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An analysis of the business model adopted by Earth-Observation satellite companies in the NewSpace Era

The cases of Planet Labs, Spire Global and BlackSky Technology

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ABSTRACT

This report explores the evolutions in the satellite industry with an in-depth analysis of the business model adopted by NewSpace Earth Observation (EO) companies. The results indicate that EO companies offer an increasingly important customer value proposition based on the use of small satellites and artificial intelligence, but the market is still in a growing phase. The authors described strategic choices and vulnerabilities, presented three case studies, and provided some recommendations. Key recommendations to improve the business model enclose developing a hybrid model for operations, identifying a target customer segment, and diversifying the revenue streams.

KEYWORDS

Strategy, Business Model, Simplified Business Model, NewSpace, Earth-Observation, Satellite Industry, Smallsats, Industry Evolution, Recommendations, Vulnerabilities, Value Proposition.

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1. Introduction (Group Part)

1.1. Motivation and Relevance

Companies are dedicating considerable time and effort in understanding how Space can add value to their businesses on Earth and by 2030 all multi-national businesses across all industries are expected to benefit from Space whether they are related with it or not (KPMG, 2020). The satellite industry is also gaining relevance as more and more companies, governments, researchers, and individuals rely on satellite data to understand the environment and act. On the other hand, daily satellite data has been transforming the way nations and industries manage valuable resources and prevent climate change relying on more sustainable practices that reduce risk and promote economic growth. In line with this trend, new players have been entering the market resulting in the coexistence of traditional and established companies that provide services essentially to governments and space agencies with other companies born in recent years such as Planet Labs and Spire Global that are making space more commercial and accessible to all. These NewSpace companies have been reshaping the market with a new business model concept and hence more innovative and disruptive approaches.

Apart from the relevancy for other entities and national economies gained in the last decade, the authors of this report were driven by the complexity and lack of recent comparative and comprehensive analysis of the topic. Additionally, the satellite industry and in particular the Earth-Observation data segment is of particular interest for the authors as all three aim to pursue a professional career either related with the industry or with other related-industry. For that reason, the authors consider that it is essential to analyze and develop a common understanding on the existing business models in the industry and the market drivers that have been impacting them.

1.2. Methodology

Several analysis methodologies were applied to conceptualize and structure the report consistently. The research methodology analyzes company documents, secondary data sources, and semi-structured verbal interviews. This report systematically used a business model analysis approach based on the five contextual dimensions that each business model consists of, leading to better comparability. Thereby the five business model dimensions: market segments, value proposition, revenue model, capabilities, and cost structure. A general overview of the history and field will be provided during the analysis with the aim to provide the reader with as clear a description as possible of the industry analyzed in this report. Regarding the data used in this report, it can be concluded that a combination of qualitative and quantitative data was utilized. Several sources were used for this analysis, such as company reports, one semi-structured interview, academic papers, investor presentations, financial reports, and secondary sources external to the companies analyzed.

Additionally, a combination of theoretical and practical databases was used. Visual illustrations of key statistics and facts can be found in the appendix while referenced accordingly within the report. Throughout the report, the term "traditional companies" refers to those companies pioneering the satellite industry, focusing on providing the highest quality of their product. On the other hand, the terms "New Space Earth Observation Companies" and EO remote sensing describe significant new companies through relevant business model changes and became the leading companies in the industry. During this analysis, in order to have a complete view of the business models in the satellite industry, were observed the main characteristics of the industry by analyzing the prominent traditional companies in the sector and the new emerging firms to monitor the key processes and the main differences in their business models. Subsequently, the analysis focused on the Earth Observation field, analyzing the leading companies in the market and describing their business models' main characteristics. Concerning the framework to be

used, the principal methods described by the leading authors have been examined. Although several definitions of business models have been developed in recent years, the authors identified various literature on general business model definitions and business model analysis yet without any clear consensus. After comparing the different business models, it was selected the simplified business model canvas (based on Afuah, 2014) because, thanks to this framework, it is possible to illustrate better the critical differences between the various players in the industry. Subsequently, three case studies were developed in order to show how leading companies in the industry implement their business models.

Finally, to ensure high data quality and provide recommendations as accurately as possible, the authors tried to contact some experts in the New Space industry. In terms of semi-structured verbal expert interviews, it can be stated that one interview was held in May 2022. It needs to be highlighted that more experts were requested for an interview; however, only one invitation was accepted. One of the authors interviewed Matteo Andrea Lorenzoni, who covers the role of Launch Strategy Manager at D-Orbit. D-orbit is an Italian company that provides a range of solutions for optimizing both in-orbit and on-ground operations, including satellite last-mile delivery, orbital transportation, space logistics, and space waste management. The interview lasted around 90 minutes. Several topics were discussed, such as the EO market and future evolutions, Vertical Integration in EO business models, Agile Aerospace and Space Venture Capital, and crucial insights were obtained for structuring the end-of-report recommendations and personal conclusions.

2. Analysis of the Concept Business Model (Group Part)

Before examining the evolution and variation of business models in the satellite industry, it is important to define the term “business model”. The first part illustrates the main theory frameworks regarding business models developed over the years. Subsequently, the second part concerns the analysis, based on Afuah framework, of the general components of the business model adopted by EO firms in the era of *NewSpace*.

2.1. General Definition of Business Model

Despite having existed informally for years, the business model definition only in the 1990s became technical jargon. A review of the relevant literature revealed a variety of explanations in well-known publications, although there is no clear consensus. Different definitions set different focus on other elements and differ in their degree of inclusiveness. One of the first business model definitions was established by Timmers (1998, 4), who states that a business model is the "Architecture for the products, service, and information flows, including a description of the various business activities and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues". In this way, the researcher assumed that a business model focuses on the architecture and interactions among various business actors.

Other publications, such as Afuah (2014), emphasize the financial dimension of business models, indicating that the business model is "a framework or recipe for making money – for creating and capturing value." In this case, Afuah focuses its definition on the revenue aspect, including that as part of the business model description, not considering the interaction between several business actors.

On the other side, Amit and Zott (2001, 515) recognize the revenue model as a separate and complementary concept to the business model. The revenue model focuses on value appropriation, whereas a business model focuses on value creation (Amit and Zott 2001, 515). On the other hand, other economists have highlighted the importance of the business model as a tool to explain how an enterprise works in the industry. One of the most popular ways to define a business model was by Joan Magretta, who describes the business model as "stories that explain how enterprises work" (Magretta 2002, 4). According to Magretta, business models showed how a company produced money and answered fundamental questions such as: "who is the customer? and "what does the customer value?" (Magretta 2002, 4). Therefore, this author argues that the objective of a business model is firmly structured around the customer dimension because two out of three components focus on the consumer. As perceived from the point of the audience, this dimension of value had a significant impact on current thinking. Furthermore, one of the key ideas behind the business model theory was defining the firm's distinctive value proposition and how it should be delivered. For consumers, "value creation" could mean fixing an issue, enhancing performance, or decreasing risk and costs, including specific value configurations such as relationships with suppliers, access to technology, and understanding of the users' needs, among others. Moreover, Magretta, in his papers, highlights the difference between business model and strategy. The author describes business models as a system and how the pieces of a business fit together. However, one crucial variable of performance that business models do not consider is competition. Every company will face competition sooner or later, usually sooner. Dealing with that reality is strategy's job. Regarding strategy, Magretta establishes that a competitive strategy discusses how you'll exceed your competitors.

Therefore, by definition, achieving better means being different. Organizations achieve outstanding success when they are one-of-a-kind, doing something no other company can

accomplish in ways that no other organization can match. When you cut through the jargon, strategy is all about finding out how to do better by being different. The logic is simple: no business will succeed if all companies offer the same products and services to the same clients while conducting the same activities. Customers will profit, at least in the short term, as competition drives prices down to a point where returns are inadequate. Shafer, Smith, and Linder (2005) were the first who attempted to establish a general and industry-wide definition of the term. They produced a comprehensive report suggesting that they could establish a broad definition by combining 42 business model components from previous work in this field. Authors stated that "business models represent a firm's underlying core logic and strategic choices for creating and capturing value within a value network" (Shafer, Smith, and Linder 2005, 202). DaSilva and Trkman (2014, 382) propose a more resource-based approach, indicating the business models are more resource-based and "represent a specific combination of resources that generate value for both customers and the organization through transactions." According to this broad overview of the several definitions of the word "business model" and its various focuses, the value logic has become more relevant throughout time. While some earlier depictions summarized what makes up a business model, contemporary definitions focus on developing, delivering, and capturing value for multiple stakeholders (Fielt 2014, 89-90). Furthermore, despite a large number of various definitions and their particular emphasis, a higher-level perspective reveals that all descriptions have a significant degree of common ground in terms of the compositional parts that characterize what makes up a business model. This common ground of compositional elements and their respective operationalization is regarded as vital for the continuing development of this research because it permits distinguishing between business models in the satellite sector.

2.2. Simplified Business Model Canvas

Even though several researchers have established many alternative models and interpretations in recent years, every business model contains standard components. The analysis will focus on the Earth-Observation field, which is typically dominated by enterprises founded in the last ten years and are part of the *NewSpace* economy. During this research, the simplified business model canvas (based on Afuah, 2014) was used because it allows having a clear overview of the five main components of each business model, including market segmentation, revenue model, value proposition, capabilities, and cost structure.

Firstly, *Market Segments* are an essential part of every business model. Thus, defining the target client is regarded as one of the most critical aspects of developing a business plan. Customers are the foundation of any firm. No business can survive for long without profitable clients.

A corporation may divide clients into various segments based on everyday needs, behaviors, or other characteristics in order to better satisfy them. A business model may define one or several large or small Customer segments. An organization must decide which segments it will serve and which sectors it will ignore. Following this decision, a business model can be carefully created on a thorough understanding of unique customer requirements. Secondly, the definition of a (customer) *Value Proposition* is the second pillar, and it is an essential step in developing a business model. A successful business model should indicate how to produce value for customers, according to the evolution of the term business model toward more value-centered definitions. Customers choose one company over another for its value proposition. It satisfies a client's need or solves a customer's problem. Each value Proposition is composed of a carefully selected set of products and services that are tailored to the needs of a particular Customer Segment. In this sense, the Value Proposition is a set of benefits that a firm provides to its customers. At this point, the organization needs to use channels to deliver the value proposition to its different customer segments. Communication with the customer is a critical

element. In this phase, channels are essential since they are customer touchpoints that have a significant impact on the customer experience. Channels serve various purposes, including increasing customer awareness of the company's products and services and offering post-purchase customer support. An organization should define the type of relationship it aims to have with each Customer Segment throughout this process.

Thirdly, each business model consists of a *Revenue Model* that describes the company's blueprint for creating financial value for itself.

By subtracting revenues from costs, the revenue streams represent the cash a company makes from each Customer Segment. A company must ask itself, for what value is each Customer Segment truly willing to pay? Successfully answering that question allows the firm to generate one or more revenue streams from each Customer Segment. Different pricing strategies, such as fixed prices, negotiating, auctioning, market dependent, or volume-dependent, may be used for each Revenue Stream. The fourth business model component is represented by Capabilities (Resources & Activities), which describe a firm's essential resources and activities. Every business model needs Key Resources, and significant resources are required depending on the type of business model. These capabilities allow a company to develop and promote a Value Proposition, reach a larger market, maintain connections with existing customers, and generate revenues. Moreover, A company's capabilities also include its key activities. These are the most important actions a company must take to operate successfully. Finally, each company has a *Cost Structure* component that describes all costs associated with running a business and expenses incurred to execute a specific business model.

This building block summarizes the most significant expenditures incurred while operating under a specific business model, such as the cost of developing and delivering value and the costs of maintaining customer relationships.

In conclusion, this framework may be used to develop business models based on capturing monetary value within the organization and delivering value to targeted stakeholders. Furthermore, it is intended to maintain the distinction between strategy and business models, with business models reflecting and operationalizing strategic decisions.

3. Business Model Variation and Evolution

This chapter aims to display the evolution and variation of business models in the satellite industry focusing on the Earth-Observation (EO) market. The first part will be focused on describing the industry and its ecosystem highlighting both the major milestones along the history of satellites and the chronological evolution of business models. The second part will be focused on identifying and analyzing the external drivers of change by evaluating their impact on the existing business models in the industry. Finally, the third part will be dedicated to the two chosen business models in the industry, describing and analyzing their characteristics and providing some real examples.

3.1. Evolution of Business Models (Group Part)

3.1.1. General Definition

A satellite is a self-contained communications system that is able to receive and retransmit signals from and to Earth with the help of a transponder – an integrated receiver and transmitter of radio signals. Satellites can operate in three different orbits: low Earth orbit (LEO), medium Earth orbit (MEO) and finally geostationary or geosynchronous orbit (GEO). It only takes three GEO satellites to provide worldwide coverage, while it takes twenty or more to do the same from LEO, as they operate at a much lower altitude than the first ones. To secure a smooth and successful connection between satellites MEO and LEO, having tracking antennas on the

ground is essential. Low Earth orbit accounts for many communications, remote sensing, and Earth-imaging satellites. MEO hosts communications satellite constellations and the Global Navigation Satellite Systems (GNSS), which provides global positioning and navigation capabilities (otherwise known as GPS). Geostationary orbit (GEO) is valid for military insights, agriculture, satellite radio, and communications. GEO satellites have the most extensive coverage through this position: 42 per cent of Earth's surface. They can collect reliable Earth data quicker than other instruments on the ground.

Satellites can help researchers to better understand the solar system and the universe beyond, and they can provide communication services such as telecommunications, broadcasting, and other data communications. Telecommunications include essentially telephone calls and services delivered to wireless, mobile, and cellular network providers. Broadcasting services include radio, television, and mobile broadcasting services. Lastly, data communications comprise the transfer of data from one point to another. This exchange of data between various locations can be used to provide powerful insights regarding possible disasters and emergencies, weather forecasting or to numerous important sectors on our daily lives such as national security, agriculture, banking, commerce, oil and gas, mining, energy production or tourism.

Besides being classified according to their purpose, satellites can also be distinguished according to their size and weight. Conventional satellites comprise all satellites weighting more than 500 kilograms (large and medium), while small satellites weight less than 500 kilograms. Within the small satellites sub-segment, Nanosatellites are the most popular ones and comprise any satellite weighting between 1 to 10 kilograms. The satellite size also dictates other characteristics. Small satellites are more accessible to companies of all sizes as they have more affordable prices, and they have shorter development times which make them more flexible, but they also have some disadvantages. Small satellites have shorter operational

lifetime and limited amount of hardware they can carry while conventional satellites have longer manufacturing and developing times, longer operational lifetime and they are able to carry considerable hardware.

Having this said, it is important to highlight that the satellites and its characteristics and applications to other businesses were not always like this. Governments, researchers, scientists, engineers and more recently private companies and other important space stakeholders have invested a huge amount of effort during almost the past century to reach where we are nowadays. Major technological breakthroughs, important collaborations between governments and private investors and the emergence of new business segments were all major milestones that contributed to the advances in the satellite industry, either on the process of manufacturing a satellite or the way to collect data from Earth to its applications on our daily decision-making process.

3.1.2. History

One is not able to analyze *NewSpace* EO companies' business model without going through the major milestones of satellites and Space history over the last century.

Satellites have been playing a significant role in the Space Economy since the beginning of the space race. The Cold War between the United States and the USSR was a major milestone that ended up setting the beginning of this race as there were many far-reaching achievements in science, space exploration, and technology. In October 1957 the USSR successfully launched Sputnik 1, the first Earth-orbiting artificial satellite in history. Sputnik 1 provided valuable insights and discoveries to scientists regarding the method of placing a satellite into Earth Orbit; the atmosphere density by calculating its lifetime in orbit and the radio and optical methods of orbital tracking. The satellite had around 84kg and 58cm diameter and orbited the planet for two months before it fell back into the atmosphere. Followed by this event and intensified cold

war tensions between the two nations, the USA established in 1958 the National Aeronautics and Space Administration (NASA), an independent agency of the U.S federal government that was responsible to lead the space exploration efforts. In the same year, the USA launched Explorer 1, the first satellite of the long-running Explorer Program from NASA. Explorer 1 had around 14kg, so around six times lighter than the one launched by the USSR, had 15,2cm diameter and orbited the planet for almost four complete months (the double of the one launched by the USRR). Finally, in 1969, Neil Armstrong became the first man to walk on the Moon, and for several historians, this event symbolized the end of the space race between both nations and the United States' victory. In just a couple of decades, the space race contributed to major scientific and engineering breakthroughs in specific countries and specific space exploration segments. However, there were not significant collaborations and knowledge-sharing between nations as military research and governments secrecy and competition forced the sector to preserve their own technological advancements.

