors such as defense, commercial and civilian use. The operational dynamics of the space industry make it resilient to commercial shocks, while increasing demand from various sectors, which is projected to contribute to market development in the future. Increased defense spending around the world with a strong focus on the development of military-based satellite communications and ISRs is expected to have a positive impact on the small satellite market.

However, the initial costs of research and development, production, and transfer of technology to poorer regions such as African countries may be an obstacle to the growth of the small satellite market.

Military satellites are used for tasks such as communications, surveillance, and reconnaissance. Military satellites can provide continuous coverage of the territory and can be used for early warning. In addition to observation, military satellites are also capable of performing both strategic and tactical operations. In addition to monitoring the development of enemy weapons, satellites can also verify international compliance with arms control treaties and assist in strategic purposes by predetermining the location of military assets at strategic points in the event of armed conflict. Manufacturers of small military satellites are focusing on cost-effective approaches to mass production of small satellites to meet growing demand. The approach involves the use of low-cost industrial-rated passives at the stages of project development and testing. The introduction of standardized satellite designs has provided more flexibility in the choice of launch systems due to the flexibility of a variety of small satellites that can be installed in multiple launch systems, which reduces the launch cost. As small military satellites can also be launched as a secondary payload, their use is increasing due to the increasing use of satellites in tactical warfare. Many innovative programs for the production and launch of small satellites for defense purposes are under development.

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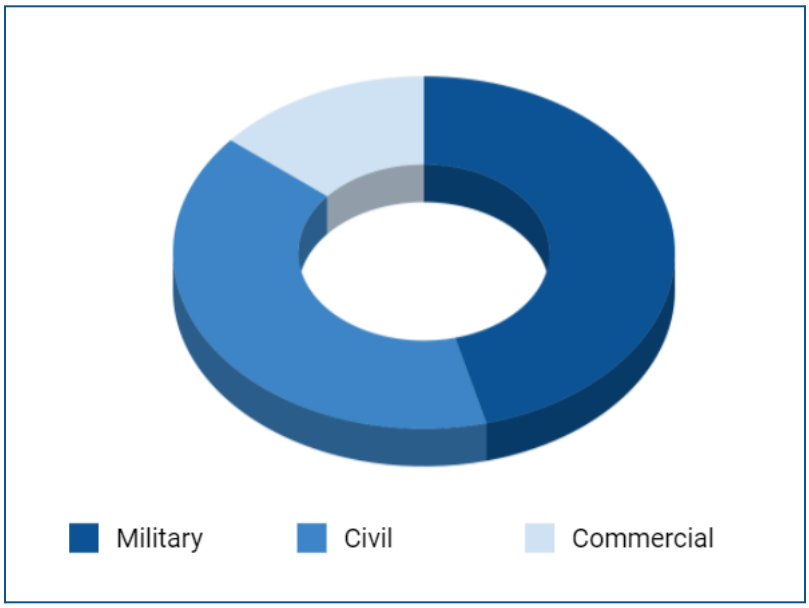
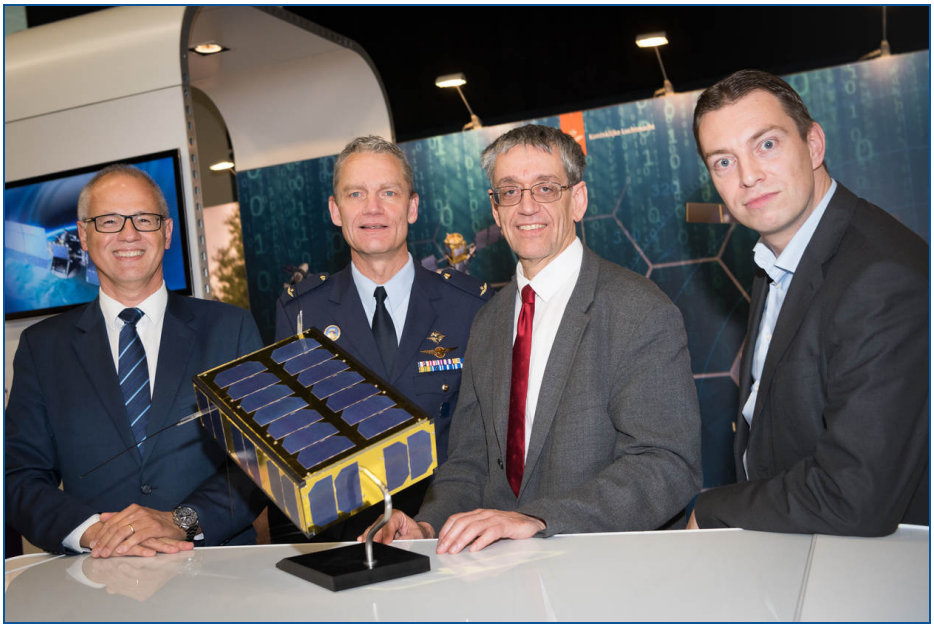
Small Satellite Global Market by End User, 2021