During the following years the space environment started to shift but at a slow pace. The Space economy as well as the satellite industry were still dominated by governments, space agencies and military facilities and only a few large private companies and contractors were on the race. Furthermore, in the 1980s only a small number of governments had the capacity to build and launch a satellite as it was very time and money consuming. At first, the U.S with NASA and Russia dominated the panorama but foreign public players like China, India, Israel, United Arab Emirates and Brussels started also to claim a stake of the Space economy. China was the world's third nation to launch a satellite in 1970 and to put its first astronaut in space in 2003.

Only around the 2000s' and thanks to a steady reduction of costs regarding space hardware and launch costs, important entrepreneurs in the internet economy such as Elon Musk and Jeff Bezos started investing in this business field. In addition to these private investors other new players across the world started to join the race for space economy seeking new sources of

economic growth and innovation. They include the sovereign wealth funds of Abu Dhabi and Saudi Arabia, high-tech investors such as Masayoshi Son's Softbank, and central American venture capital funds such as Founders Fund, Sequoia Capital, Draper Fisher Jurvetson, First Round Capital and Bessemer. The coexistence between public and private entities turned out to be relevant for the industry as both players pursue very different goals and respond to distinct needs. When it comes to public companies, as mentioned before, the main reasons to invest were related with national pride and direct military investment, while private companies have been entering the industry to make space more commercial and affordable for all citizens.

To this greater private sector involvement and the shift to a space industry driven essentially by commercial opportunities one calls it the *NewSpace* concept. According to the report "The future of the European space sector" from the European Commission, *NewSpace* was already the major contributor to the global space economy growth of 6.7% on average per year between 2005-2017. *NewSpace* reflects precisely a more global, entrepreneurial, and affordable Space industry. Governments have been outsourcing some of their space non-core activities and they have been seeking and encouraging the commercial use of Space. This mega-trend gave room for private investment to grow from around US$2.5 billion per year in 2015 and 2016 to approximately US$7.6 billion in 2020, according to Bryce Tech's Start-Up Space 2021 report. SpaceX, the American aerospace company founded by Elon Musk, was the biggest receiver of those investments and successfully launched 31 Falcon 9 carrier rockets during 2021, from which 29 were reused rockets. Another important milestone happened around 2008 when SpaceX launched Falcon 1, the first rocket launched by the private sector. Falcon 1 took around seven years to be developed and launched successfully to space.

Finally, when it comes to Earth-Observation through satellites, the sector is moving from a few large and costly EO satellites to constellations of various smaller and cheaper satellites in Low Earth orbit. Throughout the past few years, technology improvements and lower costs of

manufacturing and deploying a satellite aligned with better quality and more technical features have been driving the growth of the industries' revenues and relevance.

3.1.3. Earth-Observation Satellite Companies in the Space Ecosystem

Space comprises the full range of activities and the use of resources that create value and benefits to human beings while exploring, researching, understanding, managing, and utilizing space (OECD, 2014). According to the European Commission and European Investment Bank study "The future of the European space sector" 2019 the space can be divided into two major sectors: upstream and downstream. The upstream includes all the activities that lead to the development of space infrastructure: design, manufacture, assembly, launch, maintenance, monitoring and repair of spacecrafts, research & development activities, and all ground systems. While the downstream sector comprises, all commercial activities based on the use of data provided by space infrastructure, such as Broadcasting, Communication, Navigation, and Earth-Observation (EO). The satellite industry is present in both upstream and downstream levels and the closer the company is to the end user, the further downstream it is. By 2016, from US$329 billion in terms of global space economy turnover, more than three quarters was referred to commercial space activities. Around US$77.22 billion (23,45%) were captured by the upstream segment and around US$176.66 billion (53,34%) by the downstream segment. The remaining 23,21% referrers to government spending essentially related with defense and national security matters.

This report focuses on the *NewSpace* EO companies within the satellite industry which can be defined in general terms as companies that collect, analyze and present data about the Earth using satellites. Typically, EO satellite companies are included in the downstream segment as they provide insights directly to other businesses or governments – and as mentioned before, the closer the company is to the end user, the further downstream it is in the market. However,

as it will be analyzed in more detail in chapter 2, vertical integrated companies are emerging in the EO market, meaning that nowadays they do not only provide insights to end users, but some of them also manufacture the satellite that is going to be used to collect the inputs. In this cases, EO Satellite emerging companies are present in both downstream and upstream space segments. Considering this, within the EO satellite segment, one can distinguish companies that buy satellites ready to use and companies that design and develop their satellites in-house. However, both types rely on launch companies to put their satellites into orbit. Furthermore, in terms of supply chain, to collect insights from a satellite in space, one can distinguish three major steps:

- Design and Manufacture the satellite: The first step in the process is to design and manufacture the satellite. Some companies in the EO Satellite Industry rely on specialized suppliers to build their satellites, while others build and operate their own smallsats. In both cases, satellite companies rely on external suppliers to provide them with components, equipment, or the satellite itself. Until some years ago, manufacturers were mainly focused on the U.S. however, to keep up with the industry's growth, existing suppliers expanded their businesses to other geographic locations such as Europe, Japan, South Korea, Turkey, or Israel. Moreover, new players have emerged making it an extremely competitive market.
- Test and launch the satellite: The second step is to test and launch and vice-versa until the satellite is able to fulfill its purpose successfully. Companies test some of the technical capabilities in land to verify its readiness to launch, while the remaining capabilities can only be tested when launching or already in space. To launch their satellites to space and into the desired orbit, EO companies resort to space launch services to hitch a ride on a rocket. Usually, large satellites pay the bulk of the launch and for this reason they are considered to be a priority for most of the launch companies while small commercial satellites line up to get a "seat" on the Space Shuttle. Besides

priority to large satellites, launch companies usually have agreements with governments and national agencies such as NASA or ESA to facilitate the agencies' development of the space economy. As seen before, space exploration is not just reserved for public space agencies anymore, however, there is still a big investment portion that comes from the public sector which allows governments to have more control over the rockets' payloads. Therefore, private, and small satellite companies need to adapt and adjust their timings to rideshare the rocket with bigger players in the market.

- Collect, compile & analyze satellite data and imagery: Finally, the last step would be to collect, compile and analyze the satellite data to be able to provide to other businesses useful insights. When the satellite is launched from the carrier rocket it is thrown to the desired orbit or location in space. Satellites are then able to gather scientific data and transmit it back to Earth for ground teams to process. This is when the Satellite Ground Stations (SGS) and its services enter the process. They play a key role in collecting and streaming remote sensing satellite data to a variety of users and applications. Companies can either have their own Ground Stations or they can rent what they need on the ground – both command and control links that pilot the satellite device and the data links that connect it with its users. This last option is usually the chosen-one for startups and small companies since it allows them to begin cheaply with a "pay-as-you-go" consumption model. The ground segment has also suffered major changes in the last decades as traditional GEO satellites just required a single ground station while nowadays, *NewSpace* LEO and MEO satellite constellations move across the sky requiring multiple ground stations throughout the world.

Additionally, but not directly involved in the above-mentioned process of getting the satellite into the right orbit are the researchers and academia in general which plays a significant role as

initiators of most of the sector's innovations and disruptive concepts. They contribute somewhat to all stages of the process.

Considering this, one can say that the EO Satellite Segment is a key part of the complex Space environment. As the pursue for *NewSpace* grows and intensifies so does the search for observational data on Earth making it a segment with significant reach a wide societal and economic impacts not just for nations but also for a variety of businesses across different industries.

3.2. Key Drivers of Changing Business Models (Individual Part - Aurelio Mazzara)

A successful business model simply represents a better way of creating, delivering, and capturing value to the client. It can completely change the old way of doing things and become the new standard for the future. New and innovative business models usually emerge during disruptive times. Companies are forced to rethink their businesses and adapt in order to meet market challenges and demands or they risk losing their competitive advantage. Considering this, one can identify an array of external market drivers that have been contributing to the shift in EO companies' business models:

Increased collaboration and knowledge transfer: Since the 1990s' there has been a growing collaboration between researchers, scientists and academia which boosted technological developments in the space industry and brough extra added value to all economies in general. The globalization phenomenon of the space sector forced nations to rethink their approaches and engage with many more countries and corporate players. Thanks to this phenomenon, remarkable achievements in terms of hardware and software innovation improvements, increased data accuracy or increased imagery resolution have been conquered quicker than if there was no cooperation or knowledge dissemination at all. Due to all these scientific breakthroughs achieved, the industry has become more attractive to private entities and

investors, and this has added extra pressure to the existing businesses in the market as there is a constant need to evolve and capture value.

Evolving regulatory framework: Bureaucratic, strict, and costly regulations have negative effects specially when it comes to a market with already high initial capex investments such as the satellite Industry. Economic regulations and investment access restrictions limit who can enter in the industry, meaning that they pose more difficulties on the entry of new players and diminish their chance to gain competitive advantage over the existing players. In the specific case of the emerging industry of EO, companies can be confronted with a future risky regulatory environment when it concerns individuals' legal and ethical rights to privacy. The increased spatial resolution and quality coupled with advances in imaging processing has been raising some privacy concerns that can affect the way companies operate in the industry in the next decades.

People's enhanced awareness of the satellites potential: Although there is still low market adoption from other businesses, the world in general is now more aware of the satellite's potential and this has been putting the industry on the spotlight. Both scientific and technological innovations and findings have made satellites and its applications more accessible not just to other businesses but also to the population in general. For a long time, customers could not connect their needs to the satellite or technology sold as there was not an understanding of its potential. But people are now more aware that space-data and insights captured through satellites can help answer trivial but still deeply relevant questions. Additionally, the business itself has now a deeper understanding of the space-data and its applicability in other sectors. This trend contributes not only to an enlargement of the EO Satellite companies' potential customer base as well as to a growing number of competitors and new entrants in the market as it becomes more attractive to invest. Furthermore, it pressures the

existing companies to rethink their strategies and business models to maintain a competitive advantage over the new entrants.

Companies' demands for faster solutions: Companies and individuals want better, faster and cheaper and this has been adding pressure to the traditional and established players in the market as they lack the flexibility and speed to meet customers' needs. Similar to what is happening in other industries, the client wants to be able to access easily and quickly to all the information he needs to make informed and timely decisions. Some clients are even willing to pay a premium for faster inputs as they highly value the possibility to have access to on-time imagery and data whenever they need it. Considering this, market players need to constantly rethink and improve their manufacturing process and online platform services in order to meet these new demanding customer' requirements.

Reduced costs to launch: Rockets and launch services are essential to the delivery of EO Satellite companies' value proposition, therefore every innovation or major advancement in the rocket industry has direct impact on the satellite industry's existing business models. Many private startup companies operating in the rocket manufacturing industry have been achieving important milestones that caused development and production times to shrink and costs to decrease. Furthermore, launch costs are also declining and are still projected to decline further by around 40% with the use of partial to fully reusable launchers. To EO satellite companies this means more opportunities to send satellites to their desired orbit as more rockets are produced and launched by year. On the other hand, it means less costs for New Space Earth Observation companies as the cost for launching a satellite on one of the available rockets is now just a fraction of the price it was a decade ago. Another trend that is pushing the launch costs down is the growing development of micro launchers systems around the world with the aim to deliver small satellites to their orbits. To address and capture the smallsat demand, launch manufacturers are focused on developing new lighter and cheaper solutions for the future.

Satellites' manufacturing breakthroughs: Satellites' manufacturing innovations represent a key driver of changing business models in the industry. Emphasis on the "good enough" rather than on manufacturing state-of-the-art satellites is a growing trend that has been pressuring established market players to become more flexible and adapt their manufacturing processes. A growing number of startups are purchasing hardware and software from commercial manufacturers rather than from a specialized space supplier. The components are then adapted to be incorporated on the satellite. Acquiring this type of components has been allowing new entrants to reduce production time as there is no bottleneck concerning the market availability of the components and to reduce costs as the components are much cheaper than the first ones (the initial needed CAPEX investment is much less than before). Finally, as mentioned before, satellites are also becoming smaller and lighter. According to the BryceTech report from 2021 "Smallsats by the Numbers", Small satellites represented 94% of the total launches in 2020. Small satellites offer companies the opportunity to create and install affordable satellite constellations to provide them with good daily coverage of the Earth. Additionally, companies are already working on overcoming the small satellites' limitations such as shorter operational lifetime or restricted amount of hardware and soon new enabling technologies will be created and impact the way companies operate in the industry.

Focus on the service provided: In general, consumers from different industries value a good and differentiated service or purchasing experience. In the EO industry one has been assisting to a shift from focusing on the technical capabilities and components of the satellite itself to a growing importance regarding three major aspects: first, the accuracy and coverage of the insights provided, second the real-time ability and ease of access to consult the space-data captured by the satellite and finally they expect EO satellite companies to provide them with useful analysis and key insights regarding the data provided and applied to their specific businesses. Companies want to improve their decision-making process with the help of

analytical studies and applied knowledge based on the collected inputs from Earth-Observation. To respond to this market driver, companies need to adapt and shift from being just data providers to becoming analytical providers (vertical integration).

3.3. Variation of Existing Business Models

3.3.1. Traditional Players and Business Model (Individual Part - Aurelio Mazzara)

An in-depth analysis of the leading players in the traditional satellite market shows that most of the traditional satellite companies have a variety of common aspects on which they base their business model. These businesses have a revenue model, value chain, and value proposition that are generally similar. During this analysis, it was used the magic triangle business model established by Oliver Gassmann, Karolin Frankenberger, and Michaela Csik (2014, 2) to highlight these companies' shared aspects within their business models. The model conceptualizes the architecture of business models in four dimensions: The Who, the What, the How, and the Value.

Thanks to these common aspects, traditional enterprises can stand out from the competitors by offering outstanding quality products and attracting important customer segments such as government associations and communication companies. In fact, products produced by these significant businesses are recognized for their reliability, durability, and long-term performance. For instance, a satellite built by these companies has an average operational lifetime of almost ten years, guaranteeing high-quality performance throughout the whole period. As a result, critical governmental entities choose to delegate these relevant industries on crucial operations. For instance, Lockheed Martin, one of the world's most important global security and aerospace companies, derives most of its revenue from defense activities. In fact, the most significant portion of Lockheed Martin's revenues comes from military sales, including the U.S. government, which accounted for 78% of the company's earnings in 2015.

In addition, the firm is the largest U.S. federal government contractor and receives nearly 10% of the funds paid out by the Pentagon. Moreover, the U.S. company collaborates with over 50 national governments worldwide, assisting them in protecting their national interests while strengthening their economies, industries, and communities from within.

Furthermore, due to the complexity of their items, these firms provide outstanding customer service to guarantee the spacecraft's more remarkable performance. Especially for this customer service support that is provided during the pre-launch phase as well as during the orbit phase of the satellite, these industries stand out from the competition because they know the importance of the operations in which their products are involved and at the same time the extreme complexity of these spacecraft. In addition, the same space companies are responsible for staff training during the pre-launch phase. As a matter of fact, company staff remain available throughout the product's life cycle to offer timely and quality assistance. For example, Eutelsat, thanks to its System Integration team, offers turnkey solutions to customers worldwide, with customized product and technical training programs. Eutelsat provides several training tools, such as classroom courses, installation films, apps, roadshows, an online university, and an online portal. Thanks to these tools, Eutelsat is able to offer a complete service to clients worldwide.

On the other hand, in order to guarantee the most incredible quality offer to their clients and gain a competitive advantage, these businesses require a significant and strong value chain.