Source: Mordor Intelligence

In July 2021, the Netherlands launched the country's first military satellite. BRIK II, a nanosatellite from Virgin Orbit, is orbiting the Earth. BRIK II is a pilot project of the Royal Air Force of the Netherlands and marks the entry of the country's military into space. Such developments are expected to have a positive impact on demand for military satellites.



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The Representatives of the Four4 Participating Parties with a Model of the Brik-II Satellite.
Source: Media Overview

Advanced Space Manufacturing

Innovative technologies are used in space manufacturing to improve space products and services. Innovations in the space sector are also progressing thanks to better robotics, 3D printing, and light-based manufacturing. Because of breakthroughs in manufacturing techniques, large space constructions, reusable launch vehicles, space shuttles, and satellite sensors have become a reality. For long-term space research and missions, automation is also critical, which is why companies are developing solutions specifically for the industry.

3D-printed brackets for space
Source: ESA

In the Space 4.0 era, fuelled by digitalization and the increased global interplay of governments, private sectors, academia, and society, the space community is making major advances through spin-in and technology maturation and has equally become a stimulus for technology spin-offs.

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As a result, space has become a driver not only for knowledge, inspiration, cooperation, and policymaking but also for high-end technology integration into the manufacturing domain. Closely intertwined with Space 4.0 is, therefore, the next industrial revolution, Industry 4.0 – an era that is already showcasing the benefits of increased connectivity, intelligence, flexible automation, and advanced manufacturing in the industrial landscape.

Today, smart and advanced manufacturing technologies, including 3D printing, virtual testing, big data-driven, and quality control processes, are altering the manufacturing supply chain, progressively increasing customer value and supply chain efficiency.

Highlight: Equatorial Space Systems develops Commercial Suborbital Rockets

Singaporean start-up Equatorial Space Systems develops a commercial suborbital rocket capable of delivering small payloads above the Karman line, the boundary between space and atmosphere. Designed for cost-effective missions, the start-up's solution, Dorado, comes in two variants – a single-stage vehicle capable of reaching an apogee of 105 km and a two-stage version designed to exceed a target altitude of 250 km. The two rockets provide 3 and 6 minutes of weightlessness, respectively.

Space Traffic Management

After Over Six Decades of Spaceflight, It Is Getting Crowded Up There

Space traffic management is one of the most urgent issues to be resolved with the coming New Space Era. Satellite operators are racing to secure valuable orbits. Numerous debris objects are floating randomly in space. Thousands of satellites are going up in different orbit planes with the new broadband constellations. The number of satellites and debris is going up, which also increases the probability of collisions. This issue threatens the New Space Economy as current space monitoring systems cannot handle the traffic adequately.

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The Probability of Collisions is Rapidly Increasing

4000+ active satellites	Starlink plans to launch up to 42,000 satellites by mid-2027. Other companies have ambitious plans too
30000+ actively tracking debris	Their size is larger than 10 centimeters. Two objects slamming into each other at terrific speeds, creating numerous bits of new debris. It can result in the **Kessler syndrome**
1000000+	An estimated number of small particles (1-10 cm)
330M+	An estimated number of very small particles (less than 1 cm)
10 km/s (22,000 mph)	With such an **average speed** a 1 centimeter paint fleck is capable of inflicting the same damage as a 550 pound object traveling 60 miles per hour on earth. A 10 centimeter projectile would be comparable to 7 kilograms of TNT

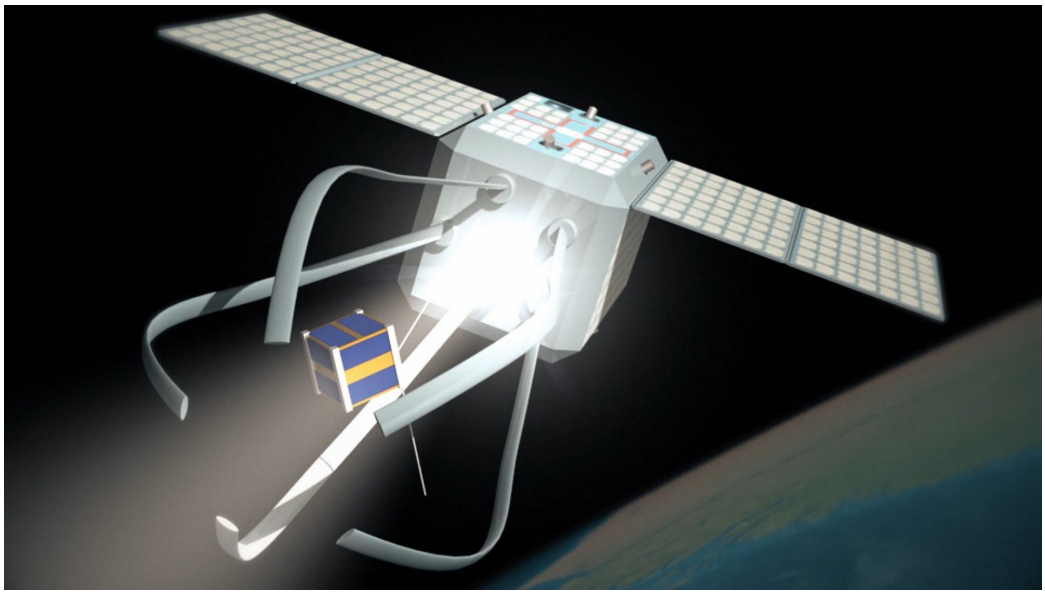
"Kessler syndrome" may cause an orbital apocalypse

Kessler syndrome is a cascading series of collisions that could clutter Earth orbit with so much debris that our use of, and travel through, the final frontier is significantly hampered, if not made impossible.

What about the ISS?

The International Space Station (ISS) is one of the largest artificial objects in orbit. Thus, it is quite vulnerable. According to NASA policy, ISS has to maneuver away from an object if the chance of collision exceeds 1 in 100,000. The ISS maneuvers by firing thrusters to raise the orbital altitude. It is expected to execute similar maneuvers about once a month to maintain orbital altitude.

Highlight: ClearSpace Removes Satellite Relics



Source: ClearSpace, via YouTube

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ClearSpace is a spin-off from the EPFL Space Center in Switzerland that develops technology for removing unresponsive or abandoned satellites from orbit. The small satellite solution developed by the business identifies, catches, and eliminates man-made space trash on a regular basis. By 2025, business hopes to have removed the first particles of junk from space.

Space Mining

Science fiction (Sci-Fi) is giving way to reality when it comes to mining celestial bodies. Through developments in space cameras and satellites, asteroid mining by private persons and companies aids in the exact finding of asteroids. These celestial planets can be exploited to extract resources like platinum, gold, iron, and even water once they have been discovered. The financial motive for space mining is clear, and many believe it has the potential to grow into a billion-dollar industry.