Nowadays, companies must constantly analyze the value they provide for the stake of maintaining their competitive advantage in the face of increasing competition for affordable pricing to keep their clients' loyalty. Therefore, suppliers play a crucial role in these companies' value chains. These industries can guarantee good delivery times and at the same time offering quality products with an expected life cycle of more than ten years, thanks to qualified and trusted suppliers who guarantee high-quality raw materials such as carbon fibers, titanium,

aluminum, recyclable, and lightweight carbon nanotubes. Indeed, product reliability is the critical quality criterion during a satellite's lifetime. For this reason, any reliability issue can lead to loss of trust, loss of future business, and order cancellations. For instance, in November 2002, PanAmSat, a satellite service provider concerned about solar array power problems in some orbit areas, decided to cancel an order with Boeing Satellite Systems because the US company was no longer using the same reflectors of the previous models on new satellites. The supply chain system of traditional business model companies comprises three main players: customers, contractors, and suppliers.

Customers create specifications and submit bid requests to contractors. Bids are prepared by contractors, including cost and delivery estimates.

Long-term agreements, in-house production, and general pricing agreements significantly contribute to the costs during this phase. Most companies build some satellite parts in-house to reduce production costs. In-house-made components are comparable in quality to subcontract parts, although they are not outsourced. In-house manufacturing is a legacy competence that is maintained thanks to the company's efficient production capabilities. Moreover, this may be used as a bargaining tool with suppliers. The contractor's final bid to the customer is based on the supplier responses that play a crucial role in the process. Contractors usually respond with individual bids; however, they may join a consortium with other contractors and suppliers to maximize their respective strengths. Finally, the customer selects the lowest bidder, and the contractor constructs the project according to the specifications. These businesses make money through product sales and service sales in terms of revenue models. Although product sales represent almost 80% of revenues for these firms, satellite companies dedicated significant attention to selling services such as training and support during launch activities in order to ensure the best performance of their products to their customers.

In conclusion, these companies dedicate more than half of their services to government projects primarily focused on military, defense, and space exploration activities. Even if these industries focus most of their business on government and national security services, they have always offered products for commercial purposes as well. In fact, satellites of these firms are also used for broadcasting services, corporate networks, mobile communications, Internet backbone connectivity, and broadband access for terrestrial, maritime, and in-flight applications. During these years, the satellite communication (SATCOM) industry has become by far the largest market for satellite services. In fact, The Global Satellite Communication (SATCOM) Industry was valued at 39.14 billion dollars in 2021 and is predicted to rise to USD 73.72 billion by 2027, with a compound annual growth rate (CAGR) of 11.45 % from 2022 to 2027. Furthermore, new markets such as M2M/IoT enabled by 5G, in-flight connectivity, connected cars, and maritime security are expected to sustain and grow the Satcom market. In conclusion, traditional companies, used to having government organizations as their main target customers, are trying to adapt to new market needs by moving towards a commercial customer segment in order to maintain a significant market share.

3.3.2. Emerging Players and Business Model (Individual Part - Aurelio Mazzara)

For decades, satellite companies and governments captured Earth imagery via large and high-cost satellites and resulted in complex data sets that only governments and large enterprises could afford or interpret (Annual Report "10-K" – Planet Lab). The satellite industry is rapidly evolving, in large part due to the growing small satellites (also known as smallsats) segment, namely satellites with a mass of fewer than 500 kilograms.

On one hand, traditional satellites mainly provide communication services (revenues in 2020 for satellite services were $117.8B, where $88.4B of revenues were for television services); they are designed and built for high performance and reliability (they have a typical ten-to-

fifteen-year operations goal) and mainly are made as one-offs or in low volumes. They cost hundreds of millions of dollars each and typically orbit between Medium Earth Orbit (MEO) and Geosynchronous Orbit (GSO).

On the other hand, smallsats operate much closer to Earth, in low Earth orbit (LEO). These new satellites are smaller and less expensive but individually less potent than traditional satellites. However, when operated in more significant numbers, the capabilities are equal (if not better) than traditional satellites. The general idea is to lower the cost of building and launching a new spacecraft enough that replacing it with more modern, more capable models becomes feasible. The paradigm shift centres on moving from fewer, larger satellites with longer lifetimes, and complicated development efforts, to a vastly more significant amount of smaller, faster satellites with shorter development timelines (1/50 the traditional time and cost).

Based on NASA classification, smallsats can be classified based on their mass and size:

- Minisatellite, 100-180 kilograms
- Microsatellite, 10-100 kilograms
- Nanosatellite, 1-10 kilograms:
    - CubeSat: the standard size uses is 10x10x10 cms (1U – one unit). Other sizes: 1.5U, 2U, 3U, 6U, and 12U.
- Picosatellite, 0.01-1 kilograms
- Femtosatellite, 0.001-0.01 kilograms

Based on the report by Bryce Tech, "Smallsats by the Numbers 2022,":

- 94% of spacecraft launched in 2021 were smallsats;
- 43% of total 2021 spacecraft upmass were smallsats;
- 37% of all smallsats in the last ten years were launched in 2021 (69% 2020 + 2021)
- smallsats represent 82% of spacecraft launched from 2012 – to 2021.

These figures show the incredible growth in applications for this type of spacecraft. This explains why new satellite manufacturer companies were born with new business models and value propositions in the last ten years. These are mostly related to "Communications/Internet services" and "remote sensing/Earth-Observation".

The first one concerns the construction of constellations of satellites to guarantee internet connection from anywhere in the world. People, whatever their location, can connect their devices through customized terminals, small as a briefcase and just as compact. The terminal encrypts data and sends it to satellite fleets passing overhead at high speed. Also, these spacecraft in the LEO give a more stable, real-time connection with no interruption and latency of 50-100ms.

Fleets keep moving, orbiting in a constellation that creates seamless coverage. Each satellite uses a set of beams to cover a vast area from its flight path and pattern. In this way, smallsats can always find the signal and get people online from even the trickiest locations with look angles that traditional GEO satellites cannot deliver.

The leaders of this market are OneWeb and SpaceX with Starlink. These companies have launched giant constellations of smallsats into space; for example, the SpaceX constellation has 1944 satellites currently in orbit.

The second most important application is Earth-Observation (EO), also generally defined as Remote Sensing. Earth- Observation companies use smallsats to provide data from Space and insights to their customers. These companies have great expertise in constructing small satellites, distributed computing, machine learning, and Al; Customers, part of industries that previously did not consider satellites as a source of value, have started asking for services from these new companies. An example is insurance companies and hedge funds. The images of the Earth, captured by satellites and subsequently processed by artificial intelligence, can highlight the changes occurring in the different regions of the world. This is valuable information to

understand, for example, the environmental impacts of an oil company and therefore understand the risk of an investment in that company. Investment management company BlackRock uses computers to sift through satellite images that monitor construction in China, helping the company decide whether or not to sell Chinese construction-related securities.

Another example is SwissRe's insurance company that signed a significant deal with an EO company called ICEYE. The partnership will advance flood risk management, assist disaster response and speed up claims payments (Mark Holmes 2021).

Agribusiness is another market benefitting from Space-based data applications. Many products and offerings cater to the agriculture industry. Agricultural applications and benefits include detecting and measuring soil moisture, more accurate weather forecasts, increased crop production levels, more efficient cattle grazing via pasture maps, weather synchronization for crop life cycles, early warning for crop pests and diseases, and monitoring environmental conditions.

Remote sensing capabilities can detect what type of vegetation is growing, the vegetation's health and vigour, and even what the environmental conditions are.

One of the most critical factors that allowed the growth of these new companies was technological progress which led to a decrease in terms of costs. However, technological progress is not the only reason. New companies have revolutionized the satellite industry value chain. To lower the costs of procuring the raw materials and components necessary for building satellites, they began to have partners and suppliers, not companies specialized in the space industry, but companies that sell commercially available off-the-shelf (COTS) products. COTS components include memories, microcontrollers, image sensors, and optoelectronic parts.

One of the most debated issues about these components relates to reliability. Having a general overview of COTS' Space applications, the main concerns are:

- Radiation: Radiation can drastically affect the performance of a semiconductor component.
- Mechanical loads: Spacecraft experience very high vibration and acceleration at the launch and landing.
- Thermal conditions: thermal conditions are much more severe than the Earth-bound use cases.

Space grade semiconductor devices have the best radiation tolerance. However, spending considerable money and time procuring such components is always impossible. Even though COTS are not designed for space use, it has been found by experimentation that some of the COTS components are radiation tolerance up to a certain degree and can be used for space application with calculated risk (Harshad Bokil 2020). The thermal operating range for COTS semiconductor components is -40°C to 120°C nowadays. This limitation is not problematic since smallsats operate in low Earth orbit (LEO).

In recent years, the profound change in the space industry has also led to a revolution in production and product design models, an example is the introduction of agile methodology in the aerospace industry. With "agile methodology" (or agile software development), in software engineering, we indicate a set of software development methods that emerged from the early 2000s and are based on a set of common principles, directly or indirectly derived from the principles of the "Manifesto for Agile Software Development," published in 2001 by Kent Beck, Robert C. Martin, Martin Fowler and others.

Agile methods are opposed to the "waterfall model" and other traditional development models, proposing a less structured approach focused on the objective of delivering to the customer quickly and frequently.

Today, agile methodology is not only used in software engineering but also in other areas, such as the space industry. The basic idea is to introduce agile approaches that support the demands

of service-based business models and the rapid creation of new customer-focused features (John Schmidtm, Marc Gelle, Ajay Chavali, Allen East 2020).

NewSpace satellite companies started using this approach. They call it agile aerospace; this represents a new way of developing satellites that focus on rapidly improving capabilities rather than designing a perfect satellite from requirements on the first attempt. This approach emphasized prototyping and testing mature systems that will get to space faster and could be upgraded once they were there.

A lower overall industry risk has also attracted the attention of new investors, and today venture capital is investing heavily in the *NewSpace* satellite industry. Based on the Brice Tech report, "Start-up Space – 2021", 211 investors invested in start-up space ventures for the first time in 2020, 117 were venture capital firms. The Most Active VCs in Start-up Space from 2000 to 2020 were Seraphim Capital, Space Capital and Techstars.

Another crucial strategic change in the business model adopted by *NewSpace* companies in the satellite industry is a revenue model based mainly on subscription-based models. The advantages of subscription-based business models are recurring revenues, lower retention spending, better financial forecasting, and regular engagement across several channels with customers. As new companies are focused on selling services, not products, this revenue model is adequate.

3.3.3. Vulnerabilities of the Earth-Observation Market and Satellite Industry (Group Part)

Despite the potential of this market, there are some threats to consider. The first point is the fact that the market is still young. This means that many companies from industries such as agriculture do not know and do not have the qualifications to understand the potential of using satellite-based data to improve their business performance. Not surprisingly, one of the four growth pillars of Spire Global, an EO company, is specifically focused on increasing marketing

activities to raise market awareness of these opportunities. Consolidation of this market and the mature phase will take some time, but data (estimated CAGR of the revenues generated by EO Big Data Applications >20%) clearly shows how much this market is growing in terms of applications and customers.

The second point concerns the complexity of the space sector, where the satellite industry is located. Designing, building and launching satellites are complex activities. NewSpace Earth Observation companies have vertically integrated business models; therefore, they design and build smallsats in-house; however, these companies depend heavily on other companies to operate. In particular, they depend on those companies that offer launch services with rockets. These players establish the requirements of the launch schedule, and this significantly affect companies' operations. Also, companies that offer launch services are few, and if this sector fails to grow, New Space Earth Observation companies may not be able to secure spaces on launch vehicles or incur higher prices for such spaces. This could cause delays in their ability to meet customers' needs or an increase in the price for the offerings, adversely affecting their financial condition, business, and operations.

The leading players offering launch services are American, Russian, Indian and European. In the last months of 2021, the price of using spaces on the rockets, mainly due to the pricing policies made by SpaceX, was around 5.000 €/kg (before SpaceX's reusable rockets, it was about 20.000 €/kg). However, some events have changed the market dynamics; in particular, the covid pandemic has had a catastrophic effect on India, which has destroyed its launch industry; due to Russian policies against Ukraine, no company uses Russian launch offers; the European launch industry was heavily based on components produced by Ukraine that it was no longer able to supply after the outbreak of the war in 2022. These events have dramatically increased the negotiating power of American players, especially SpaceX. Consequently, prices have increased dramatically, which has impacted all companies that need these services.

The third point relates to the risk of launch failure/delay that can strongly affect operations and financial condition. The loss of a fleet due to a launch failure could result in significantly increased expenses from earlier than expected and delays in anticipated revenue. In addition, companies might not be able to accommodate customers with sufficient data to meet minimum service level agreements until replacement satellites are available.

The fourth point relates to the evolving regulatory and policy environment. NewSpace's rapid evolutions have resulted in outdated space-related policies and regulations. The vast disparities between the civil and commercial industries present ongoing difficulties, and most governments struggle to address and solve them adequately. Some of the most glaring issues include gaps in commercial space regulations, slow approval processes for NewSpace companies, data and mining resource ownership rights, an absence of comprehensive international standards and policies for space, and inconsistencies between the existing regulations. Therefore, many countries are trying to develop space sector laws individually, but all experts agree on the need to improve and update the international regulatory frameworks. Several changes will occur in this area in the coming years, and companies will need to be ready for those changes. Also, there is a rapid evolution in terms of data protection, data transfer and privacy regulations. Since those companies process, manage and share data, this may impact the market.

The penultimate challenge relates to an increasingly critical problem, namely orbital / space congestion and in-orbit collisions. Companies operating in this market have fleets with a large number of smallsats. For example, Planet Labs and Spire Global have more than 600 smallsats in orbit. Other companies, such as SpaceX and OneWeb, have more than 2,000 smallsats in orbit. This large number of spacecrafts in orbital increases space congestion and the risk of collision and the so-called space rush. This is an essential factor to consider for long-term strategies.

The last challenge concerns the fact that there is an increasing number of new entrants in the Earth Observation market. The critical success factors for the companies that will dominate this market once consolidated are the size and diversity of customer bases, the timing and market acceptance of the solutions offered by the different competitors, customer service and support efforts, sales and marketing efforts, ease of use, performance, price and reliability of solutions developed by the different players and brand strengths.

4. Analysis of Business Model components (Group Part)

After an overview of the five components of the simplified business model canvas and the respective importance of each of those parts, this section provides an in-depth analysis of BM of NewSpace EO companies, based on Afuah framework. The second and final part of this chapter aims to highlight the business model vulnerabilities.

4.1. Market Segments

During these years, Earth-Observation companies diversified its market segments by offering its services to different targets. In fact, EO firms provide their products and services to various kinds of clients such as governments, researchers, journalists, and agricultural enterprises. Even if these customers operate in different business fields and use Earth-Observation data for multiple purposes, these targets are interested in the services provided by New Space Earth Observation companies due to the relevant importance of these activities on a commercial level. These companies offer daily satellite data that helps businesses, governments, researchers, and journalists to understand the physical world and act.

In fact, EO firms react to their customer's needs by assisting businesses in managing essential resources more efficiently, providing relevant insights and information flows to their customers, and becoming more sustainable. The most significant market segments in which

NewSpace EO companies currently operate are Agriculture and Government Activities, including Civil, Defense & Intelligence Agencies. Nowadays, Agriculture is one of the most exciting market segments for EO industries. In fact, leading EO firms established agreements with every significant agriculture company. These categories of businesses leverage new types of Reliable, High-Frequency satellite Imaging, giving the most current and complete agricultural information across every region and season, intending to maximize yields and ensure crop health. Growers may use EO services to track crop health from seed through harvest, allowing them to farm more efficiently, financially, and sustainably. Furthermore, these industries' daily feed of high-resolution satellite photos enables large-scale precision agriculture, even in cloudy places.

EO firms deliver valuable feedback at each stage of crop management by combining broad area coverage, field-level detail, regular in-season revisit rates, and rapid access. Furthermore, thanks to the advanced technology to which these companies can access data may be easily incorporated into a workflow using simple cloud-based APIs. The NewSpace EO companies, despite the presence of segments in great expansion such as agriculture, allocate a significant number of their projects to the government segment, which has always represented one of the largest sources of revenue for the satellite industries. In fact, Governments also represents one of the leading market segments for EO firms. In particular, civil, defense, and intelligence agencies comprise around 70% of the market of Earth-Observation Data.