In-Situ Resource Utilization Is Critical to Opening the High Frontier

The purpose of In-Situ Resource Utilization (ISRU) is to harness and utilize resources at the exploration site to create products and services that can enable and significantly reduce the mass, cost, and risk of near-term and long-term space development. The ability to make propellants, life support consumables, fuel cell reagents, and radiation shielding can significantly reduce the cost, mass, and risk of sustained human activities beyond Earth. The ability to modify the landscape for safer landing and transfer of payloads, creation of habitat and power infrastructure, and extraction of resources for construction, power, and in-situ manufacturing can also enable long-term, sustainable exploration of the solar system. Since ISRU can be performed wherever resources may exist both natural and discarded, ISRU systems will need to operate in various environments and gravitations. Also, because ISRU systems and operations have never been demonstrated before in missions, ISRU concepts and

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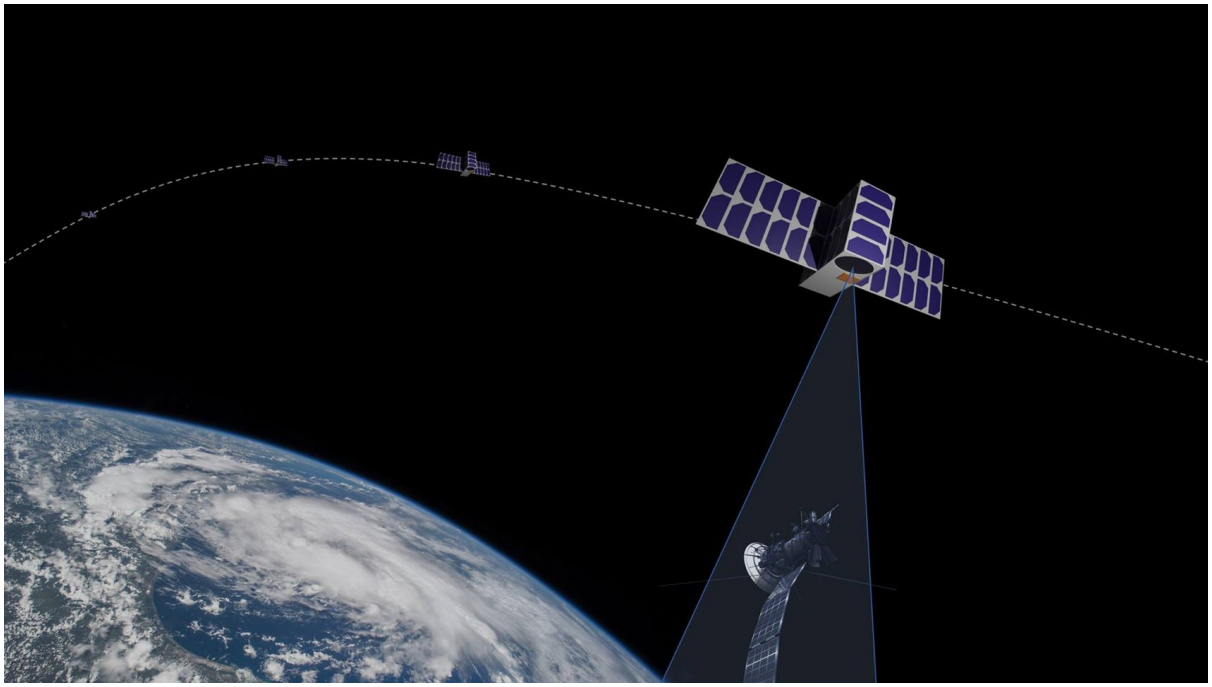
technologies must be evaluated under relevant conditions (gravity, environment, and vacuum) and anchored through modeling to regolith/soil and environmental conditions.

Many Ways To Utilize the Resources

Highlight: HEO Robotics Utilizes Space-Based Cameras for Asteroid Mining



Source: HEO Robotics

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Australian start-up High Earth Orbit Robotics combines intelligent control with space-based cameras to acquire high-quality imagery of satellites, space debris, and resource-rich asteroids. This imagery is then useful for locating and observing asteroids for mining. The start-up builds small satellites that operate in the high-earth orbit (HEO) to observe celestial bodies.

Future Projections

If 2021 is to be remembered as the year of private space tourism, 2023 and 2024 will be marked by the first steps toward a return to the moon as NASA and the growing space industry seek to maintain the momentum that has been building over the past several years in what has amounted to a renaissance of exploration. The rapid expansion of the commercial space industry over the last couple of years has led early-stage investors to consider very different types of companies than they did when space start-ups were a novelty. The availability of more affordable rides to space, the maturity of ground infrastructure, and improvements to accessibility and usability of earth observation data have combined to position entirely new breeds of space-related ventures as ripe for high-risk, high-growth investment. Starship in particular will open opportunities for previously unimaginable levels of space activity.