For this reason, NewSpace Earth Observation companies are trying to establish agreements with leading worldwide government agencies during these years. For instance, Planet Labs, one of the prominent Eo firms, has established partnerships with government agencies in several parts of the world, such as Japan, Germany, Canada, the Netherlands, Australia, Thailand, Brazil, and the European Commission. Especially, Civil defense and intelligence agencies require EO services for crucial activities such as weather monitoring, Security& Safety. In this

way, EO firms aspire to revolutionize how state and municipal governments manage essential resources in order to make communities that are safer, cleaner, and more productive. Satellite imaging assists governments in making quick, data-driven decisions to make safer communities and offer better visibility of natural resources. Earth-Observation industries provide governments with accessible, dependable, and real-time coverage of every area of interest on Earth, intending to increase economic efficiency, obtain a cleaner environment, and early detection of changing conditions. Generally, NewSpace EO companies provide two kinds of resolution imagery. Firstly, medium-resolution imaging allows identifying change and studying activity across large areas. Finally, high-resolution photography provides a close-up view of company areas of interest, allowing see finer details like tree canopies, maritime boats, and wildfire burn scars. Thanks to exact data about land use nationally and internationally and leverage of extensive historical image archive of these firms, governmental clients can easily track and monitor Land Use Globally level.

On the other hand, new satellite companies are increasingly looking for emerging market segments to operate, given the importance of the services offered in different business sectors. Therefore, NewSpace Earth Observation companies are expanding their business into new markets such as forestry, energy and natural resources and finances to differ as much as possible in their customer segment. Because of the social importance of the issue, satellite monitoring of energy and infrastructure is an important market segment for organizations. Monitoring energy resources and infrastructure from space orbit can be extremely important in preventing large-scale disasters. NewSpace EO companies' mission is to enhance operational efficiency by reducing the need for human inspections, overseeing energy developments, and keeping operations on schedule with high-frequency satellite imagery.

Thanks to a continuous market analysis with real-time data on ground conditions, satellite firms allow their customers to identify easier market changes and anticipate the global impact on their business with a comprehensive global vision.

On the other hand, EO observation data are beneficial for global environmental protection, one of the foremost contemporary priorities. EO industries aim to help their customers tackle complex sustainability challenges that balance economic growth, social well-being, and ecological stewardship.

Furthermore, worldwide high-frequency data elaborated by NewSpace EO companies can help examine the effect of sustainable agriculture practices and identify potential food security threats worldwide. At the same time, the climate risks constitute the deterrence of energy grids and infrastructure. During these years, some Earth-Observation companies developed sustainability programs which include public-private collaborations that are crucial for developing technologies and implementing rules that evaluate and verify sustainability efforts in the agricultural and energy sectors. For Instance, Planet Labs is a critical partner in the Carbon Mapper, a first-of-its-kind public-private partnership that brings together a broad-based coalition of industry, government, philanthropies, and academic institutions to identify and accelerate pathways to reduce methane and carbon dioxide point source emissions over the next decade and beyond. Moreover, thanks to the quality data service provided by NewSpace Earth Observation companies, customers can monitor encroachment and manage vegetation in the context of more extreme weather events. Equally, forestry management is a growing market segment for these firms. Indeed, EO remote sensing technology and data analysis help forest owners and stakeholders stay on the cutting edge of innovation. Satellite imagery and data assist forest managers and timber operators in optimizing management strategies to assure production without compromising environmental stewardship or land use legislation compliance. Furthermore, customers can track forest harvest and clearing, monitor forest health, and

enhance forest management practices thanks to these services. In addition, forest owners with Earth data have the possibility to monitor distributed assets and track the life cycle of trees to improve forestry operations and proactively manage forest health with continuous monitoring, detect change as it happens, and respond to natural disasters pests, and disease promptly.

EO services can be beneficial for businesses, even in the financial sector. In fact, relevant and accurate intelligence is exceptionally relevant to financial institutions and insurers. NewSpace EO companies address these data demands by reducing and managing risks so that their customers can obtain a competitive market advantage and use a comprehensive global dataset that is updated daily to support decision-making. The process to be most efficient is conducted cloud-based platform and API, which facilitate analysis to obtain and scale insights based on targeted capture of wide-area image data. In this way, Planet gives insurers and financial institutions the intelligence they need to close information and data gaps and take effective action in crucial situations.

Moreover, NewSpace Earth Observation companies can also support Hedge funds, Asset Managers, and Private Equity trying to anticipate the market and make better investment decisions with global, high cadence imagery and analytics. For these reasons, EO data plays a crucial role also in this industry. These data help companies in the process of monitoring opaque markets, bridging information gaps, and addressing activity in these kinds of markets with daily revisit and global coverage. In addition, thanks to high-quality customer services offered by new satellite industries, clients can understand claim events in real-time with high cadence and high-resolution imagery and analytics, leveraging continuous satellite imaging and historical image archive provided by EO firms to feed pricing models, validate claims and credit, forecast potential risk, and identify opportunities within new markets. Planet Lab invested many resources in this new market segment regarding Investment in Sustainable Finance. Indeed, Planet's daily revisits and global coverage enables investment firms to deploy private finance

and sovereign funds toward more sustainable outcomes by assessing and managing environmental risks. Thanks to Planet services, clients are able to monitor assets and measure environmental, social, and governance risks in real-time, quantify the impact of deforestation and natural disaster on local economies and integrate ecological and climate risk considerations into the global equity investment process.

4.2. Customer Value Proposition

The elements of the customer value proposition represent how this type of business model generates value for customers. Generally, Earth-Observation companies use their satellites to capture data from the Earth's surface, process this data, and share insights with their customers to scale their operations, boost efficiency, mitigate risk, and develop new answers to handle their critical challenges. There are several examples of how this happens, and several industries benefit from it. For example, Spire Global, one of the leaders in this market, provides companies that manage port traffic with solutions to track incoming vessels, including reliable estimated arrival time, plan berths and resource allocation, and optimize daily port operations. The main factors that characterize the customer value proposition are shown below:

1. Frequent cadence: some companies offer up to 10 revisits per day, i.e. the number of times company satellites image a particular area of interest on a given day. This allows for detailed and precise information.
2. Daily, global scanning: these satellites can capture data relating to any land surface without operational limits.
3. High-resolution imagery: on average, the resolution of the images is about 3 meters. Resolution refers to the smallest size an object or detail can be represented in an image. Higher resolution means that pixel sizes are smaller, providing more detail. For example,

30cm resolution satellite imagery can capture details on the ground that are greater than or equal to 30cm by 30cm (Eric Setyawan 2019).

4. Large fleets: Companies use large fleets of smallsats to provide as much information as possible to their customers. Below are the data relating to some of the leading players in this market: Planet Labs 485 satellites, Spire Global 147 satellites, Satellogic 25, BlackSky 14, ICEYE 12 (based on "Smallsats by the Numbers 2022" - Bryce Tech).
5. Automated data processing: Data processing concerns transforming raw data into a usable format. In particular, the main phases of this part of the value chain are three: data processing, data fusion (data from other sources, such as statistics, probes, internet, merged with the data captured by the satellites), and analysis through algorithms. Firms leverage machine learning to transform global, daily satellite imagery into information feeds that detect and classify objects, identify geographic features, and monitor change over time. These intelligent information feeds integrate into existing workflows and gives customers unprecedented insights about places they care about.
6. Cloud APIs & easy integrations: these companies use innovative delivery models based on API (application program interfaces - a set of definitions and protocols for creating and integrating software). The EO satellite companies develop the APIs and thus make it easy, safe and fast to share data directly with the companies software. This allows a significant saving of time and money. Furthermore, this technology allows an organization to interact and share information with other firms at an unprecedented scale, taking advantage of the far-reaching progress in digitization and the rising influence of software in our day-to-day lives.

4.3. Revenue Model

A company's revenue model is defined as the way by which its value proposition is converted into a financial gain or income. In this way, while traditional EO satellite companies generate revenue mostly through one-time purchases, *NewSpace* EO satellite companies generate revenue mainly by charging a recurring fee to their customers. This means that the end-users pay a regular fee to access a certain service or content provided by the company, the so-called subscription revenue model. A subscription revenue model brings benefits not just to the EO Satellite companies as they can rely on a recurring income but also to customers as they are able to enjoy the convenience of auto-renewals and have access to high-value offer for a smaller recurring payment compared with one-off purchases. The predictable subscription and usage-based model enables the companies to scale its operations steadily and reduces the level of risk and uncertainty inherent to this specific industry. Within a click any business or individual can create an account and explore the companies' platforms – either an online catalog, sample datasets, alerts, research programs with deeper and specialized data, reports, articles (both on current and past events), cloud imagery, continuous and complete view of the world from above and other array of data formats and imagery. All the content can be accessed through the payment of a specific fee depending on the type of access and content the end-user wishes. Hence, EO satellite companies combine different pricing models that vary from simple, fixed or flat-rate to complex and variable plans. Fixed or flat-rate plans only include access to the main features and applications of the platform, while complex and variable plans usually comprise additional or premium features and functionalities (for instance, customized solutions to some extent). The key to a successful subscription revenue model is to focus on customer retention rather than customer acquisition as the client becomes more valuable the longer, he keeps using the services and pays for the subscription. Therefore, EO satellite companies have a well-defined customer retention strategy that builds customer loyalty and improves customer

lifetime value. So, in order to keep the subscribers satisfied, companies strategically try to upsell and cross-sell other types of services and space-data to complement the subscription package the clients already have. Upgrading customers to a larger plan as their need for the company's services grow or provide additional features to augment the services the customer already has, allow the company to generate the non-recurring revenue or extra-revenue. Furthermore, the retention strategy also includes the possibility to try a freemium plan or free trial of an additional feature or application. By having this clear strategy, NewSpace EO companies are able to retain the subscribers as long as possible in order to decrease the cost per user, turn a profit and expand the number of clients who can afford the service. In terms of capturing new clients and thus strengthen their recurring revenue base, NewSpace Earth Observation companies also offer the above-mentioned benefit – a freemium plan, free trial, or a pilot period. As it is an industry that is suffering major technological shifts and improvements it is extremely important to show to potential customers the value that the company can bring to their businesses. Although maintaining subscribers is key to have a stable revenue growth, increasing service and brand awareness to potential clients is also crucial when it comes to a long-term growth strategy and increased market reach. To do so, NewSpace EO companies provide to the potential client a pilot engagement period that includes training to fully empower customers and show them the return on investment.

Finally, these types of companies have highly diversified revenue bases as they can provide a wide portfolio of high-quality and reliable data and services to a variety of businesses across many different markets. The subscription base of EO satellite companies include from individual users to tech companies, environmental organizations, governments, academia and researchers or private and public consortiums. California's Office of Emergency Services has a paid subscription to receive alerts during California's fire season; an Airbus-led consortium in Europe is supplied with high-resolution imagery through the Copernicus Earth-Observation

program; the Brazilian forest division receives alerts that helps them prevent illegal logging; U.S energy customers subscribe to alerts showing new roads near Oklahoma's Cushing Oil Field or even the NASA's Earth Science Division and the National Geospatial-Intelligence Agency have subscription plans with *NewSpace* EO companies. As a result of having these established subscription businesses with multiple market players, the companies are able to capture a massive market and revenue opportunities.

4.4. Capabilities & Resources

The company's capabilities are the building blocks of what makes it what it is, and they are required to actualize the strategic objective and deliver business results. A company's capabilities rely on key activities and key resources that allow it to gain a competitive advantage against its competitors and help increase the value of a firm.

Every business model requires Key Resources. These resources allow an enterprise to create a value proposition, reach markets, maintain relationships with customer segments, and earn revenues. Key resources may be owned or leased by the firm or acquired from key partners. Several kinds of resources play a crucial role in the company's performance that can be physical, financial, intellectual, and human. A corporation must have efficient key resources, especially in an industry like satellites, where technological competencies are essential. In fact, having a well-equipped, high-tech fleet and a qualified support team is a critical aspect of the long-term success of satellite companies. EO corporations devote as much of their resources as possible to developing a technologically advanced satellite fleet. In this way, EO firms deliver geospatial insights at the pace of change with a unique coverage, frequency, and resolution, allowing them to acquire the most sophisticated understanding of changing ground conditions. In this way, organizations, thanks to timely geospatial insights provided by New Space EO companies with

the highest quality imagery, can quickly monitor areas of interest, validate field information, and find relevant trends.

On the other hand, although technologies play a primary role in this industry, equally important resources are the experts in the various teams of the New Space Earth Observation companies. Indeed, due to the high technological complexity of the products offered by this category of industries, the operational and technical competencies of the several teams are critical in delivering the value proposition of these businesses. Moreover, having a well-organized structure made up of a group of professionals such as rocket scientists, software engineers, creatives, business strategists, and researchers is critical in these companies in order to build a team with perfectly compatible skills capable of solving any doubt or problem both within the corporation and for the customer. Furthermore, clients are also a valuable resource for these kinds of companies. Clients are a valuable resource in two ways: financially, by remunerating the company for its services, and creatively, by generating new ideas for the use of services in other industries. In reality, given the considerable flexibility of NewSpace EO companies' services, clients play an essential role in identifying new applications for the data and giving insights provided in integration with the company. However, all companies need to execute key activities to make their business model perform at its best. Every business strategy requires a combination of key activities. These are the most critical steps that a business must take to succeed.

Moreover, like Key Resources, key activities are responsible for developing and delivering a value proposition, reaching out to new markets, maintaining customer relationships, and making income.

Regarding NewSpace Earth Observation companies, one of the main activities they are involved in is the maintenance and development of their software. Considering the significance of technological components for this industry, they must continue developing their software to

provide their clients with reliable images and high-quality data. The maintenance of smallsats is another key activity for EO firms. Companies structures their key activities in three steps. Firstly, the development and investigation that concerns the smallsats. This activity is imperative if a company would improve the efficiency of its operations and services in this business field. Secondly, the maintenance of these devices and the servers is essential if a company wants to keep safe data storage.

Finally, the study of the information collected because the interpretation phase is crucial to the creation and delivery of value for the customer. For all these reasons, the design, assembly, testing, and optimization of satellites is a primary aspect for NewSpace EO companies. Moreover, one of the essential key activities in some NewSpace EO companies' business models is related to vertical integration. Vertical integration is a business approach that allows a corporation to streamline operations by taking complete control of various stages of the manufacturing process rather than depending on outside contractors or suppliers. A company can achieve vertical integration by acquiring or establishing its suppliers, manufacturers, distributors, or retail outlets rather than outsourcing them. One company that has decided to follow this strategy is Planet Labs, with a backward integration process. This process happens when a company decides to move the ownership control of its products to a point earlier in the supply chain or the production process. For instance, Planet develops and manufactures its satellites in-house, allowing them to iterate quickly and incorporate cutting-edge technology into their small satellites. The company's complete vertical integration will enable it to respond rapidly to consumer requests while also continuing to improve its technology. Thanks to this strategy, NewSpace Earth Observation companies can have total control by managing most of the activities within the manufacturing process. In addition, companies benefit from lower production costs, reducing dependence on third-party companies as much as possible.

4.5. Cost Structure

As stated before, the cost structure describes all costs incurred to operate a determined business model. *NewSpace* EO companies have a cost-driven structure and high operating leverage as opposed to the conventional companies in the industry. Having a cost-driven business model means that companies focus on minimizing costs wherever it is possible to do so. On the other hand, having high operating leverage indicates that a business can generate high gross margin with low variable costs. EO companies must cover a larger amount of fixed costs each month regardless of whether they acquire new subscribers or not. This happens, as one will analyze in more detail afterwards, because the most significative costs of EO companies are related with the provision of an ongoing customer service, which does not depend directly on the amount of sales; it does not increase in the same proportion as revenues. The same applies to the costs of manufacturing the satellites as it requires an initial high investment but over time the company is able to benefit from economies of scale. Their satellites constellations are used to provide space-data and insights either to one client or to a hundred. Having this said, one can distinguish the following types of costs:

1. Costs with the components to manufacture the satellites: *NewSpace* EO companies manufacture all their satellites in-house. Therefore, the costs related either with raw materials or satellite components, direct labor, and other overheads play a leading role on their total cost structure. Regarding the acquisition of components, *NewSpace* EO companies use a Commercial off-the-shelf approach, "COTS", meaning that the components used to be incorporated on the satellites are already available in the market and the company just needs to make some minor adjustments and adaptations depending on the satellites' goal. Using components from suppliers operating in the consumer electronics industry and not from specialized companies that produce for the space industry means cheaper components and a smoother manufacturing process as there is no need to wait for the specific component to be

available in the market. The goal is to have a rapid and flexible manufacturing process with no frills which is crucial to provide the geospatial insights at the highest speed to meet customers' needs. Besides this, the smaller satellite sizes and the miniaturized components also push the cost down. On the contrary, for other players in the market either these costs do not exist in their cost structure because the satellites are bought to external manufacturers or if the satellites are manufactured in-house, traditional players rely on specific space suppliers to provide them with the high-quality and cutting-edge components to manufacture their satellites. Furthermore, as seen before, the manufactured satellites are smaller and therefore also cheaper.

2. Launch costs: *NewSpace* EO companies rely on both private and public launching companies to put their satellites into the desired orbit, and this has costs. Some years ago, launch costs were a very government-dominated capability and represented a considerable part of the companies' cost structure, however, nowadays, private, or public-private launching companies are able to do the same for a fraction of the price paid before. Having this said, launch costs are indeed essential to the business model but they have been representing less than they did before.

3. Costs with the space-data and services provided: *NewSpace* EO companies have cloud hosting costs, software costs and costs with the operations and technical support teams. All these types of costs are essential to a company that has a subscription revenue model as the success of the "access to content" depends on the quality of the service provided and the ease of access of the online platforms. They play a fundamental role on the business model structure as they are key for the companies' delivery of its value proposition. Additionally, one can say that these costs are diluted as the customer base grows, so the cost per user decreases.

4. R&D costs: The Research & Development costs comprise all costs related with the engineering operations, software development and data science. *NewSpace* EO companies

invest a considerable R&D amount in tools for enhanced data insights and analytics; new ESG data sets and ML-readiness.

5. Sales & Marketing: Regarding Sales & Marketing, as mentioned on the Revenue Model, companies are focused on one hand, in retaining customers by building a strong subscribers base and on the other hand, they are also investing in expanding this base are there is a constant/growing need to reach to new markets and show them the potential. Scalable model through platform ecosystem; multi-year subscription model that drives high customer lifetime value.

6. Other administrative cost: Finally, and similar to other businesses, EO companies have costs related with corporate matters such as finance, human resources & recruitment, legal and regulatory and any other cost that is crucial to maintain the company operating.

4.6. Vulnerabilities of the *NewSpace* EO Companies' Business Model (Individual Part – Rita Pereira)

Based on the business model analysis of *NewSpace* Earth-Observation (EO) companies, specific vulnerabilities can be derived. Regarding market segments, it can be stated that not having a specific customer (offerings range from agriculture to finance, and logistics) segment may be a risk. To satisfy the needs of companies, it is necessary to know the problems and demands of the specific markets. With a broad offer, the company runs the risk of not developing specific solutions or developing the necessary skills too slowly. Furthermore, this can be expensive because EO companies must invest in hiring professionals with different backgrounds and specializations.

Another vulnerability comes from the revenue model. Having a subscription business model has many advantages, but some elements should be considered. Firstly, there is the constant need to provide new value to customers; otherwise, there will be a considerable churn rate.

Providing new value means investing a tremendous amount of money into R&D, which could be not sustainable in the long-term. Also, managing a long-term relationship with a client has a significant impact on flexibility. A 5-year contract can be an element of a slowdown in strategic evolutions. At the same time, customers are afraid of commitments from contracts and subscriptions in general. As it has been described, this market is changing rapidly, and revenue models need to be flexible.

Regarding customer value proposition. Ultimately for the end-user, the technical details of the satellites will not even matter, neither metric of the algorithm. They can be abstracted away, and all that matters is that the client can use quick and accurate insights to improve his business. This is the result of the evolution of the applications of Space-based data, no more just for governments and researchers: shifting away from delivering data like pictures and numbers towards simply delivering real-time on-demand insights, quickly and easily. Therefore, EO companies need to focus on competing in this market offering customer value propositions based on providing precise answers to questions, not just better technical features (compared to competitors). This means being able to understand customer's necessities, hire talented salespeople and develop many partnerships to have more data and deliver better insights.

Considering capabilities, different aspects should be considered. Having a vertically integrated business model has a significant impact on increasing the complexity of the organization and, at the same time, it is capital intensive. Different processes may boost the risk of organization inefficiency. Also, a higher upfront investment reduces the company's flexibility (this means a more difficult exit in case of market's downshift).

Another vulnerability, as described before, is related to "Commercial-Off-The-Shelf" (COTS) products. Using these components decreases costs, but many people are still afraid about their reliability, which could impact the scientific credibility of smallsats companies.

In addition, another vulnerability is present in the capabilities of EO companies' business models. Companies that operate in this market are deep-tech organizations. Their value proposition is firmly based on providing technical features developed by rocket scientists and software engineers with outstanding expertise in the STEM area. For this reason, these companies have primarily technical profiles in their teams. Frank Salzgber, head of the Technology Transfer and Business Incubation Office at the European Space Agency, stated, "Space's problem right now is not the technology; it is the business model". This represents a risk because players in this market are too focused on developing technology, missing other critical aspects, such as marketing & communication, HR management, and financial management.

The last point concerns agile methodology. The advantages of this approach are not in doubt, but there are some elements to consider. Firstly, if agile is a factor of growth for startups, this does not mean that these principles will be helpful for a mature company in the future. The poor resource planning, the fragmented output coming from an iterative approach, a vague idea of the "final product", the problematic application of KPIs to measure progress, and a not-shared culture of continuous improvement in big companies, make agile risky in the long term, especially for public companies that need to share precise results and plans to investors.

5. Case studies

In this chapter, short case studies have been developed for three companies: Planet Labs, Spire Global, and BlackSky. The objective is to concretely illustrate the main choices made by these companies to understand how the previously analyzed business model is concretely applied. The three companies are the current leaders in terms of innovation and performance in the Earth-Observation domain.

5.1. Planet Labs (Individual Part – Francesco Gagliano)

I. Profile

In 2010, former NASA Scientists Will Marshall, Robbie Schingler, and Chris Boshuizen created a startup, called Cosmogia, known today as Planet, in Cupertino. Planet is one of the first private, venture-backed, Earth-Observation startups using smallsat. Planet went through several quick early-stage funding rounds with venture capital groups. These investments resulted from Planet's smart decision to use the tech industry approach of presenting a minimum viable prototype to investors before spending time and money on analysis and systems development - a strategy the founders refer to as "agile aerospace". Once Planet proved that its product would work, funding began to flow in, and the startup hired engineers before promptly moving toward its goal of rapidly imaging Earth. Planet successfully deployed Flock-1, its first commercial constellation of twenty-eight Earth-sensing CubeSats (called Doves), from the ISS in 2014. As of Q1 2020, the company has deployed over 200 Doves into orbit. Planet's early and continued success resulted from a strong combination of factors. First, the startup's founders leveraged new technology-smartphone components and COTS parts to develop an inexpensive but innovative product with robust processing capabilities. They had a tenacious business model of "release early, release often", which attracted substantial capital investments and support; and because the technology they used continued to improve while becoming more affordable, so did their products-allowing them to compete with the established satellite magnates and cater to both existing and emerging markets. In addition, the affordability of Planet's CubeSats reduces the risk for the company and stakeholders in the event of damage or destruction; The company received over $300 million in private investments in its first ten years. After a 2018 funding round, Planet's valuation was estimated to be over $1.4 billion. The startup now has hundreds of employees and partners in over forty countries, working in markets

that include agriculture, government, defense and intelligence, emergency management, energy, and finance.

Planet's mission is: To image the whole world every day, making change Visible, Accessible, and Actionable.

II. Products

Planet is a company that operates in the Earth-Observation (EO) market; therefore, its primary offering is Earth imagery and imagery-derived insights. This company primarily generates revenue by selling licenses to their data and analytics to customers over an entirely cloud-based platform via fixed-price subscription and usage-based contracts. They adopted a "one-to-many" data subscription model, as each image they capture can be sold unlimited times.

Planet serves its customers through PlanetScope (PS) and SkySat (SS) constellations. The first one is made of more than 200 Dove CubeSat satellites and the second one is a constellation of 21 satellites. PS satellite imagery is represented by single frame images known as "scenes." These scenes may be acquired as a single RGB (red, green, blue) frame or a split-frame with an RGB half and a NIR (near-infrared, namely a region of the electromagnetic spectrum) half (Planet Imagery Product Specifications - 2020).

Planet Labs offers 3 product lines for PS imagery: a Basic Scene product, an Ortho Scene product, and an Ortho Tile product. The Basic Scene product is designed for users with advanced image processing. Ortho Scenes are image captures with additional post-processing applied. Ortho Tiles are multiply orthorectified (a process of correction of the geometric image distortion) scenes in a single strip that have been merged.

SkySat imagery is similar to PlanetScope, and it is available in two product lines: the Basic Scene and Ortho Scene.

Planet delivers data and insights through its proprietary platform that processes and manages a vast amount of data every day. Also, it offers REST API (Application Processing Interface) that allows listing, filtering, and downloading of data to anyone using a valid API key.

III. Customers and Markets

Planets Labs has 770 customers (total customers increased approximately 25% for the fiscal year ended January 31, 2022), 200 partners and 34.000 users in over 40 countries. Customers come from different industries; therefore, this company has a highly differentiated and diversified revenue base: based on FY2021A Revenues, 24% were from Civil, 23% were from Agriculture, 22% were from Defense & Intelligence, 17% were from mapping, 14% was from Energy & Infrastructure, Education & Research, Commercial Forestry, Finance & Insurance, ISV, BI & Analytics. Planet targets to increase the last segment from 14% to at least 40% of its revenue base.

In the following lines, it is reported a list of applications for some market segments:

- Agriculture: examples of use cases are monitoring, variable rate seeding, crop yield, directed scouting, and harvest planning. The associated advantages and customer value are less time in the field, less crop damage, greater cost-efficiency, and more significant revenue. The main customers of Planet in this vertical are Corteva, Granular, Bayer, Syngenta, and Taranis.
- Finance: examples of use cases are asset monitoring, risk calculation, commodity pricing, yield estimation, and ESG scoring. The associated advantages and customer value are economic insights, global visibility, and ground truth. The primary Planet's customer in this vertical is Moody's.
- Civil government: examples of use cases are environmental monitoring, disaster management, forest management & fire prevention, track & mitigate climate change.

The associated advantages and customer value are decreased disaster impact, natural resource protection, more excellent value to citizens, and transparency. The primary Planet's customer in this vertical is Nasa.

IV. Manufacturing Process

Planet Labs is one of the first satellite companies adopting agile methodology in manufacturing process; it has been refining and improving it through more than 18 satellite design revisions and after 450 satellites that they have launched. One specific product of this approach is the radios that they use to download images. They have steadily increased in speed over time, and today they are 150.000 times faster than they were on the first satellite just eight years ago. It is faster for them to download an image from space than over a gigabit internet connection at home. Another result is that they increased the number of imaging pixels each satellite is collecting by more than 10x, making the data more precise and reliable. They have applied this mentality also to operations by lowering the orbits of satellites and making software updates to improve their resolution over time. This is relentless behind the scenes engineering, which means they can deliver more relevant data of higher quality faster and faster every year.

With such a rapid design cycle, it is fundamental to have a very agile manufacturing process. They created a just-in-time manufacturing system that enabled them to build and test dozens of satellites per week. Thanks to vertical integration with their factory testing facilities, they kept these capabilities in-house, reducing all the bureaucracy that would otherwise slow them down and giving more agility and flexibility; this can pay dividends when problems arise, for example, during launch failures. Planet buys launch services from other companies; rockets launch fails about five per cent of the time. This is part of the space industry. Today Planet has 30 successful launches, but they also have three that did not make it to space. The most dramatic of these failures has to be when 26 of their satellites exploded shortly after liftoff in 2014; this

was a painful experience and potentially a real setback for a small startup. The next day they got back to work, and within two weeks, they had built and tested new satellites; these were launched into space and collected imagery less than two months later. It's the same story for the other two failures. In other words, they have engineered this business to be resilient to this type of risk. A large satellite fleet, rapid manufacturing, and frequent launches mean they can shack off setbacks like these, allowing them to continue serving customers reliably even when things go wrong.

Another critical factor in applying this methodology is automation. In contrast to the classic image of a big operation centre with engineers operating consoles around the clock, Planet's philosophy is that the system should run completely hands-off and people should only tough it to make improvements or to debug the occasional issues; therefore, they have built an automated mission control system: a global network of 48 ground stations in 11 different countries and a planetary scale data processing pipeline to handle the sheer extent of operations. These systems run day and night autonomously to manage the fleet and process the more than 25 terabytes of imagery that they are downloading every day. True operational reliability and scale come from this type of behind-the-scenes infrastructure.

5.2. Spire Global (Individual Part – Francesco Gagliano)

I. Profile

Spire Global was founded in June 2012 in San Francisco (California, US) with the name "NanoSatisfi Inc" by Peter Platzer, Jeroen Cappaert and Joel Spark. The company launched the first two 1U CubeSats in 2013: ArduSat-1 and ArduSat-X. In 2014, the first Lemur (Low Earth Multi-Use Receiver) satellite, developed in just seven months with a 3U measure (their current standard satellite format), was launched. With this new format, they could provide better quality, which was a success. In the same year, Spire announced a $25M Series A funding

round and, one year later, a $40 Million Series B. Thanks to this round, the company was able to design and build the batches of Lemur-2 that were launched in 2015. In the following years, other nanosatellites went into orbits.

In March 2021, the company went public, targeting more than $1 billion in revenue by 2025.

Today Spire builds and operates one of the world's most prominent constellations of multi-functional satellites combined with a growing network of ground stations. Thanks to its software analytics, it delivers proprietary data, insights, and predictive analytics to customers as a subscription.

The company has a vertically integrated business model; the most critical elements are

- Proprietary satellites: Spire designs and builds in-house its LEMUR nanosatellites. This improves the quality, increases capabilities and decreases unit production costs;
- Proprietary software analytics platform: Spire has developed the algorithms and mathematical models to analyse and manage data on its platform;
- Proprietary ground station network: this accelerates collection-to-delivery and provides operational flexibility and foundation for Space-as-a-Service.
- Global licenses: Spire owns domestic, regional, and international licenses for space and ground stations.

The only not vertically integrated activity is "Satellite Launch". For this reason, Spire works with launch brokers and launch companies.

The company capture data in the radio frequency spectrum, namely radio signals that encode readable data like aircraft and sea vessel tracking, other signals that reflect off surfaces like ocean wave height and soil moisture, or still others that bend from the density of the atmosphere to improve significantly weather forecasting. Spire Global can measure these aspects at night and through clouds, providing an unprecedented offering thanks to radio frequencies.

Furthermore, Spire collects, organises and analyses those data through its platform to help predict the future and fuel innovation.

Spire counts more than 400 employees; The company's mission is "to provide previously unattainable knowledge and insights about Earth from the ultimate vantage point – space – to enable organizations to act now and make smarter, better, faster decisions about what to do next in a rapidly changing world". To complete this mission, the company developed a strategy based on four main pillars: invest in sales, marketing and product, expand into new geographies and use cases, expand the capabilities of data and analytics, and execute strategic acquisitions to strengthen market position.

II. Products

Spire Global sells four types of offerings based on different data solutions:

- Clean data: this type of data directly comes from Spire's fleet; no post-elaboration or integration is added.
- Smart data: the company applies data processing and data fusion (with third-party datasets) to share insights about what they are interested in with customers.
- Predictive data: By developing Machine Learning (ML) and Deep Learning (DL) algorithms and big data fused with proprietary data, the company can share precise insights and predictive analytics.
- Solutions: Spire can provide data-driven recommendations about specific issues in different kinds of businesses and industries through a deep analysis of several data types.

Data are delivered through a cloud-based Software-as-a-Service (SaaS) platform and Application-Program-Interfaces (APIs).