The space industry uses the latest technologies, including 5G, advanced satellite systems, 3D printing, Big Data and quantum computing to modernize and scale operations in space. Many services such as weather forecasting, remote sensing, Global Positioning System (GPS) navigation, satellite TV, and long-distance communications rely on space infrastructure. As private investment in the industry increases, start-ups are developing technologies to facilitate Earth-to-space travel, operations, and communications.

Global funding for space exploration is expected to experience a stable growth to achieve around $30 billion by 2029. The main drivers will be moon exploration, transportation, and orbital infrastructure.

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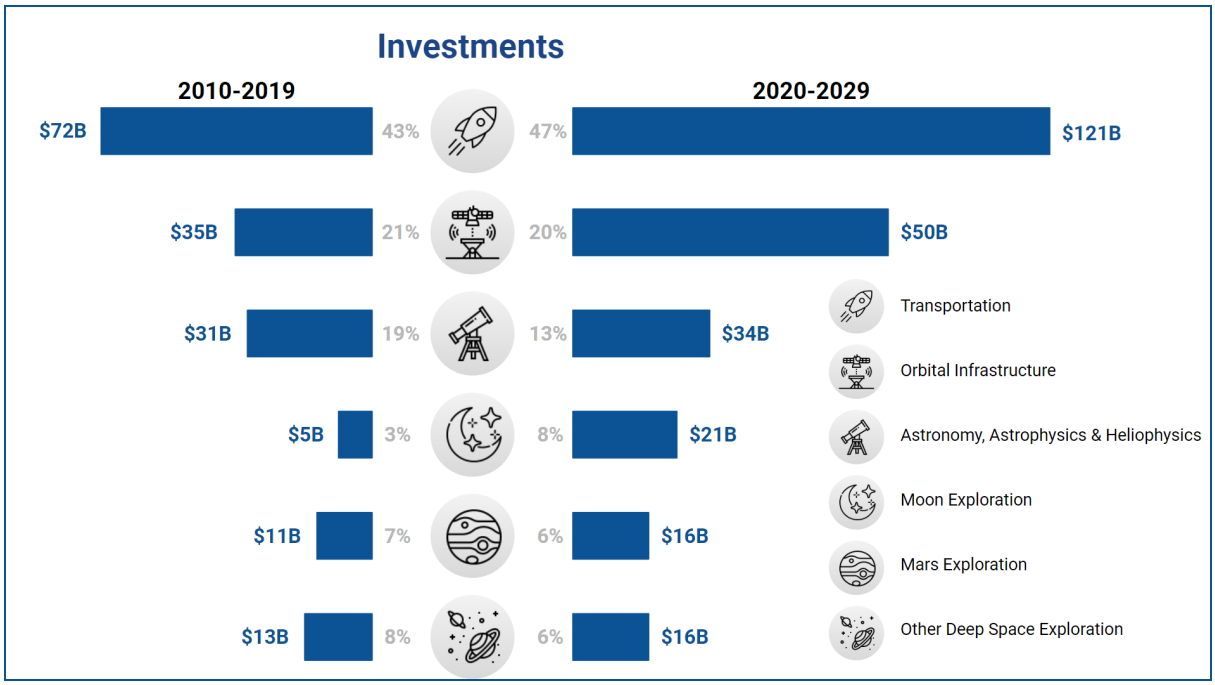
Investments in Space Exploration



Source: Euroconsult

- **Transportation** is a field of application that leads and will manage governments' investments in space exploration. It is expected that in 2029 it will increase to $14.2billion. Growth will be supported by high investment in many countries, including the United States, to support the development of next-generation crews and /or trucks for LEO and BLEO activities (including monthly landings).

- **Orbital infrastructure** is the second largest application with $4.4 billion in 2019 due to the ISS program and increased investment for China's Space Station. Total global funding is expected to continue to grow due to increased funding from the ISS partners for the development of lunar gateways, as well as the completion of the Chinese space station.