III. Customers and Markets

Spire Global currently has more than 1.000 Annual Recurring Revenue (ARR) customers (nearly 300% increase from 2020 to 2021); it operates in different industries, including agriculture, logistics, financial services, insurance, aerospace, energy, fishing, academia, and real estate. The largest market verticals are:

- Maritime: Spire provides current and historical data, insights and predictive analytics for ship monitoring, real-time vessel updates, supply chains and port operations, ship safety (monitoring illegal activities and compliances) and route optimisation (for example, optimising fuel efficiencies), commodity trading analysis.
- Aviation: Spire provides global satellite-based aircraft tracking data to power applications, drive decision-making, and improve cost efficiencies. Some examples of applications are flight tracking, estimated time of arrival/on-time performance, air cargo and freight analytics, predictive maintenance, and aircraft management.
- Weather: Spire provides space-based data, AI-powered insights, and predictive weather analytics to empower the world to optimize costs, increase safety, boost decarbonization and make optimal business decisions. Examples of concrete applications are asset protection, crop yields, local weather forecasting, reducing losses and insurance, and minimizing supply chain disruptions.

IV. Manufacturing Process

Spire has clear goals in terms of operations. These goals can be summarized in launching every six weeks, building spacecraft at "volume", reliably and deterministically, quickly, affordably, never missing a launch, and continually building the latest and greatest design.

To do that, Spire uses an iterative approach, called the "Constant New Product Introduction (NPI)" model, based on four different levels of iteration (to be considered as parallel iterations) (Daniel Bryce, Jeroen Cappaert 2019):

- Define & improve the manufacturing model: Spire experimented with different manufacturing models to find the perfect system to achieve its goals:
    - Outsourcing model: this model was based on finding external partners that handle AIT (assembly, integration, and testing) processes, but this did not work well because it was costly, external partners were never as invested as Spire's team, it was too slow for the speed and volume of changes.
    - Build to launch: the model was based on building satellites structurally aligned with the requirements of a specific launch schedule or launch service provider. With this system, the company was too exposed to changes in the launch schedule that meant reworking, rebuilding, and retesting. Furthermore, company flexibility was impacted because they could not move to other launch service providers with other specifications.
    - Build to stock: this model was based on building satellites that enveloped all known launch service providers' requirements. This caused an overstock of old designs while new hardware was already available (because of the need to be aligned with external requirements). Also, this system ended up delaying build start dates.
    - Build to Monte Carlo prediction: Spire developed a Monte-Carlo model of launch pipeline to determine build schedule and procurement needs. The result was negative. The launch schedule was still too unpredictable, and it ended up over-ordering and having too much stock or scrambling and building faster than anticipated.

- Hybrid model: the company adopted this hybrid manufacturing model based on previous experience. In particular, they manufacture batches loosely associated with the launch schedule, and the design is focused on allowing late changes without intrusive rework while all the activities are vertically integrated. This allowed cycle time reduction (>40%), cost reduction (>70%), increase in the quality, perfect track record of on-time time delivery to their launch partners.

- Develop the manufacturing team: initially, manufacturing activities were performed mainly by senior design engineers that followed both build activities and assembly, integration and test (AIT) processes. Spire adopted a de-skilling and automation strategy; in this way, senior engineers could focus only on their core activity, which was successful. Through a transition in staff assigned, where only technicians were involved in AIT activities, the company resulted in a 3x testing capability and a flat yield rate of around 94%.
- Design, Install & maintain the right manufacturing facility: Spire decided to vertically integrate to avoid all the costs associated with manufacturing. In July 2016, Spire bought a 6,000 sq/ft facility, with all the simulators, special chambers, and necessary instruments installed. In December 2016, they delivered the first satellites from this facility.
- Enhance the integrated design and manufacturing process: testing processes are comprehensively tracked to minimise manufacturing risks and quickly identify defaults. This is allowed thanks to Spire Requirements Planning (SRP) software. This in house tool collects and manages data, produces reports, and solves issues about various activities, such as manufacturing requirements planning, product lifecycle management, warehouse management, factory control, and document management.

As it has been described, this model has resulted in a conversion cost reduction of >70%, build cycle time reduction of >40% and, most importantly, increased on-orbit performance and reliability. Also, thanks to this system, Spire today is one of the leaders in the Earth-Observation (EO) market.

5.3. BlackSky Technology (Individual Part – Francesco Gagliano)

I. Profile

BlackSky is an American public company founded in 2014 and based in Seattle. It counts 12 smallsats on Low-Earth-orbit (they expect to add four additional satellites by the end of 2022), and it offers geospatial intelligence solutions for government and commercial applications, providing on-demand and high-frequency monitoring and AI-enabled analytics of the most critical and strategic locations, economic assets, and events on planet Earth.

The company started as a subsidiary of Spaceflight Industries, an aerospace company focused on geospatial intelligence founded in 2009 by Jason Andrews in Virginia.

BlackSky developed and launched the first satellite, BlackSky Pathfinder-1, in September 2016. Two years after, two additional satellites, BlackSky Global-1 and BlackSky Global-2, were launched. In the following year, more BlackSky Globals were operational. The company aims to have a constellation of 60 satellites.

In 2017, BlackSky signed a joint venture partnership with Thales Alenia Space and Telespazio to build BlackSky's constellation. The new company was called LeoStella LLC, and it is currently operative. This partnership was also meaningful because it meant the beginning of the transformation strategy towards the *NewSpace* logic for Thales Alenia Space, intending to become the most important manufacturer of smallsats with a high-revisit rate in Europe and the United States. At the same time, thanks to this partnership, BlackSky made a vertical integration and was to control the design, manufacturing, and operation process.

Along with its constellation, BlackSky owns another operating asset, namely its Spectra AI software platform that processes enormous amounts of data every day from BlackSky's constellation and other third-party data. This software uses mathematical models and ML algorithms to transform these data into insights. Customers can access these data and insights through easy-to-use web services or through platform application programming interfaces ("APIs").

BlackSky counts more than 200 employees. The company's vision is "to build the world's leading geospatial data and analytics platform". Its growth strategy is based on six pillars: increase customer base, expand the customer base, penetrate international markets, extend value proposition, grow distribution channels and channel partner ecosystem, and grow a third-party developer community. At the same time, BlackSky is focused on maintaining its competitive differentiation based on low-cost imagery capture, high-revisit rate, and proprietary intelligence data repository.

II. Products

BlackSky sells imagery and software analytics services delivered through the Spectra AI platform. Two main offerings can be identified:

1. Imagery services include all those offerings related to providing data without integrations or elaborations. In particular:
    - BlackSky On-Demand: customers can access the BlackSky constellation and obtain data regarding specific needs.
    - BlackSky Assured: this solution is for those customers who need continuous monitoring to obtain data.
2. Data, Software, and Analytics: these include all those offerings to provide insights to customers. Insights are the result of data fusion and data processing. In particular:

- BlackSky Detect: through this solution, customers can identify automatically specific elements in images (such as ships, aeroplanes, buildings). With more advanced analysis, BlaclSky can detect evolutions and changes for these elements in the areas of analysis.
- BlackSky Site Monitoring: this solution is perfect for monitoring facilities, critical infrastructure, military bases, construction sites, or other areas of interest.

BlackSky offers flexible pricing and usage plans, such as usage-based pricing, subscriptions and transactional licenses. In this way, customers can use what best suits their business needs. Also, clients can buy solutions based on their priorities; for example, during specific periods, they can pay a premium price to prioritize their monitoring and imagery captures. Customers can opt for lower priority collections to allow for more economical utilization in other moments.

III. Customers and Markets

BlackSky operates in different markets, including energy and utilities, insurance, commodities, mining, manufacturing, logistics, agriculture, and environmental. Examples of applications are production planning, commodities traffic, production rates, and mapping.

The largest customer segment for BlackSky is Government; its main offerings are defence and intelligence, tactical intelligence, surveillance and reconnaissance, and civilian government.

In 2021, 85% of revenues came from the U.S. federal government and agencies, while the remaining 15% was represented by commercial clients from Asia, the Middle East, and other countries.

IV. Manufacturing Process

LeoStella uses Intelligent Manufacturing, which leverages state of the art digital tools and statistical process controls.

This approach relies on a workflow management system that tracks satellite components and hardware. Employees utilize a digital dashboard to ensure that every part is in its correct place at the appropriate time. In this way, the company can also register all of the manufacturing details, and it can do statistical process control to understand where there are areas for improvement.

The facility maximizes efficiency by achieving a capacity of 40 satellites per year through this system. This manufacturing system enables the company to be competitive and produce smallsats faster and faster.

6. Recommendations

Based on the previous analysis, some recommendations have been identified to ensure long-term success. Since the Earth-Observation market if changing rapibly, Busines Model Innovation (BMI) is essential. BMI can provide companies a way to break out of intense competition, under which product or process innovations are easily imitated, competitors' strategies have converged, and sustained advantage is elusive. It can help address disruptions such as regulatory or technological shifts that demand fundamentally new competitive approaches (Lindgardt, Reeves, Stalk, Deimler, 2009).

This section of the report aims to provide four recommendations regarding some of the identified business model vulnerabilities. The intent is not to present recommendations that represent a new business model but rather to improve the current business model components and their robustness.

6.1. Develop a hybrid model for operations (Individual Part – Rita Pereira)

One of the critical sections about EO business models is the use of agile methodologies. Even if EO companies today successfully apply the agile methodology, which helps them in continuous innovative product development, it is not guaranteed that this methodology will bring the same results in a future phase. Actually, the agile method is not well adapted to the business models of large corporations due to a variety of limitations, previously described.

After analysing the business models of Earth-Observation companies, the recommendation is to develop a hybrid approach in view of a mature phase of the market. The hybrid model represents the union of agile principles and waterfall methodology. In this way, it is possible to limit the operative weaknesses of the agile model, such as lacking planning of resources, fragmented output, and difficulty in setting KPIs.

In contrast to the agile methodology, the waterfall method is a traditional system development life cycle model that uses a linear and sequential approach to design a system. This methodology is structured in several phases, in which the output of one phase is used as input for the following phase. In this method, every phase must be completed before the next one begins, and the phases must not overlap. EO firms using the hybrid methodology in the future may see a significant advantage in their business model. Firstly, through a hybrid methodology, EO companies will be able to organise their key resources more efficiently. Thanks to this approach, EO firms would be able to prevent a lack of key resources, resulting in a breakdown of business processes. Secondly, using the hybrid methodology would remove the risk of obtaining a fragmented output at the end of the process because the teams would work sequentially with a highly methodical approach, with the priority being continuous updating of information among teams; in this way, new team members can get up to speed quickly if necessary.

In this case, all company members can be aligned on current priorities and the next steps and goals. Moreover, with the hybrid approach, EO firms could avoid the risk of being unprepared when an unexpected event occurs.

Thirdly, EO companies using the hybrid methodology would be able to define the KPIs of each project clearly. Thanks to the integration with the waterfall method, the hybrid model defines the project objectives from the first phase. This method is ideal for EO companies since many are publicly traded. Indeed, firms must show precise results and be accountable to their investors.

Finally, EO companies should implement the waterfall approach during the planning phase, making it easier to define deadlines and milestones for various projects. At the same time, introducing the agile methodology during the project execution phases, thus having a more flexible approach during the work.

On the other hand, although these variations may improve the business model of EO firms, there are some limitations. The transition from an agile to a hybrid approach takes time, especially for those companies that have always been used to working with a flexible approach rather than a sequential approach. For this reason, this change requires a significant amount of time for a company to reorganise its services and processes and reformulate its priorities. This switch could lead to conflicts and delays within the organisation.

In conclusion, the agile approach brings many advantages to a startup or small company. However, as the company grows, it could turn into a vulnerability. The agile approach is still a good choice since the EO market is growing. On the other hand, there will be a consolidation of the market and EO companies will need to adopt a hybrid approach in order to adapt to this new phase of the market.

6.2. Identify a target customer segment (Individual Part – Rita Pereira)

EO companies do not have a specific target customer segment; This aspect is relevant because segmentation allows a company to learn more about its audience, tailor its messaging to customer needs, and create a customised business solution. Moreover, it can be highly beneficial to the organisation when segmentation is done effectively. Firstly, companies can increase their focus on a specific target to optimise the customer experience thanks to correct segmentation. This aspect is crucial for a company's success in the long-term period because it is necessary to understand and answer the problems and demands of distinct markets. When a company understands its different customer segments, it can offer a superior service. Furthermore, a well-structured customer experience is essential for any enterprise, allowing a firm to offer some levels of personalisation to make potential customers feel understood and valued and prevent alienating them due to misunderstandings or inappropriate offerings.

Furthermore, even if Earth-Observation companies offer services to many different industries, it is still challenging to customise their offers for each client segment where they are involved if there is no specific knowledge in a particular area.

In addition, EO companies focusing on a particular market segment would have the opportunity to get to know their customers better and build a value proposition tailored to them, such as improving algorithm metrics in a specific field. For this reason, firms need to know every aspect of the market in which they operate to create a compelling and consistent value proposition for customers.

Secondly, EO companies, until they decide to focus on specific customer segments, will always be forced to face higher costs. Currently, EO companies operate in different customer segments such as agriculture, government, Forestry, Energy & Natural Resources, insurance and investment banking. Due to this strategic decision, firms are forced to hire professionals with different backgrounds and specialisations.

A specific customer target would reduce costs significantly by adopting tailored marketing communication styles that will naturally decrease the costs of users' interactions, and at the same time, it will also increase the return for each user group. Organisations that can identify distinct segments and tailor their messaging to them will be able to interact with them again, increasing profitability. In addition, having personalized communications for various audience groups will improve how users respond to messages across the customer lifecycle.

Thirdly, another consequence of not focusing on a specific client segment is that developing specific skills becomes increasingly problematic. Understanding the needs of specific customer segments will also help organisations develop specific solutions and skills that are crucial to improving the product development process and increasing results. Moreover, thanks to market segmentation, companies can identify niche products or needs that have not been addressed yet. This would provide enterprises with a competitive advantage, potentially extending their market opportunities.

Although the decision to focus on a single customer segment can bring benefits to the business model of EO companies, there are some aspects to consider. It might be difficult for a corporation to specialize in a single market niche. In fact, the corporation revenues could probably rely exclusively on a single sector. As a result, a market sector collapse would be catastrophic for the company. At the same time, considering EO firms are currently focused on a broad range of industries, most of them different from each other, thorough a further analysis of each sector in which the firms are involved before making this move could mitigate this risk, allowing the company to enjoy the benefits of this risky decision. For this reason, while this strategy could potentially benefit companies who choose to execute it in practice, it represents a step that not all companies in the industry would be willing to take in the short term.

In conclusion, because EO companies offer a product that has become crucial in some sectors, firms should start to specialise in a specific market segment, allowing them to reduce expenses

and provide a higher-quality product and more efficient service across the customer's complete purchasing process.

6.3. Diversify the revenue streams (Individual Part – Rita Pereira)

The third recommendation to overcome the identified vulnerability regarding the reliance solely on a subscription revenue model is to diversify the company's way of generating revenue. As a startup or recent company in the industry, it might be hard to manage one revenue stream at first, but as soon as the company becomes more mature and established in the market, the safer it will be to diversify its revenue streams. The importance of diversifying the revenue streams derives essentially from the following three major aspects:

- Better preparation for economic downfalls and less financial vulnerability: When one revenue stream becomes compromised and sales start to decline, companies are able to resort to other income sources. This gives the company the possibility of having a more stable growth and less risky future when it comes to market fluctuations.
- Increased visibility and market reach: In this case, for companies that have more than one revenue stream, it is easier to get more visibility and awareness and consequently, companies are able to expand their market reach without almost any additional effort.
- Increased effort on exploring new business opportunities: A single revenue stream can distract the company from growth as all resources are channeled to that exclusive income source, and in consequence, this leaves little room to explore other opportunities. By actively sourcing new revenue streams, the company is also dedicating considerable time and energy to exploring new ways of creating value for the end-user.

In this case, combining the subscription business model with one or two additional revenue streams such as licensing, transaction-based sales, or consultancy would be recommended.

Each of these revenue streams already exists in the satellite industry; however, we do not see a combination of them. As opposed to the subscription revenue model, licensing does not foresee a continued innovation in the product or service offered nor ongoing customer service. That said, licensing would be the right fit, for instance, for historical data that does not require constant updates and over the years it is not expected to suffer any major changes. The transaction-based option would be similar to the licensing one, with the only difference being that this last one would be a one-time purchase. Lastly, consultancy would focus on developing tailored solutions to overcome a specific challenge posed by the customer. The satellite company would select a task force with the required knowledge and experience to dig deep into the clients' business. By understanding in detail the clients' value proposition or the challenge faced, the *NewSpace* EO company would be able to provide a customized solution rather than just granting access to their data platforms as they already do with all the other subscribers. We believe that by including this personalized and exclusive type of consultancy services in their revenue model, the *NewSpace* EO companies would benefit even more from their flexible environment and manufacturing process, as this is key to responding to the end-users demands. This recommendation would have considerable impacts and implications on the other business model components. For both licensing and transaction-based revenue streams, the company would be providing the same type of space data but in a different way, meaning that it would not have any impact on the customer value proposition. On the other hand, including consultancy services would mean an extended and differentiated range of data and services provided to the customer, resulting in an extension of the customer value proposition. In terms of market segment, diversifying revenue streams does not necessarily mean that the company would extend their reach to new industries but rather expand its business within the targeted customer segment. Considering this, companies would have an enlarged customer base as they would be able to meet the needs and requirements of a more significant number of customers,

namely, the ones that are still skeptical over the use of space data to be willing to pay for a subscription right away. In terms of cost structure, companies would be less dependent on the subscription model, and therefore, they would not have the constant need to provide extra features and added value to their clients, as the cost would end the moment the service or product is sold. In turn, this would mean that additional investments to improve access to data and insights to keep the customer satisfied would represent a lower percentage of the total costs over time.

Furthermore, consultancy services would imply the acquisition of talent with specific knowledge of the clients' industry. Finally, both resources and activities would need to be adapted in order to reach a successful combination of revenue streams. Once again, offering consultancy services would imply having extra human resources as there would be a need to have specific expertise to develop a tailored solution for a certain business. Alongside, the activities concerning the development and analysis of the data collected would be extended and adapted. While the subscription revenue model allows the clients to have a certain degree of personalization, the consultancy services would provide them with unique insights and data analysis. Finally, concerning limitations, we can state that diversifying revenue streams can hinder the quality of the service provided and increase complexity and mission drift. The revenue stream mix must be totally aligned with the company's mission and long-term strategy to be successful.

6.4. Diversify the team (Individual Part – Rita Pereira)

The fourth recommendation would be to diversify the team. As mentioned before on the cost structure component of business models, the *NewSpace* EO companies' teams include mainly rocket scientists, software engineers and space-related researchers. Diversifying the company in terms of background or areas of study would tackle some of the identified vulnerabilities and

bring an array of advantages to the business model. The negative effects of having a too broad market segment could be diminished if *NewSpace* EO companies had experts in the segments they are targeting. Experts in a specific industry could bring valuable expertise and know-how to the team, improving the quality of the value delivered to the end-user. For instance, having an expert in insurance and banking services would help the companies better to understand the needs and challenges of the sector and bring possible creative and innovative ideas to expand the company's portfolio or new ways to deliver the value proposition. Furthermore, at the same time, employees who work together in a diverse environment can develop and expand their existing skill sets. In fact, this strategy can benefit a company because enhanced skill sets may improve productivity, performance, and quality of work. Employees in a diverse environment could improve essential soft skills such as communication, negotiation, problem-solving, and critical thinking abilities.

On the other hand, diversifying the team would improve the company's problem-solving capabilities and enhance its decision-making process. This is particularly important since *NewSpace* EO companies use an Agile approach that relies on constant iteration and testing. In addition, diversification of group members could foster creativity and innovation, which is an essential variable in this industry. Indeed, creating a team with diverse perspectives, backgrounds, and contributions can facilitate the group in discovering creative solutions to problems. Each team member brings unique perspectives and ideas that more homogeneous teams may miss. With increased team creativity, teams also benefit from improved innovation. Finally, a diversified team would also tackle the unclear customer value proposition vulnerability. Due to the co-existence of different perspectives and mindsets, EO satellite companies could easily reach the end-users of space data and create in some way a degree of proximity and understanding with the client that is not yet so developed. Moreover, bringing

people who do not have any background in space-related studies could also help communicate and engage potential clients unaware of space-data applications.

In terms of impacts on the business models' components, the cost structure would change as the companies would have higher personnel costs deriving from the new hires. However, on the other hand, the company would benefit from increased efficiency, which would then result in the long-term on a decrease in costs related to the service or data provided and a decrease in research and development costs. They would be extended in terms of resources and activities due to this recommendation. Key resources would then also include the team of experts and the potential new data applications and combinations deriving from diversity gains. Considering market segment, similar to the impact on resources and activities, there would be the possibility to expand the targeted segments (further than specific industry verticals) as the company would have the necessary in-house expertise to reach them. In terms of the revenue model, we believe that diversifying the team would not directly impact the revenue streams but would indeed increase the revenues from new clients.

Finally, when it comes to limitations, this recommendation would make more sense to be applied in a more mature phase of the company and not at an early stage of it. *NewSpace* companies are not yet fully established in the market and there are still a lot of business opportunities to be explored and an outstanding need to invest in the development of technical features and applications for space-data.

The authors highlight that hiring new talent from different industries could significantly increase the cost structure and may not mean a direct increase in sales in the short run. Acquiring distinct talent alone is not enough to provide the company with a competitive advantage over the other players. It is essential to find and attract people that fit in the company's culture rather than just trying to have the most skilled candidate. Lastly, over-diversification can negatively

impact the quality of the service provided and, consequently, can affect brand reputation and reliability, two major aspects of being successful and thriving in the market.

7. Conclusions

This report analyzed how the satellite industry has evolved, primarily due to the changes related to the logics of *NewSpace*; new business models were born, and the authors focused on the description of the business model adopted by new satellite companies operating in the Earth-Observation domain. The main components of this business model were analyzed based on the simplified business model framework. The analysis continued with identifying the principal vulnerabilities of this model and recommendations were provided to improve these vulnerabilities, based on the literature and available data, as well as insights from professionals in this field.

To summarize, smallsats, geospatial data, and platforms will drive a fundamental change in how governments and businesses operate. This is part of a broader digital transformation; three specific factors will dominate the Earth-Observation market. The first one is the increasing fusion of datasets from different sensors; this means taking different images from different types of cameras and combining these to build up a better understanding of what is happening than any one set of images could offer; the resulting product is greater than the sum of the parts. The second trend is the shift away from delivering data, like pictures, towards simply delivering real-time on-demand insights. This could be enabled by the combination of communications networks that can move data around the globe in near real-time and advanced analytics that quickly turn that data into answers. The third trend is towards all this becoming more broadly available and easily accessible. Imaging satellites are no more only for governments; interpreting the data no longer requires huge teams of geospatial scientists. New platforms (part of the assets of *NewSpace* satellite companies) will allow the data to be streamed, joined, and

analyzed systematically; therefore, the obstacles to using the data are being removed, allowing for much wider adoption and deeper adoption integration.

The Earth-Observation market is not yet mature, but it is a growing market, mainly thanks to the new smallsats companies that have made services cheaper and insights more precise by re-engineering the business model. The new leaders of this market are mainly American and this is also connected to the fact that there are many American companies in the space industry that facilitate, for example, the launch of satellites and all necessary services in orbit. The history and culture of individual countries have determined different developments in the space industry in distinct parts of the world. However, more and more, it will be necessary to build international legal frameworks on Space to maintain a peaceful Space environment, track and manage Space debris and manage Space commercialization.

To date, the academic literature on the specific topics covered is limited. This means that there is not much academic research that deals with in-depth analyzes of the business models adopted by companies in this phase of commercialization of the Space, called *NewSpace*. For this reason, the primary sources used were the reports produced by the companies that were analyzed based on the research and competences of the authors. Most of the companies present in this market today are public companies, so this has allowed to have a lot of valuable information for analysis. Also, in developing this report, the authors mainly focused on business aspects rather than technological aspects that are critical in the Space industry.

The rapid evolution of *NewSpace* and the growth of this market will still bring many changes. This report has outlined the principal elements and strategic choices helpful in understanding this evolution. There will be more and more academic papers on *NewSpace* and Earth-Observation, and this will lead to ever more complete and structured debates.

The potential of smallsats is immense in terms of benefits they can bring. It was and will be fundamental to re-engineer and improve the business model to make this type of offer even

more sustainable, as also stated by Will Marshall, Cofounder & Chief Executive Officer, Planet Labs "We started Planet because of its potential to aid humanitarian causes, and then we realized that the best way to have that impact and be sustainable was to develop a highly profitable business model ".

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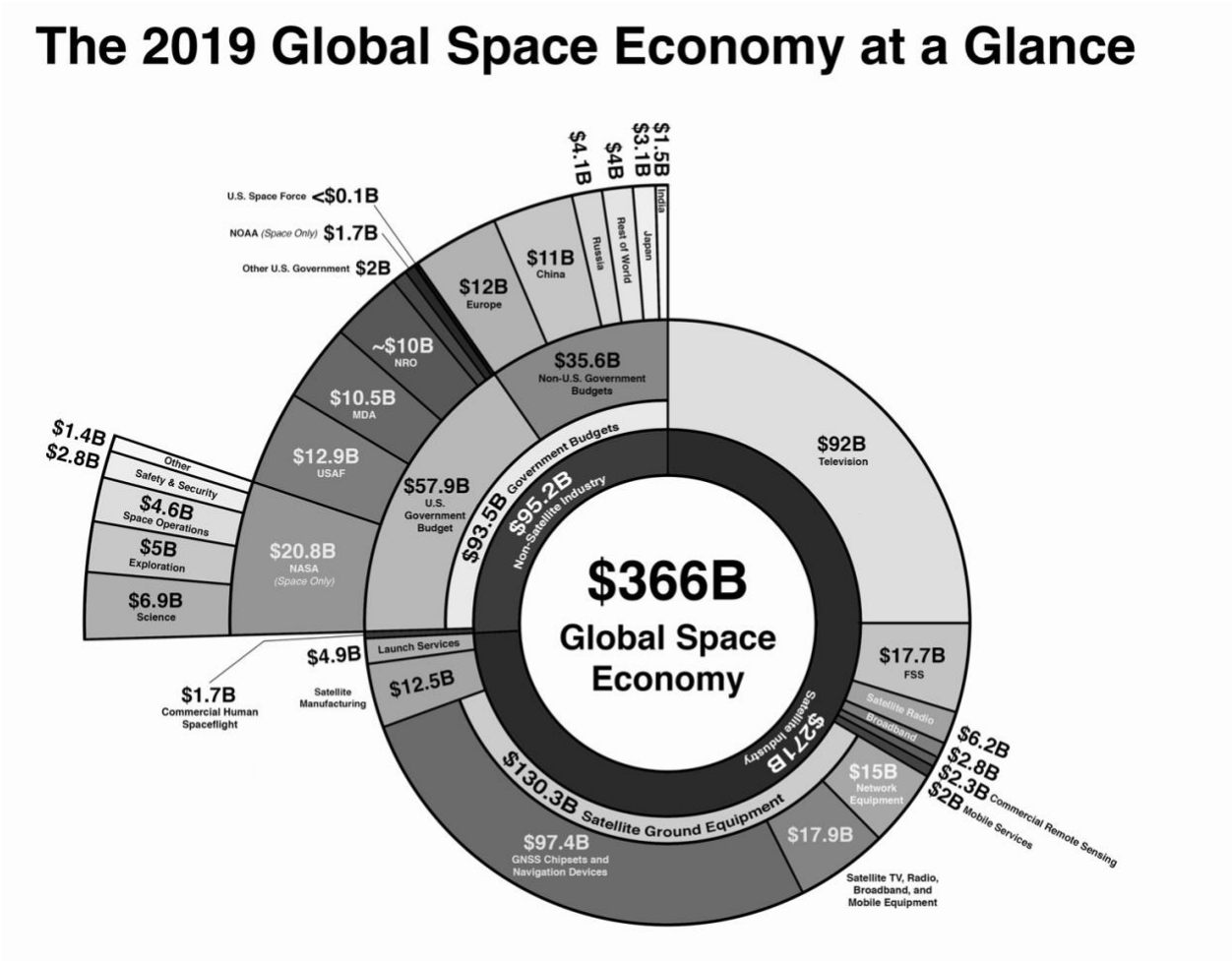
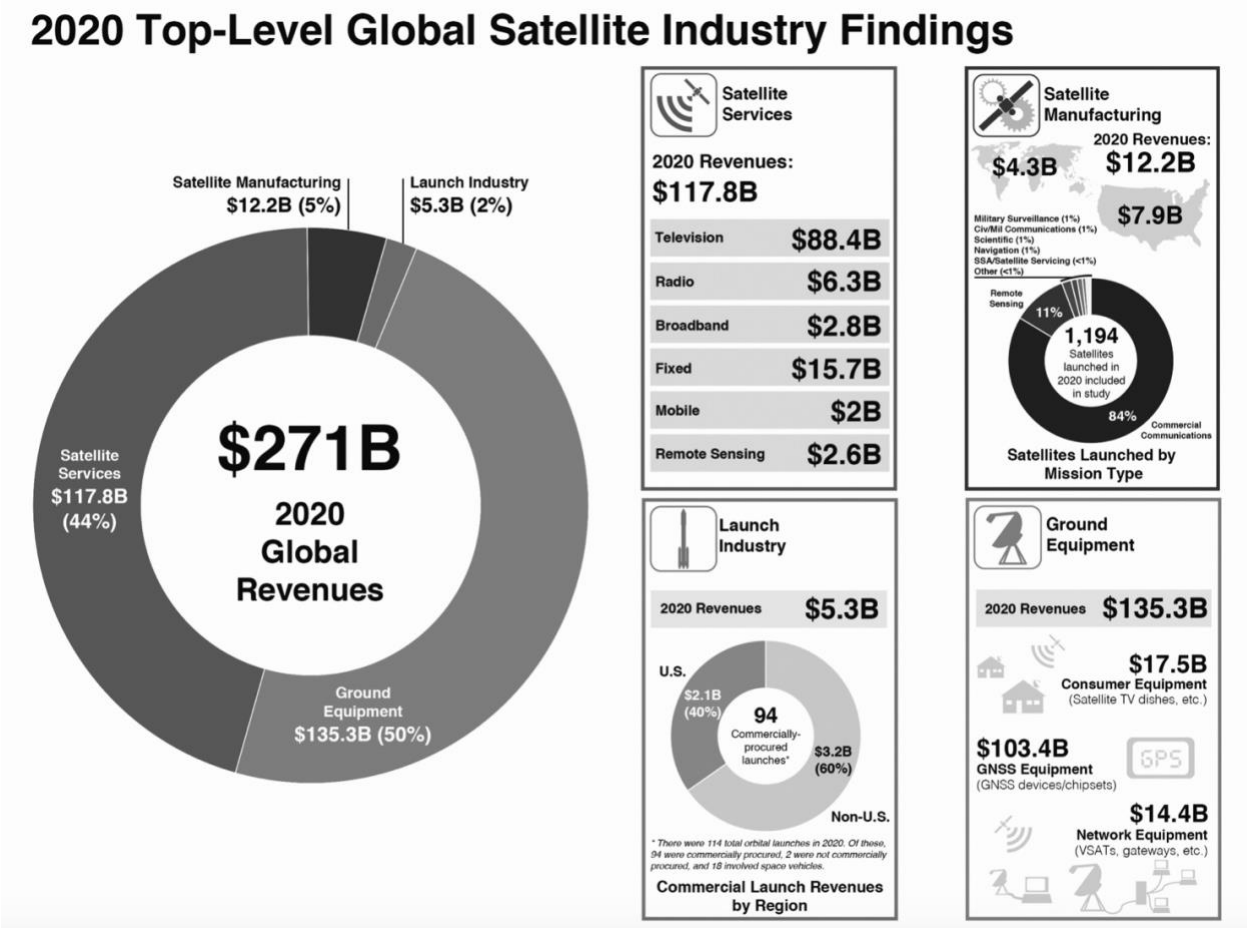
Appendix