- Over the past 2 years, **moon exploration** has increased significantly as lunar exploration has become central to the research strategy of most forward-looking agencies. By 2029, it is expected to reach its highest sustainable growth of

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$2.7billion. This will support future robotic government missions and commercial partnership programs.

- In 2019, **Mars exploration** amounted to $1.4 billion driven by three missions scheduled in 2020 (plus ExoMars has now been postponed to 2023, with the rest being postponed as well). Global funding is expected to decline as moon exploration programs are the first to be preferred. New investment cycles are expected in the second half of the decade to support plans such as Mars-sample return missions.

- **Other deep-space** exploration programs have grown to $1.8 billion in 2019 to support the development of several missions in the near future (primarily from the United States, ESA, and Japan). Global funding is expected to reach $1.6 billion a year to support various planned missions.

- **Astronomy, Astrophysics, and Heliophysics** programs were in the peak phase to fund major flagship programs in 2019. This will continue to be an important area of application for space agencies around the world.

Number of Missions Launched

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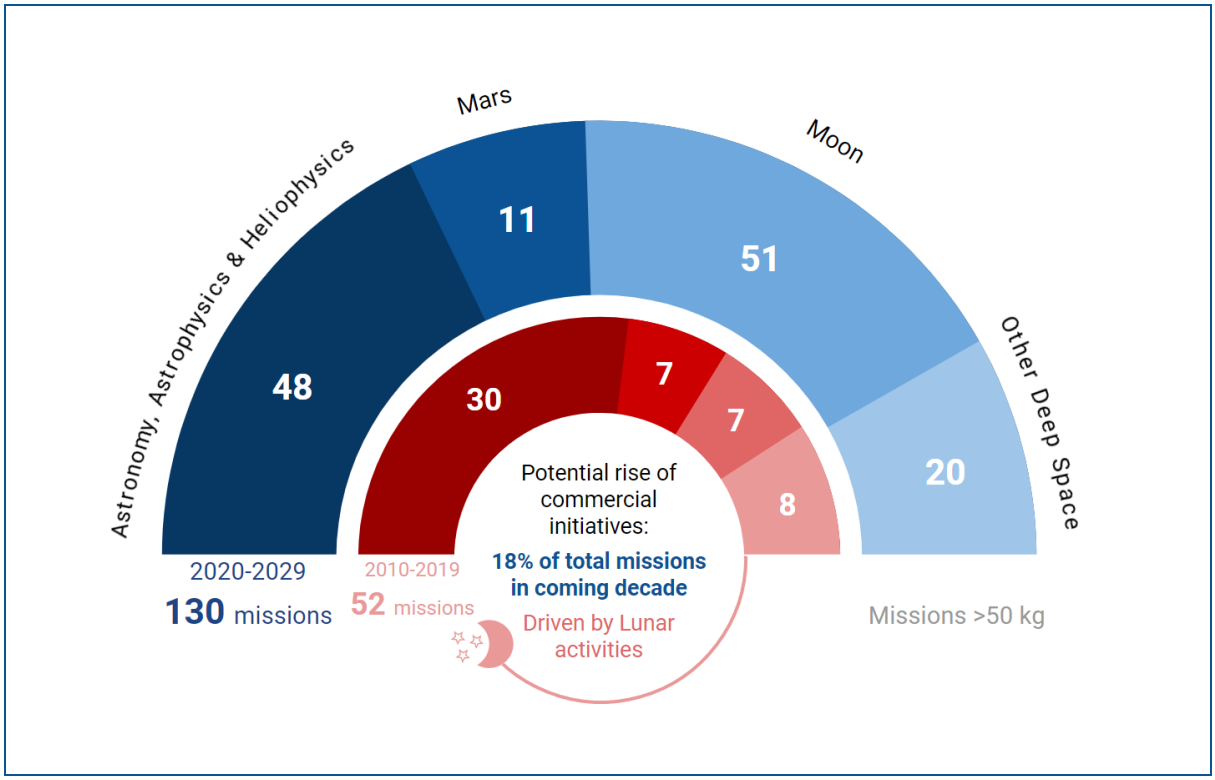

Source: Euroconsult

Approximately 130 missions are expected over the coming decade, compared to 52 missions conducted from 2010 to 2019. In terms of missions, moon exploration will dominate, with almost 40% of all planned missions, reflecting the fact that lunar exploration remains the focus of stakeholder space exploration strategies. Commercial missions are projected to account for 18% of all missions launched over the decade, mainly through monthly initiatives.