Figure 1: The Global Space Economy in 2019



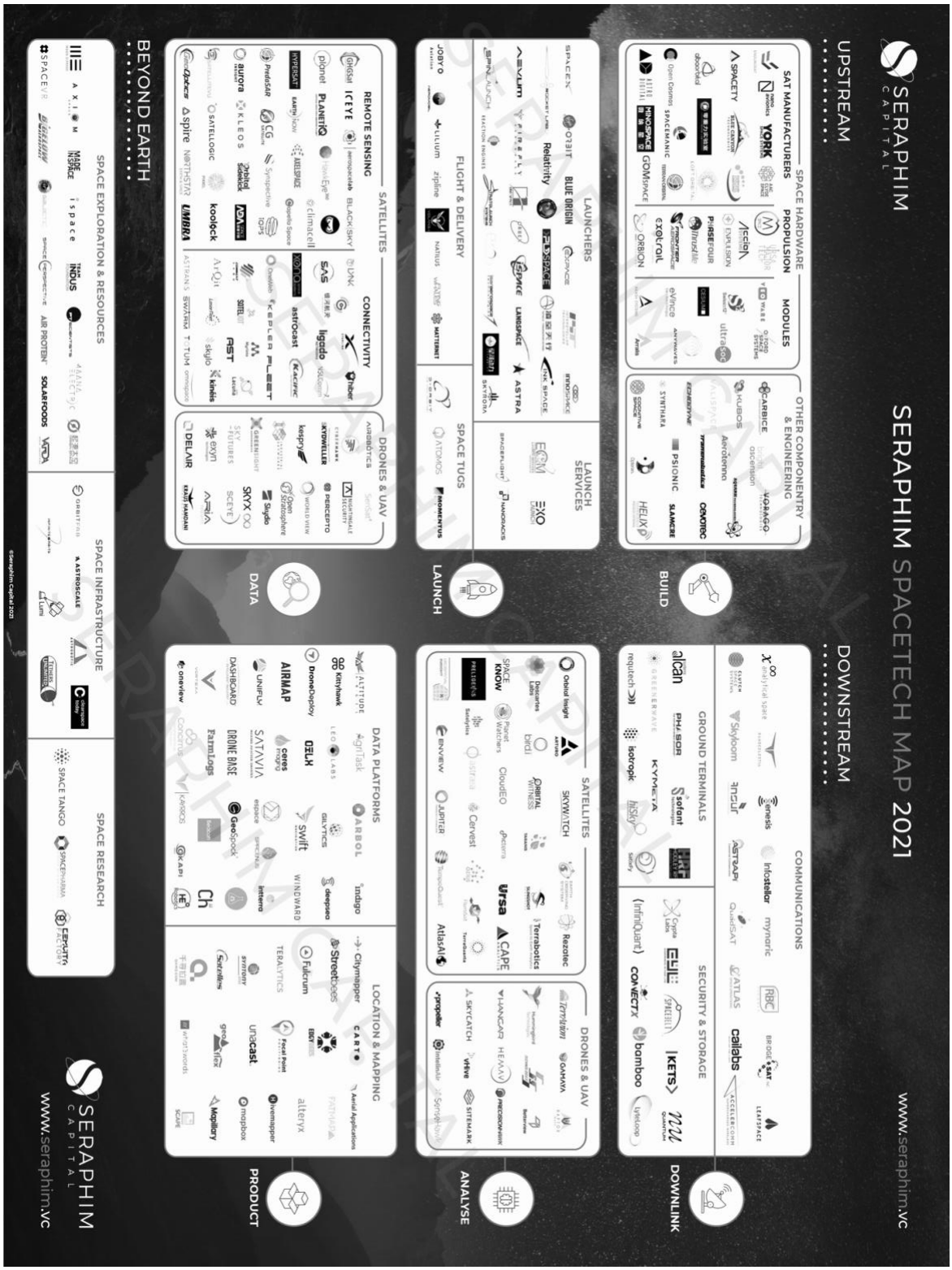
Source: infographic made by BriceTech; «BryceTech - Reports». https://brycetech.com/reports

Figure 2: 2020 Top-Level Global Satellite Industry Findings



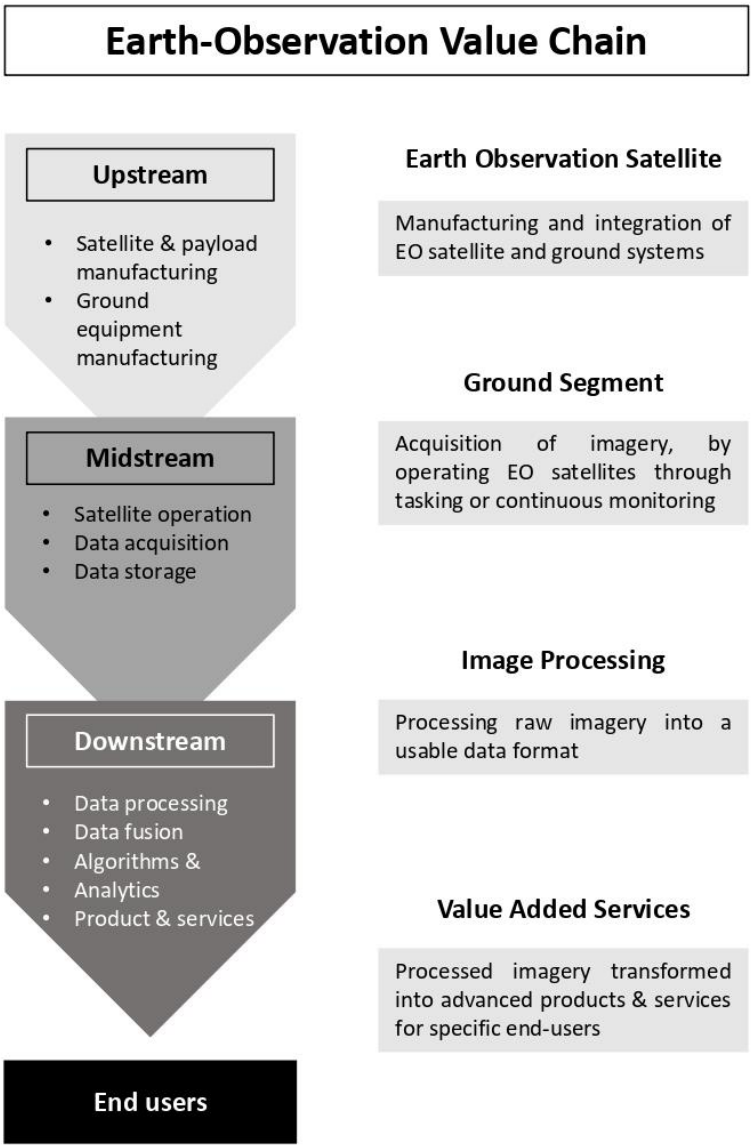
Source: infographic present in the report "State of the Satellite Industry Report - June 2021" published by BriceTech and SIA; «BryceTech - Reports». https://brycetech.com/reports

Figure 3: Spacetech Map 2021 – Industry Segments



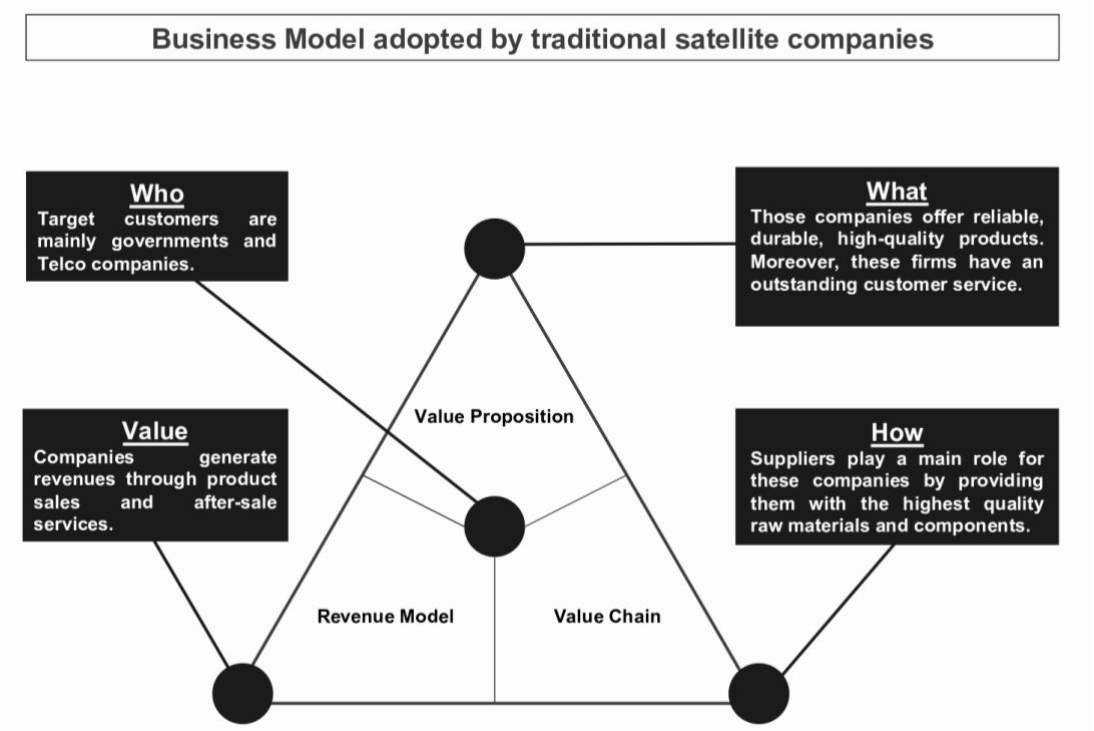
Source: infographic made by Seraphim Space; Seraphim Space. «Research». https://seraphim.vc/category/research/

Figure 4: Earth-Observation Value Chain



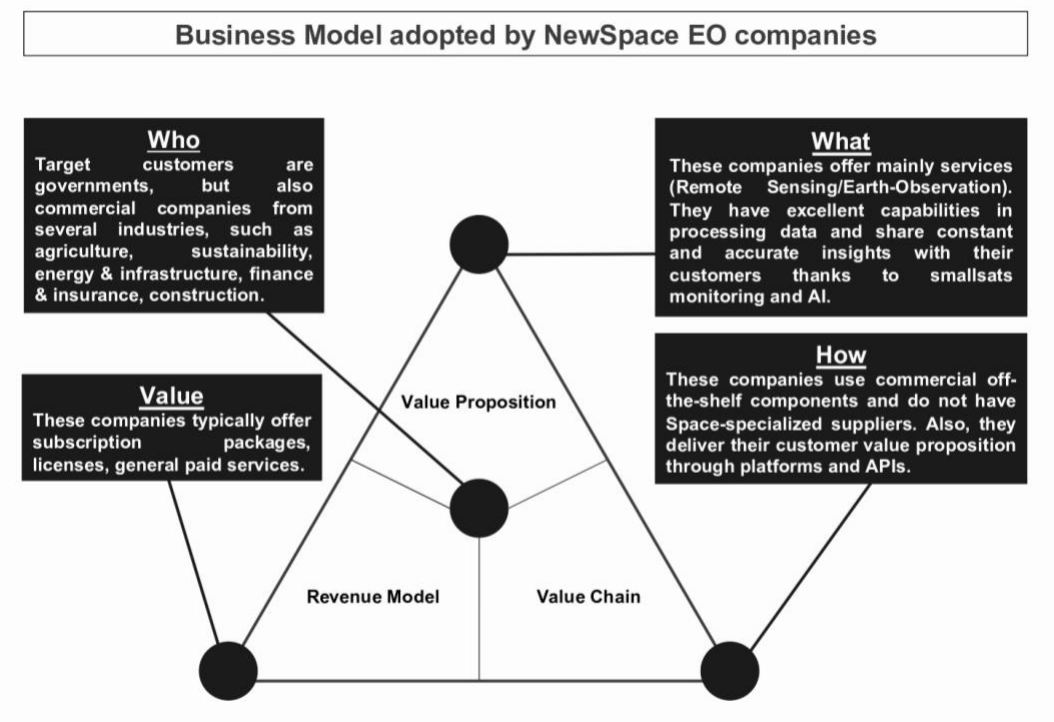
Source: own illustration based on the report "Main Trends & Challenges in the Space Sector- 2nd Edition" published by PwC in December 2020

Figure 5: Business Model adopted by traditional satellite companies



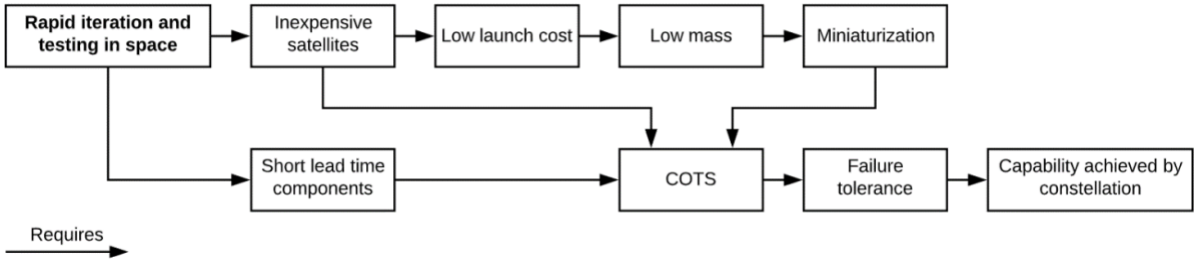
Source: own illustration based on the research of the authors

Figure 6: Business Model adopted by NewSpace EO companies



Source: own illustration based on the research of the authors

Figure 7: Agile Approach of Planet Labs



Source: infographic presented on the article "What is Agile Aerospace? Learn Planet's Approach" published by Ben Howard in 2019. https://www.planet.com/pulse/what-is-agile-aerospace-learn-planets-approach

Table 1: Planet Labs – Financial Highlights Year 2022

Financial Highlights – Planet Labs
Revenue increased 16% from $113.2 million as of January 31, 2021 to $131.2 million as of January 31, 2022.
Full-year gross margin expanded to 37%, compared to 23% in the fiscal year 2021.
Ended the year with $490.8 million in cash and cash equivalents and no debt.
The net dollar retention rate for the entire year (January 31, 2021 - January 31, 2022) was 116%, including wingbacks.
Net Loss $137.1 million as of January 31, 2022, compared to $127.1 million as of January 31, 2021.

Source: «Planet Reports Financial Results for Fourth Quarter and Full Year of Fiscal 2022». https://investors.planet.com/news/news-details/2022/Planet-Reports-Financial-Results-for-Fourth-Quarter-and-Full-Year-of-Fiscal-2022/default.aspx.

Table 2: Spire Global – Financial Highlights Year 2021 (Year Ended December 31)

Financial Highlights – Spire Global
Revenue increased $15.0 million, or 52%, to $43.4 million for the fiscal year 2021, from $28.5 million for the fiscal year 2020.
Full-year gross margin decreased to 57%, compared to 67% in the year-end 2020.
Ended the year with $270.5 million in cash and cash equivalents.
The Annual Recurring Revenue Net Retention Rate (an ARR Net Retention Rate greater than 100% is an indication that the company is growing the value of the solutions its

customers are purchasing from them from a fiscal period end versus the prior fiscal period end) for the fiscal year 2021 was 110%.
Net Loss $19.3 million in year 2021 compared to $32.5 million in year 2020.

Source: Spire Global, Inc. «Spire Global Announces Preliminary Fourth Quarter and Full Year Fiscal 2021 Results; Provides First Quarter and Full Year 2022 Guidance». https://ir.spire.com/news-events/press-releases/detail/100/spire-global-announces-preliminary-fourth-quarter-and-full.

Table 3: BlackSky Technology – Financial Highlights Year 2021

Financial Highlights – BlackSky Technology
Revenue increased $13.0 million, or 61.3%, to $34.1 million for the fiscal year 2021, from $21.1 million for the fiscal year 2020.
Total costs increased $11 million, or 45.6%, to $34.7 million for the fiscal year 2021, from $23.9 million for the fiscal year 2020.
Ended the year with $275 million in cash and cash equivalents.
Net Loss $245.6 million in fiscal year 2021 compared to $19.5 million in in fiscal year 2020.

Source: BlackSky Technology Inc. «BlackSky Reports Fourth Quarter and Full Year 2021 Results». https://ir.blacksky.com/news-events/press-releases/detail/58/blacksky-reports-fourth-quarter-and-full-year-2021-results.