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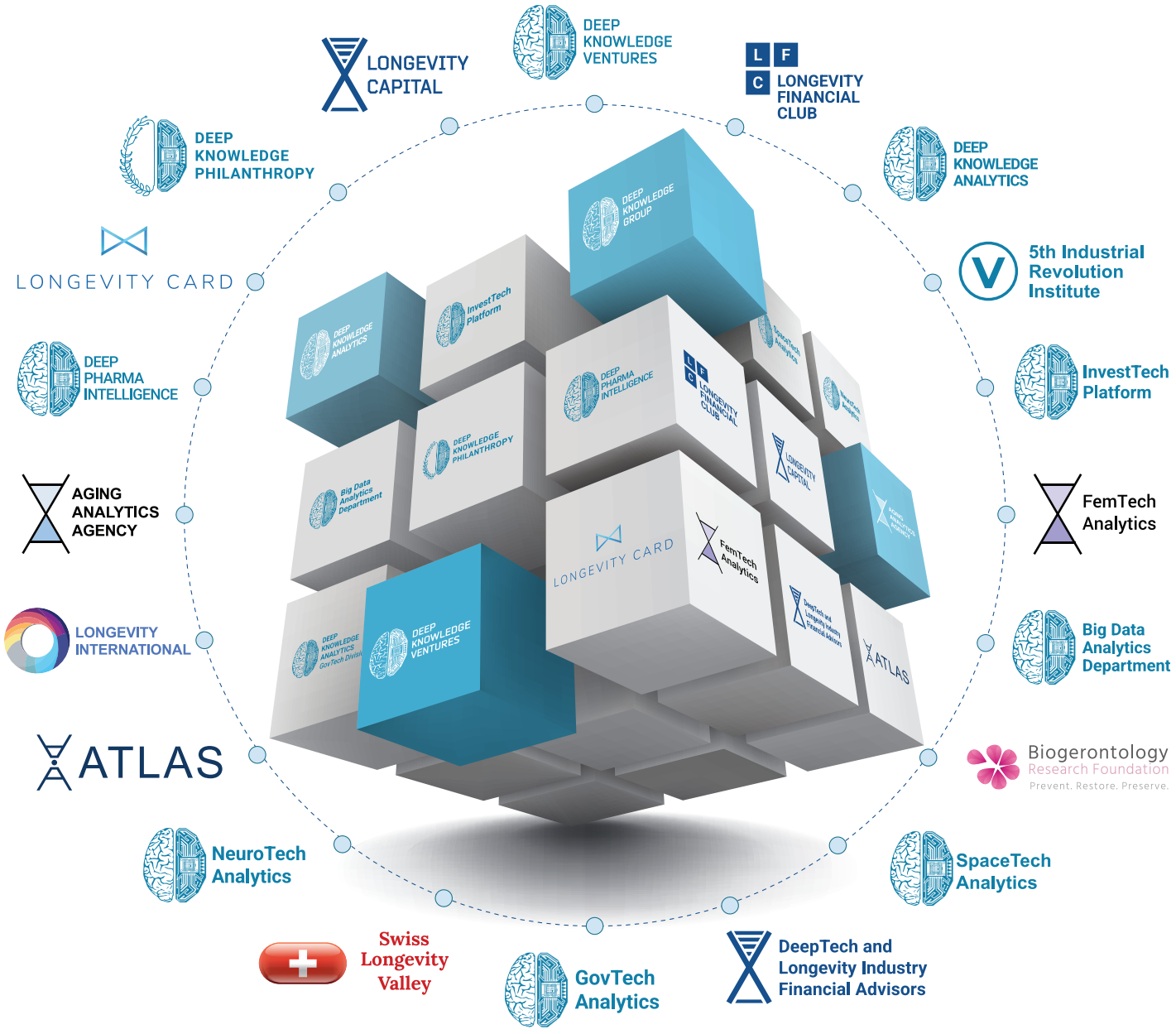
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